FSWX
Signal and Spectrum Analyzer
User Manual



1179655002
Version 03

ROHDE&SCHWARZ
Make ideas real

This manual applies to the following FSWX models with firmware version 1.20 and later:

- FSWX3026 (1348.0000K21 / 1348.0000K22)
- FSWX3044 (1348.0000K41 / 1348.0000K42)

In addition to the base unit, this manual describes the following FSWX optional hardware and software:

- R&S®FSW3-B2, YIG Preselection (1347.5443.xx)
- R&S®FSW3-B4, OCXO precision frequency reference (1348.6450.xx)
- R&S®FSW3-B5, additional interfaces (1348.3580.02)
- R&S®FSW3-B15X, hardware extension and cross-correlation in Spectrum mode (1347.5537.xx)
- R&S®FSW3-B18, Spare CF Express Card (1347.5543.02) / R&S®FSW3-B20, Removable CF Express Card Drive (1347.5572.02), R&S®FSW3-B20D, Default Internal Solid State Drive (1349.0110.02)
- R&S®FSW3-B24, RF preamplifier (1347.5595.xx)
- R&S®FSW3-B25, Enhanced Electronic Ranging (1348.1093.xx)
- R&S®FSW3-B114, Enhanced Computing Power (1348.4528.xx)
- FSWX bandwidth extension options: R&S®FSW3-B100 (1347.5672.xx / 1347.5689.xx) / R&S®FSW3-B320 (1347.5708.xx / 1347.5714.xx) / R&S®FSW3-B600 (1347.5737.xx / 1347.5743.xx) / R&S®FSW3-B1G2 (1347.5766.xx / 1347.5772.xx) / R&S®FSW3-B2G (1347.5795.xx / 1347.5808.xx) / R&S®FSW3-B4G (1347.5820.xx / 1347.5837.xx)
- R&S®FSW3-KR110 User-defined Frequency Correction by SnP File (1347.8113.xx)
- R&S®FSW3-KR200 External Frontend Control (1347.8107.xx)
- R&S®FSW3-KM135 Cross-Application Control and Triggering (1349.2129.xx)

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Throughout this document, R&S® is indicated as R&S.

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1 Safety and regulatory information

The product documentation helps you use the product safely and efficiently. Follow the instructions provided here and in the following sections.

Intended use

The product is intended for the development, production and verification of electronic components and devices in industrial, administrative, and laboratory environments. Use the product only for its designated purpose. Observe the operating conditions and performance limits stated in the specifications document.

Target audience

The target audience of this document includes developers and technicians, administrators and maintenance personnel performing RF signal measurements. The required skills and experience of the users depend on the test setup and application of the product.

Where do I find safety information?

Safety information is part of the product documentation. It warns you of potential dangers and gives instructions on how to prevent personal injury or damage caused by dangerous situations. Safety information is provided as follows:

- In Section 1.1, "Safety instructions", on page 7. The same information is provided in many languages in printed format. The printed "Safety Instructions" for Mains-Powered Products, Heavy (document number 1171.1788.99) are delivered with the product.
- Throughout the documentation, safety instructions are provided when you need to take care during setup or operation.

1.1 Safety instructions

Products from the Rohde & Schwarz group of companies are manufactured according to the highest technical standards. To use the products safely, follow the instructions provided here and in the product documentation. Keep the product documentation nearby and offer it to other users.

Use the product only for its intended use and within its performance limits. Intended use and limits are described in the product documentation such as the specifications document, manuals and the printed "Safety Instructions" document. If you are unsure about the appropriate use, contact Rohde & Schwarz customer support.

Using the product requires skilled persons or specially trained personnel. These users also need sound knowledge of at least one of the languages in which the user interfaces and the product documentation are available.

Reconfigure or adjust the product only as described in the product documentation or the specifications document. Any other modifications can affect safety and are not permitted.

Never open the casing of the product. Only service personnel authorized by Rohde & Schwarz are allowed to repair the product. If any part of the product is damaged or broken, stop using the product. Contact Rohde & Schwarz customer support at https://www.rohde-schwarz.com/support.

Lifting and carrying the product

The product is heavy. Do not move or carry the product by yourself. A single person can only carry a maximum of 18 kg safely depending on age, gender and physical condition. Look up the maximum weight in the specifications document. Use the product handles to move or carry the product. Do not lift by the accessories mounted on the product. Accessories are not designed to carry the weight of the product.

To move the product safely, you can use lifting or transporting equipment such as lift trucks and forklifts. Follow the instructions provided by the equipment manufacturer.

Choosing the operating site

Only use the product indoors. The product casing is not waterproof. Water that enters can electrically connect the casing with live parts, which can lead to electric shock, serious personal injury or death if you touch the casing.

If Rohde & Schwarz provides accessories designed for outdoor use of your product, e.g. a protective cover, you can use the product outdoors.

You can operate the product up to an altitude of 2000 m above sea level. If a higher altitude is permissible, the value is provided in the specifications document. The product is suitable for pollution degree 2 environments where nonconductive contamination can occur. For more information on environmental conditions such as ambient temperature and humidity, see the specifications document.

Setting up the product

Always place the product on a stable, flat and level surface with the bottom of the product facing down. If the product is designed for different positions, secure the product so that it cannot fall over.

If the product has foldable feet, always fold the feet completely in or out to ensure stability. The feet can collapse if they are not folded out completely or if the product is moved without lifting it. The foldable feet are designed to carry the weight of the product, but not an extra load.

If stacking is possible, keep in mind that a stack of products can fall over and cause injury.

If you mount products in a rack, ensure that the rack has sufficient load capacity and stability. Observe the specifications of the rack manufacturer. Always install the products from the bottom shelf to the top shelf so that the rack stands securely. Secure the product so that it cannot fall off the rack.

Connecting the product

Before connecting the interfaces or measuring inputs of the product to other products or electrical circuits, make sure that the other products or electrical circuits provide special protection against electric shock. This protection principle is referred to as SELV (safety extra-low voltage) and is based on a low voltage level and increased insulation. Exceptions are indicated by a measurement category on the product and given in the specifications document.

Connecting to power

The product is an overvoltage category II product. Connect the product to a fixed installation used to supply energy-consuming equipment such as household appliances and similar loads. Keep in mind that electrically powered products have risks, such as electric shock, fire, personal injury or even death. Replace parts that are relevant to safety only by original parts, e.g. power cables or fuses.

Take the following measures for your safety:

- Before switching on the product, ensure that the voltage and frequency indicated on the product match the available power source. If the power adapter does not adjust automatically, set the correct value and check the rating of the fuse.
- Only use the power cable delivered with the product. It complies with country-specific safety requirements. Only insert the plug into an outlet with protective conductor terminal.
- Only use intact cables and route them carefully so that they cannot be damaged. Check the power cables regularly to ensure that they are undamaged. Also ensure that nobody can trip over loose cables.
- Only connect the product to a power source with a fuse protection of maximum 20 A.
- Ensure that you can disconnect the product from the power source at any time. Pull the power plug to disconnect the product. The power plug must be easily accessible. If the product is integrated into a system that does not meet these requirements, provide an easily accessible circuit breaker at the system level.

Using headphones

Take the following measures to prevent hearing damage. Before using headphones, check the volume and reduce it if necessary. If you monitor varying signal levels, take off the headphones and wait until the signal has settled. Then adjust the volume.

Cleaning the product

Use a dry, lint-free cloth to clean the product. When cleaning, keep in mind that the casing is not waterproof. Do not use liquid cleaning agents.

Meaning of safety labels

Safety labels on the product and its accessories warn against potential hazards.

	Potential hazard Read the product documentation to avoid personal injury or product damage.

	Heavy product Be careful when lifting, moving or carrying the product. Carrying the product requires a sufficient number of persons or transport equipment.

	Electrical hazard Indicates live parts. Risk of electric shock, fire, personal injury or even death.

	Hot surface Do not touch. Risk of skin burns. Risk of fire.

	Protective conductor terminal Connect this terminal to a grounded external conductor or to protective ground. This connection protects you against electric shock if an electric problem occurs.

1.2 Labels on the product

Labels on the casing inform about:

- Personal safety, see "Meaning of safety labels" on page 9
- Product and environment safety, see "Labels regarding product and environment safety" on page 10
- Identification of the product, see Section 3.4.2, "Rear panel view", on page 40

Labels regarding product and environment safety

	Labeling in line with EN 50419 for disposal of electrical and electronic equipment after the product has come to the end of its life.

	Take care when handling electrostatic sensitive devices.

1.3 Warning messages in the documentation

A warning message points out a risk or danger that you need to be aware of. The signal word indicates the severity of the safety hazard and how likely it will occur if you do not follow the safety precautions.

WARNING

Potentially hazardous situation. Could result in death or serious injury if not avoided.

CAUTION

Potentially hazardous situation. Could result in minor or moderate injury if not avoided.

NOTICE

Potential risks of damage. Could result in damage to the supported product or to other property.

1.4 CE declaration of conformity

The CE declaration of conformity of the base unit is delivered with the product. Keep the document for further reference.

The current version of this CE declaration of conformity is available at:

www.rohde-schwarz.com/company-documents/FSWX

1.5 Where to find key documents on Rohde & Schwarz

Certificates issued to Rohde & Schwarz that are relevant for your country are provided at www.rohde-schwarz.com/key-documents, e.g. concerning:

- Quality management
- Environmental management
- Information security management
- Accreditations

2 Documentation overview

This section provides an overview of the FSWX user documentation. Unless specified otherwise, you find the documents at:

https://www.rohde-schwarz.com/manual/FSWX

Further documents are available at:

https://www.rohde-schwarz.com/product/FSWX

2.1 Getting started manual

Introduces the FSWX and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc. A printed version is delivered with the instrument.

2.2 User manuals and help

Separate user manuals are provided for the base unit and the firmware applications:

- Base unit manual
  Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- Firmware application manual
  Contains the description of the specific functions of a firmware application, including remote control commands. Basic information on operating the FSWX is not included.

The contents of the user manuals are available as help in the FSWX. The help offers quick, context-sensitive access to the complete information for the base unit and the firmware applications.

All user manuals are also available for download or for immediate display on the Internet.

2.3 Service manual

Describes the performance test for checking compliance with rated specifications, firmware update, troubleshooting, adjustments, installing options and maintenance.

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS):

2.4 Instrument security procedures

Deals with security issues when working with the FSWX in secure areas. It is available for download on the internet.

2.5 Printed safety instructions

Provides safety information in many languages. The printed document is delivered with the product.

2.6 Specifications and brochures

The specifications document, also known as the data sheet, contains the technical specifications of the FSWX. It also lists the firmware applications and their order numbers, and optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

See https://www.rohde-schwarz.com/brochure-datasheet/FSWX.

2.7 Calibration certificate

The document is available on https://gloris.rohde-schwarz.com/calcert. You need the device ID of your instrument, which you can find on a label on the rear panel.

2.8 Release notes and open-source acknowledgment (OSA)

The release notes list new features, improvements and known issues of the current software version, and describe the software installation.

The software uses several valuable open source software packages. An open source acknowledgment document provides verbatim license texts of the used open source software.

See https://www.rohde-schwarz.com/firmware/FSWX

2.9 Application notes, application cards, white papers, etc.

These documents deal with special applications or background information on particular topics.

See https://www.rohde-schwarz.com/application/FSWX

2.10 Video tutorials

Video tutorials that introduce new features or show you how to perform basic tasks with the FSWX are available on the Rohde & Schwarz internet site:

https://www.rohde-schwarz.com/manual/fswx-tutorial-videos-manuals_78701-1605396.html

Find various videos on Rohde & Schwarz products and test and measurement topics on YouTube: https://www.youtube.com/@Rohde-Schwarz

3 Getting started

3.1 Key features

The FSWX signal and spectrum analyzer sets standards in RF performance and usability. The FSWX provides the following outstanding key features:

- Unmatched phase noise
- Excellent dynamic range
- Widest bandwidth on the market with full image rejection
- Multiple measurement applications can be run and displayed in parallel.
- First signal analyzer with multiple RF input connectors, allowing for:
  - Phase-coherent measurement on multiple signals, such as array antennas for beamforming applications
  - MIMO decoding, such as WLAN or 5G signals
- Split input supported for the widest dynamic range with cross-correlation, allowing for:
  - Detection of small spurs or noise figure measurements with a noise floor close to the physical limit of -174 dBm/Hz
  - Phase noise measurements with suppressed phase noise of the internal LO
  - EVM measurements with an increased signal-to-noise ratio, not limited by the inherent noise of the instrument
- Use of filter banks instead of YIG-preselection, allowing for:
  - Faster sweep speed for spectrum analysis
  - Higher accuracy for level measurements
  - I/Q analysis with image suppression

  (Optional YIG-preselection available.)
- Easy and intuitive to operate via the large touchscreen user interface and optimized user guidance.
- Easy and intuitive setup of
  - Measurements with multi-input instruments
  - Simultaneous measurements
  - Cross-correlation analysis
- SCPI recorder simplifies code generation.
- Integrated support of R&S®NRP-Zxx power sensors

Due to these features, the FSWX is ideal for various measurement tasks, for instance:

- Measuring oscillators for radar and communications applications due to the low phase noise and cross-correlation
- Measuring wideband-modulated or frequency-agile signals due to the large bandwidth. Preselection avoids distortion due to out-of-band interferers and signals at the image frequency.

- Detecting errors caused by interaction between signals by measuring multiple standards simultaneously, even with frequency offsets wider than the analysis bandwidth.
- Phase-coherent inputs for analysis of electronic warfare scenarios, such as jamming
- Measuring very small spurs and interferers
- Measuring noise figures for components such as amplifiers or frequency converting devices
- Two-port component tests, comparing the DUT output with a reference signal

3.2 News for users of previous FSW family instruments

If you are familiar with instruments of the previous FSW family, you will notice the following changes and improvements to operation and handling.

Linux operating system

The FSWX is now based on the Linux operating system, transitioning from the previously used Windows platform. This change brings several significant advantages, including:

- Enhanced security features
- Greater system stability
- Improved performance efficiency

The open-source nature of Linux allows for more customization and flexibility, enabling us to better meet the specific needs of our users. Additionally, this shift supports a broader range of software compatibility and development tools. We are confident that this upgrade provides a more robust and reliable user experience.

Windows-based virtual machine

Optionally, you can use a virtual machine (VM) with a Windows operating system directly on the instrument.

Thus, you can:

- Execute Windows-based scripts, tools and programs
- Transfer files easily between the instrument firmware and a Windows-based host
- Control the instrument remotely from a Windows-based host

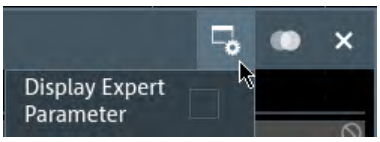
Basic vs. expert parameter display

Some dialogs initially provide only basic parameters to improve readability. If further (expert) parameters are available, an icon is displayed in the dialog title bar.

The basic dialog contains the most important, frequently required settings.

The expert parameters are required for very specific measurement tasks.

Select the icon to display or hide the expert parameters.





If the expert parameters are displayed, the icon is highlighted blue.

Once enabled, the expert settings are displayed in *all* dialogs until you disable the setting again.

You can also enable the expert parameter display by default in the general display settings.

For details, see "Display Expert Parameters" on page 426.

Input assistant

The "Input Assistant" helps you configure the input source for the measurement. The input source determines which data the application analyzes.

The "Input Assistant" dialog contains the most important and frequently used signal parameters for each input source. Detailed parameter views provide additional parameters, in separate tabs. The "Input Assistant" dialog is identical for all applications, for the input sources the application supports.

Multi-input vs split input

For FSWX models with more than one RF input connector ("RF A | B"), you can input 2 different signals at the same time. Some applications can combine multiple signals in one result.

As opposed to providing 2 different signals at separate input connectors, an optional splitter transmits a single input signal to 2 different signal paths. Thus, the same signal can be processed using different parameters. Signal splitting is required for cross-correlation, for example.

For details, see Section 4.1.4.3, "Multi-input and combined input", on page 154.

I/Q Capture and I/Q Spectrum Analyzer applications

The basic "I/Q Capture" application is provided as part of the FSWX base unit. The basic data capturing application allows you to capture signals from multiple connectors simultaneously.

The optional "I/Q Spectrum Analyzer" provides comprehensive data capture, measurement and display functions for I/Q data. The "I/Q Spectrum Analyzer" application requires the I/Q Spectrum Analyzer (R&S FSW3-KM100) license.

For details, see the R&S FSW3-KM100 I/Q Spectrum Analyzer user manual.

For more information on applications, see Section 4.1.1.3, "Available applications", on page 105.

3.3 Preparing for use

Here, you can find basic information about setting up the product for the first time.

3.3.1 Lifting and carrying

For safety information, see "Lifting and carrying the product" on page 8.

The four handles of the product are designed for lifting, carrying, moving or securing the product.

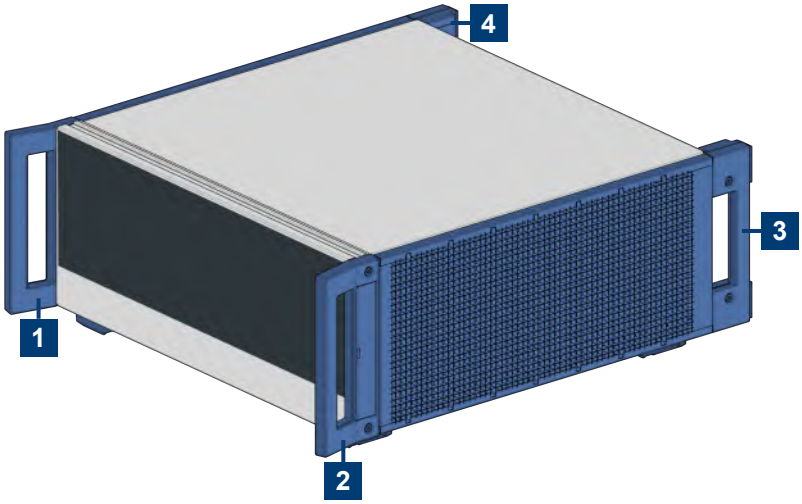


Figure 3-1: Front and rear handles

1, 2 = Front handles
3, 4 = Rear handles

3.3.2 Unpacking and checking

1. Unpack the product carefully.
2. Retain the original packing material. Use it when transporting or shipping the product later.
3. Using the delivery notes, check the equipment for completeness.
4. Check the equipment for damage.

   If the delivery is incomplete or equipment is damaged, contact Rohde & Schwarz.

3.3.3 Choosing the operating site

Specific operating conditions ensure proper operation and avoid damage to the product and connected devices. For information on environmental conditions such as ambient temperature and humidity, see the specifications document.

For safety information, see "Choosing the operating site" on page 8.

Electromagnetic compatibility classes

The electromagnetic compatibility (EMC) class indicates where you can operate the product. The EMC class of the product is given in the specifications document.

- Class B equipment is suitable for use in:
  - Residential environments
  - Environments that are directly connected to a low-voltage supply network that supplies residential buildings
- Class A equipment is intended for use in industrial environments. It can cause radio disturbances in residential environments due to possible conducted and radiated disturbances. It is therefore not suitable for class B environments.
  If class A equipment causes radio disturbances, take appropriate measures to eliminate them.

3.3.4 Setting up the product

For safety information, see:

- "Setting up the product" on page 8
- "Intended use" on page 7

3.3.4.1 Placing the product on a bench top

Place the product on a stable, flat and level surface. Ensure that the bench can support the weight of the product. For information on the weight, see the specifications document.

Allowing sufficient airflow

The air flow of products from Rohde & Schwarz is standardized. If you look at the product from the front, the air is sucked in from the right side and is blown out on the left side.

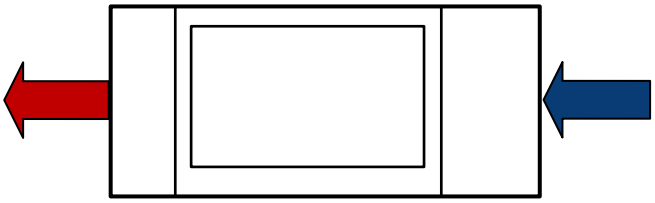


Figure 3-2: Air flow of Rohde & Schwarz products

Allow sufficient airflow because overheating can damage the product. When placing the product on a bench top, observe the following:

- Keep a minimum distance of 10 cm between the fan openings of the product and any object in the vicinity to provide sufficient airflow and ventilation.
- Do not place the product next to heat-generating equipment such as radiators or other products.

Stacking products

If you stack products, consider the following:

- Does the bench support the weight of the stack?
- How much weight can each of the products carry that you want to stack?
- Are the products suited for stacking?

If stacking is not possible, you can mount several products in a rack to save space.

The weight that a Rohde & Schwarz product can carry depends on its own weight.

Our lightweight products that weigh below 18 kg are not built to carry a heavy load. Thus, if you stack products, always place the lightweight product on top of the stack.

Our heavy products that weigh 18 kg and more can carry the following loads:

- 50 kg when a product of identical dimensions is stacked on top (1).
- 25 kg when a product of smaller dimensions is stacked on top (2).

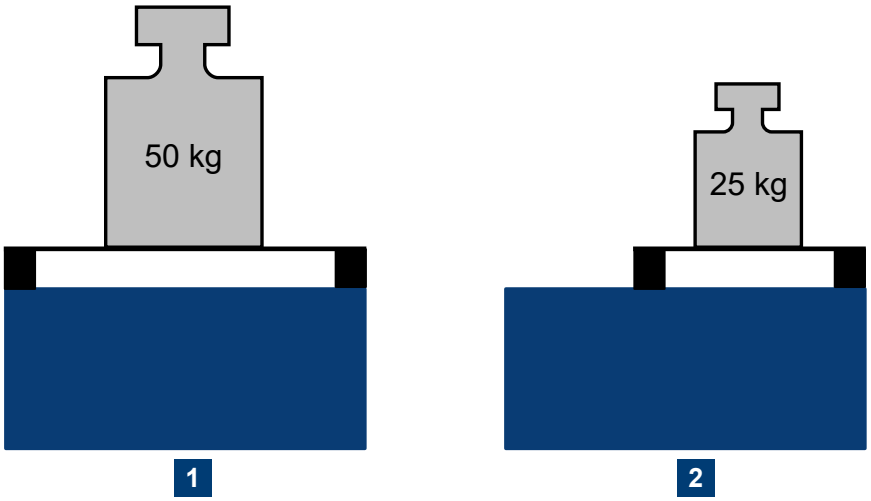


Figure 3-3: Load limits of Rohde & Schwarz heavy-duty products

Products of other manufacturers have other load limits. See the instructions provided by the manufacturer of the product.

To stack products

1. **WARNING!** A stack of products can fall over and cause injury. Never stack more than three products on top of each other. Instead, mount them in a rack.

Build a stable stack:
- If possible, stack products of the same dimensions.
- If the products have different dimensions, stack according to size and weight.

2. Observe the load limit of each product. For example, if the second product in the stack already has the maximum weight that the product beneath can carry, only stack two products.

3.3.4.2 Mounting the product in a rack

To prepare for rack mounting

1. Observe the requirements and instructions in "Setting up the product" on page 8.
2. **NOTICE!** Insufficient airflow can cause overheating and damage the product.
   Design and implement an efficient ventilation concept for the rack.
3. Order the adapter kit designed for the product. For the order numbers, see the specifications document.
4. Using the adapter kit, prepare the rackmount configuration of the product. Follow the assembly instructions provided with the adapter kit.
5. If you use a rack adapter with a telescopic rail, order adapter brackets from Rohde & Schwarz or another manufacturer. These adapter brackets are not part of the adapter kit.
6. If the rack is high, use a safe climbing aid when working on upper shelves.

For information on the airflow of Rohde & Schwarz products, see "Allowing sufficient airflow" on page 19.

To mount the product in a rack

1. **WARNING!** The product is heavy. For safety information, see "Lifting and carrying the product" on page 8.
   Bring the lifting equipment to shelf height.
2. Grip the product by the handles. Slide the product onto the shelf.
3. If you use a rack adapter without a telescopic rail, secure the product as follows:
   a) Position the product so that the rack brackets fit closely to the rack.
   b) Fix all rack bracket screws to the rack with a tightening torque of 2.35 Nm.
4. If you use a rack adapter with a telescopic rail, secure the product as follows:
   a) Mount the adapter brackets on the rack, two on the front and two on the back. The height must match the brackets on the telescope rail.
   b) Position the product so that the front brackets on the telescope rail fit closely to the adapter brackets on the rack.
   c) Screw the front brackets onto the adapter brackets.

d) Adjust the rear brackets on the telescope rail in depth so that they fit closely to the adapter brackets on the rack.
e) Screw the rear brackets onto the adapter brackets.

To unmount the product from a rack

1. Loosen the screws at the rack brackets or adapter brackets.
2. **WARNING!** The product is heavy. For safety information, see "Lifting and carrying the product" on page 8.

   Bring the lifting equipment to shelf height.
3. Remove the product from the shelf.
4. If you want to operate the product on a bench top, prepare the benchtop configuration of the product. Follow the instructions provided with the adapter kit.

3.3.5 Considerations for test setup

For safety information, see "Connecting the product" on page 9.

Cable selection to minimize electromagnetic interference (EMI)

Electromagnetic interference (EMI) can affect the measurement results.

To suppress electromagnetic radiation during operation:

- Use high-quality shielded cables, for example, double-shielded RF and LAN cables.
- Always terminate open cable ends.
- Ensure that connected external devices comply with EMC regulations.

Preventing electrostatic discharge (ESD)

Electrostatic discharge is most likely to occur when you connect or disconnect a DUT.

► **NOTICE!** Electrostatic discharge can damage the electronic components of the product and the device under test (DUT).

Ground yourself to prevent electrostatic discharge damage:

a) Use a wrist strap and cord to connect yourself to ground.
b) Use a conductive floor mat and heel strap combination.

Signal input and output levels

Information on signal levels is provided in the specifications document and on the instrument, next to the connector. Keep the signal levels within the specified ranges to avoid damage to the FSWX and connected devices.

3.3.6 Connecting the AC power

In the standard version, the FSWX is equipped with an AC power supply connector.

The FSWX can be used with different AC power voltages and adapts itself automatically to it. Refer to the specifications document for the requirements of voltage and frequency.

For safety information, see "Connecting to power" on page 9.

Risk of data loss due to voltage surges and dips

High-voltage surges can occur due to various factors such as lightning strikes, power line disturbances, or switching operations in electrical networks. A high-voltage surge at the power connector causes the instrument to reboot. Similarly, a 0 % voltage dip (power failure) with a duration of 10 ms or longer can cause a reboot of the instrument.

Note that after the reboot, the instrument loads the settings that were active before the most recent regular shutdown. Configuration changes are only stored and restored after a reboot if you perform a regular shutdown.

To connect the AC power



1. Plug the AC power cable into the AC power connector on the rear panel of the instrument. Only use the AC power cable delivered with the FSWX.

2. To avoid data loss due to power outage, use an interruption-free power supply. Plug the AC power cable into a power outlet with ground contact.

   The required ratings are listed next to the AC power connector and in the specifications document.

For details on the connector, refer to Section 3.4.2.3, "AC power supply connection and main power switch", on page 43.

3.3.7 Switching the instrument on and off

Table 3-1: Overview of power states

Status	LED on Power key	Position of main power switch
Off	gray	[0]
Standby	orange	[I]
Ready	green	[I]

To switch on the FSWX

Prerequisites:

The FSWX is off but connected to power.

No RF input is connected to the instrument.

1. Set the switch on the power supply to position [I].
   See Section 3.4.2.3, "AC power supply connection and main power switch", on page 43.

   The LED of the "Power" key is orange.

   See Section 3.4.1.1, "Power key", on page 32.

   Note: If the FSWX was disconnected from power before it was switched off regularly, it automatically switches back on when the power is reconnected.
   Using a LAN-controlled power switch, you can take advantage of this behavior to switch the device on and off remotely.

2. Press the "Power" key.
   See Table 3-1.

   The LED changes to green.
   The FSWX boots.

   After booting, the instrument is ready for operation.

Warm-up time for OCXO
When the instrument is switched on, the OCXO requires an extended warm-up time.

To shut down the product

Prerequisites:

The product is in the ready state.

Any RF input is disconnected from the instrument.

► Press the ["Power"] key.

The operating system shuts down. The LED changes to orange. The product changes to standby state.

If the instrument temperature exceeds the limit defined in the specifications document, the FSWX automatically shuts down to protect the instrument from damage.

To disconnect from power

The FSWX is in the standby state.

1. **NOTICE!** Risk of data loss. If you disconnect the product from power when it is in the ready state, you can lose settings and data. Shut it down first.

   Set the switch on the power supply to position [0].
   See Section 3.4.2.3, "AC power supply connection and main power switch", on page 43.

   The LED of the standby key is switched off.

2. Disconnect the FSWX from the power source.

3.3.8 Connecting to RF coaxial connectors

The most common interface used to provide signal input to the FSWX is the RF input 50 ohm connector.

The RF input can be coupled to the DUT by alternating current (AC) or direct current (DC). AC coupling blocks any DC voltage from the input signal. It is the default setting to prevent damage to the instrument. However, some specifications require DC coupling.

In this case, protect the instrument from damaging DC input voltages manually. For example, insert a DC blocker or use a bias tee to bias your DUT and supply the DC input to the instrument. For details, refer to the specifications document.

To prepare for connecting

1. **NOTICE!** Damaged or not clean connections can lead to RF insertion loss and mismatch, and even premature wear of the connectors.

   Before connecting to the port, inspect the RF connector visually. Check that it is clean, undamaged and mechanically compatible.

2. Use a high-quality RF cable that matches the RF connector type. See also Section 3.3.5, "Considerations for test setup", on page 22.

You can connect to two kinds of connectors:

- "To connect to screwable connectors" on page 25
- "To connect to pluggable connectors" on page 25

To connect to screwable connectors

To connect the cable with the connector, proceed as follows:

1. Carefully align the connector of the cable and the connector along a common axis.
2. Mate the connectors along the common axis until the male pin of the inner connector engages with the female socket of the outer connector.
3. Turn the nut of the outer connector until the connectors are firmly coupled.
4. **NOTICE!** Excessive tightening can damage the connectors.

   Do not fasten the 1.00 mm "RF Input" connector with a torque larger than 0.23 Nm. Rohde & Schwarz delivers an appropriate torque wrench with the instrument (R&S®ZN-ZTW Torque 0.23 Nm).
   Using a calibrated torque wrench, torque the nut to the limit. Hold the opposite connector part stationary with a spanner.

To connect to pluggable connectors

The FSWX provides pluggable Bayonet Neill-Concelman (BNC) connectors.

To connect the RF cable with the BNC connector, proceed as follows:

1. Carefully align the connector of the cable and the BNC connector along a common axis.

2. Mate the connectors along the common axis until the male pin of the connector of the cable engages with the female socket of the BNC connector.

3.3.9 Connecting to LAN

You can connect the instrument to a LAN for remote operation via a PC.

For details on the connector, see Section 3.4.2, "Rear panel view", on page 40.

Provided the network administrator has assigned you the appropriate rights and adapted the firewall configuration, you can use the interface, for example:

- To transfer data between a controlling device and the test device, e.g. to run a remote control program.
- To access or control the measurement from a remote computer using the "Device web browser" application (or a similar tool).
- To connect external network devices (e.g. network storage).
- To transfer data from a remote computer and back, e.g. using network folders.

► **NOTICE!** Network environment.
Before connecting the product to a local area network (LAN), consider the following:
- Install the latest firmware to reduce security risks.
- For internet or remote access, use secured connections, if applicable.
- Ensure that the network settings comply with the security policies of your company. Contact your local system administrator or IT department before connecting your product to your company LAN.
- When connected to the LAN, the product may potentially be accessed from the internet, which may be a security risk. For example, attackers might misuse or damage the product.

Connect the FSWX to the LAN via the LAN interface on the rear panel of the instrument.

The operating system automatically detects the network connection and activates the required drivers.

By default, the FSWX is configured to use DHCP and no static IP address is configured.



The default instrument name is <type>-<variant>-<serial_number>, for example, FSWX3-41-123456. For information on determining the serial number, see Section 3.4.2.1, "Device ID", on page 42.

For more information on LAN configuration, see Section 4.13.6, "How to set up a network and remote control", on page 526.

3.3.10 Exchanging a removable system hard disk (CFexpress)

The (optional) removable system hard disk ("CFexpress") contains all operating system, firmware, measurement and user data from the FSWX, allowing you to store the data securely in an external location.

To exchange the system hard disk

Prerequisite: The instrument is switched off. See "To shut down the product" on page 24.

Do not remove the hard disk during instrument operation. To ensure flawless operation, the instrument firmware must be able to access the hard disk at all times. After switching off the instrument, you can remove the hard disk safely.

1. Remove the two screws on the CFexpress retainer and the retainer itself.



2. Press the CFexpress hard disk lightly to release it from the drive.
3. Pull out the hard disk from the drive.
4. Insert the other hard disk in the drive.
5. Press the hard disk until you feel it snap into place.
6. Replace the retainer and fasten the two screws.
7. Start the instrument.

We recommend performing a self-alignment after exchanging the system hard disk.

3.3.11 Connecting a USB storage device

You can connect or disconnect all USB devices from the FSWX during operation.

Using USB storage devices can be restricted in the operating system settings for security reasons. Depending on the settings, possibly you can only read data but not store it on the USB storage device, or the use of USB storage devices is disabled entirely.

To check the settings, select "Open Settings" in the "Removable Devices" dialog, see below.

For details, see "USB Storage" on page 472.

To connect USB storage devices

USB storage devices, such as memory sticks, allow you to transfer data from or to the FSWX. You can also use them for firmware updates.

► Connect the USB storage device to any of the USB connectors.

The FSWX automatically detects a USB storage device when you connect it. In the File Manager, the device is mapped to the run/media/instrument/usb/ directory.

To disconnect a USB storage device

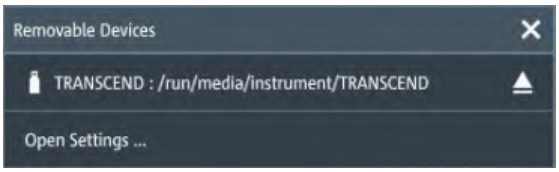
Before you remove the USB storage device from the instrument, you should unmount it to avoid data loss or corrupt data on the device.



1. To access the operating system, select the "Operating system" icon.
2. From the operating system task bar, select the "Removable devices" icon.



3. Select the "unmount" entry for the USB device you want to remove.



After a message confirms that the device was successfully unmounted, you can remove it safely.

3.3.12 Connecting a keyboard

The FSWX automatically detects a keyboard when you connect it. The default input language is English (US). However, you can also connect foreign-language keyboards.

Currently, the FSWX supports the following languages:

- English (US)
- German (DE)

To configure the keyboard language



1. To access the operating system, select the "Operating system" icon.
2. Select "Keyboard".

For details, see Section 4.12.3.4, "Keyboard settings", on page 466.

3.3.13 Connecting an external monitor

You can connect an external monitor (or projector) to the "HDMI" or "Display port" connector on the rear panel of the FSWX. See also Section 3.4.2, "Rear panel view", on page 40 and Section 3.4.2.6, "Display Port and HDMI display connectors", on page 44.

Screen resolution and format

The touchscreen of the FSWX is calibrated for a 16:10 format. If you connect a monitor or projector using a different format (e.g. 4:3), the calibration is not correct and the screen does not react to your touch actions properly.

The screen has a resolution of 1280x800 pixels. By default, the display of the external monitor is a duplicate of the instrument's monitor.

If you configure the external monitor to be used as the *only* display in the system configuration dialog ("Show only on 2"), the maximum screen resolution of the monitor is used. In this case, you can maximize the FSWX application window and see even more details. You cannot change the monitor's screen resolution via the standard system configuration dialog.

The FSWX supports a minimum resolution of 1280x768 pixels.

3.3.14 Operating system

The instrument contains the R&S Linux operating system which has been configured according to the instrument's features and needs. You only have to change the system setupto install peripherals like a keyboard or a printer, or if your network configuration does not comply with the default settings. After the FSWX is started, the operating system boots and the instrument firmware is started automatically.

To access the operating system menu

The operating system menu provides access to the R&S Linux functionality and installed programs.



► Select "Operating system" in the toolbar.

The operating system menu is displayed.

You can access all system settings and functions from the operating system menu.

For available settings and functions, see Section 4.12, "System settings and functions", on page 461.

3.3.15 Logging on

R&S Linux requires that users identify themselves by entering a user name and password in a login window. By default, the FSWX provides the following user accounts:

The operating system requires that users identify themselves by entering a user name and password in a login window. By default, the instrument provides the following user accounts:

- **"instrument"**: a standard user account with limited access
- **"security"**: a user account with special rights, e.g. for firewall or security settings
- **"VNC"**: a special user account to access the instrument via vnc (including the "Device web browser" application).

Passwords

For all default user accounts, the initial password is *894129*. Note that this password is very weak, and it is recommended that you change the password for all users after initial login.

Some settings that are relevant for security, e.g. firewall settings, require a security password.

For details, see Section 4.12.3.6, "Password Manager", on page 469.

Auto-login

When shipped, the instrument automatically logs on the default "Instrument" user to R&S Linux (with full access) using the default password.

3.3.16 Checking the supplied options

The instrument can be equipped with both hardware and firmware options. To check whether the installed options correspond to the options indicated on the delivery note, proceed as follows.

1. Select "Setup".
2. Select "Instrument Configuration" > "Versions + Options".

   A list with hardware and firmware information is displayed.
3. Check the availability of the hardware options as indicated in the delivery note.

3.3.17 Performing a self-alignment

When temperature changes occur in the environment of the FSWX, or after updating the firmware, you have to perform a self-alignment to align the data to a reference source.

During self-alignment, do not connect any signals to any of the RF input connectors. Running a self-alignment with a signal connected to one of the RF input cconnectors can lead to false measurement results.

Performing a self-alignment

Before performing this alignment, make sure that the instrument has reached its operating temperature (for details, refer to the specifications document).

A message in the status bar ("Instrument warming up...") indicates that the operating temperature has not yet been reached.

Depending on the installation settings, an automatic self-alignment is performed after installation. A dialog is displayed indicating how much warm-up time is still required before self-alignment can be performed.

► Select "Setup" > "Alignment" > "Start Self-Alignment".

Once the system correction values have been calculated successfully, a message is displayed.

To display the alignment results again later

► Select "Setup" > "Alignment".

3.4 Instrument tour

3.4.1 Front panel view

This section describes the front panel, including all function keys and connectors.



Figure 3-4: Front panel view of FSWX

1 = Power key
2 = Touchscreen
3 = Numeric keypad
4 = Function keys
5 = Navigation controls
6 = USB connectors
7 = System keys
8 = Trigger input / output
9 = Headphones connector (Phones)
10 = Noise source control and power sensor
11 = Fast access knobs
12 = RF input 50 ohm

3.4.1.1 Power key



The power key is on the lower left corner of the front panel. It starts up and shuts down the instrument.

See also "Connecting to power" on page 9 and Section 3.3.7, "Switching the instrument on and off", on page 23.

3.4.1.2 Touchscreen

All measurement results are displayed on the screen on the front panel. Additionally, the screen display provides status and setting information and allows you to switch between various measurement tasks. The screen is touch-sensitive, offering an alternative means of user interaction for quick and easy handling of the instrument.

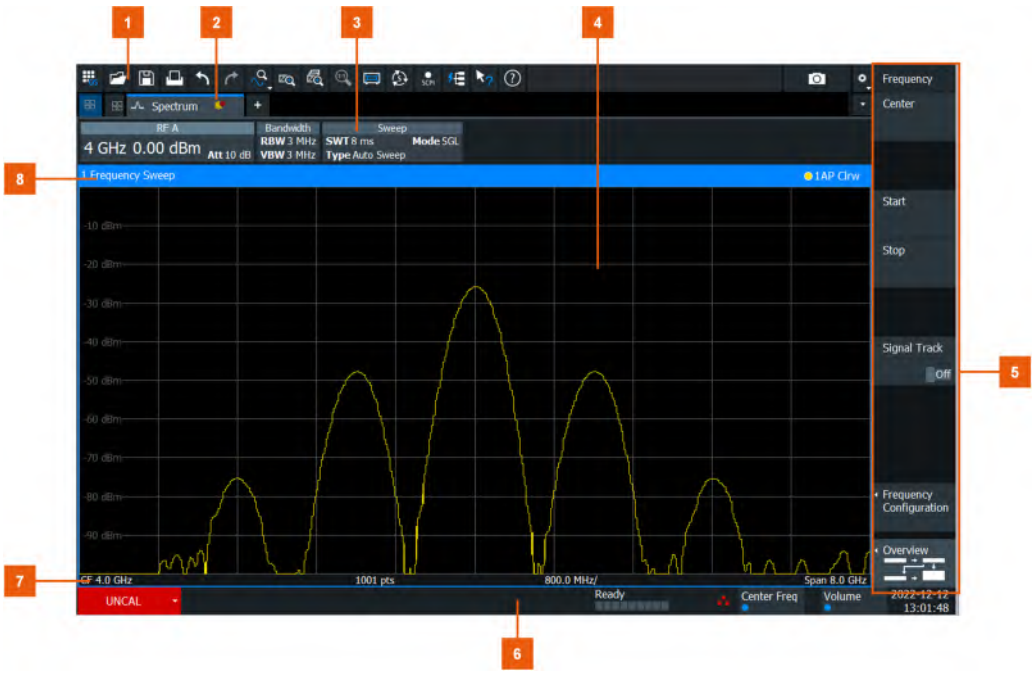


Figure 3-5: Touchscreen elements

1 = Toolbar with standard application functions, e.g. print, save/open file etc.
2 = Tabs for individual application instances
3 = Application info panel for application-specific settings
4 = Measurement results area
5 = Softkeys for function access
6 = Instrument status bar with error messages, progress bar and date/time display
7 = Diagram footer with diagram-specific information, depending on application
8 = Window title bar with diagram-specific (trace) information

Any user interface elements that react to a click by a mouse pointer also react to a tap on the screen, and vice versa. Using touchscreen gestures, you can perform the following tasks (among others):

- Changing a setting
- Changing the display
- Moving a marker
- Zooming into a diagram
- Selecting a new evaluation method
- Scrolling through a result list or table
- Saving or printing results and settings

To imitate a right-click by mouse using the touchscreen, for example to open a context-sensitive menu for a specific item, press the screen for about 1 second.

For details on touchscreen gestures, see "Touchscreen" on page 86.

3.4.1.3 Numeric keypad

The numeric keypad is used to enter numeric parameters, including the corresponding units (see also "To enter numeric parameters using the touchscreen and the front panel operating controls" on page 97). It contains the following keys:

Numeric keys
Enter numbers in edit dialogs.

Decimal point
Inserts a decimal point "." at the cursor position.

Sign key
Changes the sign of a numeric parameter. Inserts a "-" at the cursor position.

Unit keys (GHz/-dBm MHz/dBm, kHz/dB and Hz/dB)
Adds the selected unit to the entered numeric value and completes the entry.

For level entries (e.g. in dB) or dimensionless values, all units have the value "1" as the multiplying factor. Thus, the unit keys have the same function as an Enter key.

[Esc] key
Closes all kinds of dialogs, if the edit mode is not active. Quits the edit mode, if the edit mode is active. In dialogs that contain a "Cancel" button, it selects that function.

For edit dialogs the following mechanism is used:

- If data entry has been started, it retains the original value and closes the dialog.
- If data entry has not been started or has been completed, it closes the dialog.

Backspace key
If an alphanumeric entry has already been started, this key deletes the character to the left of the cursor.

↵(Enter) key
- Concludes the entry of dimensionless entries. The new value is accepted.
- With other entries, this key can be used instead of the "Hz/dB" unit key.
- In a dialog, selects the default or focused element.

3.4.1.4 Function keys

Function keys provide access to the most common measurement settings and functions.

A detailed description of the corresponding functions is provided in the FSWX User Manual.

Basic measurement settings

[Freq]
Sets the center frequency and the start and stop frequencies for the frequency range under consideration. This key is also used to set the frequency offset and the signal track function.

[Span]
Sets the frequency span to be analyzed.

[Ampt / Scale]
Sets the reference level, the displayed dynamic range, the RF attenuation and the unit for the level display.

Sets the level offset and the input impedance.

Activates the optional preamplifier.

[Autoset]
Enables automatic settings for level, frequency or sweep type mode.

[BW]
Sets the resolution bandwidth and the video bandwidth.

[Sweep]
Sets the sweep time and the number of measurement points.

Selects continuous measurement or single measurement.

[Trace]
Configures the measured data acquisition and the analysis of the measurement data.

[Trigger]
Sets the trigger mode, the trigger threshold, the trigger delay, and the gate configuration for gated sweep.

Marker functions

[Marker]
Sets and positions the absolute and relative measurement markers (markers and delta markers).

[Peak Search]
Performs a peak search for the active marker. If no marker is active, normal marker 1 is activated and the peak search is performed for it.

[Marker Function]
Provides additional analysis functions of the measurement markers:
- Frequency counter (Sig Count)
- Fixed reference point for relative measurement markers (Ref Fixed)
- Noise marker (Noise Meas)
- Phase noise (Phase Noise)
- n dB down function
- AM/FM audio demodulation
- Peak list

[Marker ->]
Used for search functions of the measurement markers (maximum/minimum of the trace).

Assigns the marker frequency to the center frequency, and the marker level to the reference level.

Restricts the search area (Search Limits) and characterizes the maximum points and minimum points (Peak Excursion).

Measurement and evaluation functions

[Meas]
Provides the measurement functions.
- Measurement of multicarrier adjacent channel power (Ch Power ACLR)
- Carrier to noise spacing (C/N C/N_0)
- Occupied bandwidth (OBW)
- Spectrum emission mask measurement (Spectrum Emission Mask)
- Spurious emissions (Spurious Emissions)
- Measurement of time domain power (Time Domain Power)
- Signal statistics: amplitude probability distribution (APD) and cumulative complementary distribution function (CCDF)
- Third-order intercept point (TOI)
- AM modulation depth (AM Mod Depth)

[Meas Config]
Used to define measurement configuration.

[Lines]
Configures display lines and limit lines.

[Input/Output]
Displays softkeys for input/output functions.

Measurement start functions

[Run Single]
Starts a single new measurement (Single Sweep Mode).

[Run Cont]
Starts a continuous measurement (Continuous Sweep Mode).

Function execution (in navigation controls area)

[Undo]
Reverts last operation.

[Redo]
Repeats previously reverted operation.

3.4.1.5 Navigation controls

The navigation controls include a rotary knob, navigation keys, and Undo / Redo keys. They allow you to navigate within the display or within dialogs.

Navigating in tables
The easiest way to navigate within tables (both in result tables and configuration tables) is to scroll through the entries with your finger on the touchscreen.

Rotary knob



The rotary knob has several functions:

- For numeric entries: increments (clockwise direction) or decrements (counterclockwise direction) the instrument parameter at a defined step size
- In lists: toggles between entries
- For markers, limit lines, and other graphical elements on the screen: moves their position
- For active scrollbars: moves the scrollbar vertically

- For dialogs: Same effect as the Enter key when pressed

In addition to the main rotary knob in the navigation control area, two rotary knobs are available among the connectors for user-defined functions. See Section 3.4.1.11, "Fast access knobs", on page 39.

Navigation keys

You can use the navigation keys as an alternative to the rotary knob to navigate through dialogs, diagrams or tables.

Arrow Up/Arrow Down Keys

The <arrow up> or <arrow down> keys do the following:

- For numeric entries: increments (Arrow Up) or decrements (Arrow Down) the instrument parameter at a defined step size
- In a list: scrolls forward and backward through the list entries
- In a table: moves the selection bar vertically
- In windows or dialogs with a vertical scrollbar: moves the scrollbar

Arrow Left/Arrow Right Keys

The <arrow left> or <arrow right> keys do the following:

- In an alphanumeric edit dialog, move the cursor.
- In a list, scroll forward and backward through the list entries.
- In a table, move the selection bar horizontally.
- In windows or dialogs with horizontal scrollbar, move the scrollbar.

Undo/Redo keys

- [Undo] reverts the previous action, i.e. the state before the previous action is retrieved.
  The undo function is useful, for example, if you accidentally select a different measurement. In this case, many settings are lost. However, if you press [Undo] immediately afterwards, the previous state is retrieved, i.e. the previous measurement and all settings.
- [Redo] repeats the previously reverted action, i.e. the most recent action is repeated.

The [Undo] function is not available after a "Preset" or "Recall" operation. When you use these functions, the history of previous actions is deleted.

3.4.1.6 USB

The front panel provides four female USB connectors (two USB-A, two USB-C) to connect devices like a keyboard or a mouse. In addition, a memory stick can be connected to store and reload instrument settings and measurement data.

The rear panel provides further USB connectors. See Section 3.4.2.5, "USB", on page 43.

The connectors on the front panel support the following standards:

- USB-A: 3.2 Gen 1
- USB-C: 3.2 Gen 1

3.4.1.7 System keys

System keys set the instrument to a predefined state and change basic settings.

Table 3-2: System keys

System key	Assigned functions
[App Preset]	Resets the active application to its default state.
[Preset]	Resets the instrument to the default state.
[Mode]	Provides a selection of available applications.
	Provides basic instrument configuration functions, e.g.: ● Reference frequency (external/internal), noise source ● Transducer and (optional) frequency response correction ● Display configuration ● Self-alignment ● Parameter coupling ● Network and remote operation settings ● Firmware update and enabling of options ● Information about instrument configuration incl. firmware version and system error messages ● Service support functions (self-test etc.)
	Configurable [Favorites] key for quick access to frequently used functions. Currently, this key is not yet configurable, but opens the "Recall" dialog. Also note the two configurable fast access knobs that are available for frequently required functions. See Section 3.4.1.11, "Fast access knobs", on page 39.

3.4.1.8 Trigger input / output

Use the female "Trigger Input" connector to input an external trigger or gate data. Thus, you can control the measurement using an external signal. The voltage levels can range from 0.5 V to 3.5 V. The default value is 1.4 V. The typical input impedance is 10 kΩ.

Use the female BNC "Trigger Input / Output" connector to receive a second external signal or to provide a signal to another device. The signal is TTL compatible (0 V / 5 V). You control the connector usage in the "Trigger In/Out" settings ([Trigger] key).

The rear panel provides one more "Trigger Input" and one more "Trigger Input / Output" connector, see Section 3.4.2.11, "Trigger Input/ Output", on page 45.

3.4.1.9 Phones

You can use headphones to monitor demodulated audio frequencies in time domain measurements acoustically.

Connect headphones equipped with a miniature jack plug to the "Phones" female connector. If a headphone is plugged into the instrument, the internal loudspeaker is automatically switched off.

To set the volume:

- Use the right fast-access knob (see Section 3.4.1.11, "Fast access knobs", on page 39)
- Open the "Markers" or "Output Configuration" dialog.

See also "Using headphones" on page 9.

3.4.1.10 Noise source control and power sensor

The Lemosa female connector is used to connect Rohde & Schwarz power sensors, but also smart noise sources. For a detailed list of supported sensors and smart noise sources, see the specifications document.

For details on configuring and using power sensors, see Section 4.2.3.4, "How to work with a power sensor", on page 199.

A smart noise source (SNS) provides its own ENR and uncertainty tables and a temperature value from an internal measurement. Thus, accuracy is improved and less configuration effort is required compared to common noise sources.

Connect the smart noise source to the Lemosa "Noise Source Control" / "Power Sensor" connector on the FSWX. Then connect the SNS output to the DUT or the "RF A | B" connector on the FSWX.

When you connect a smart noise source, the FSWX automatically loads its ENR table and stores it for future measurements. The ENR table remains stored on the instrument even after the noise source is disconnected. If the table already exists on the FSWX, the contents are updated, if necessary. The identification and setup procedure after connecting the R&S FS-SNS can take up to 10 seconds.

For details on Rohde & Schwarz smart noise sources, see the product documentation.

3.4.1.11 Fast access knobs

The two knobs on the front panel provide fast access to a user-configurable set of settings. Using the knobs, you can change these settings without blocking the screen with dialogs. You can assign several different functions to each knob. The currently active assigned function is indicated above the knobs on the touchscreen.



By default, the "Center Frequency" is accessible via the left knob, the "Volume" for the audio output is accessible via the right knob.

For a comprehensive description of the fast access knobs, see Section 3.6.5.6, "Fast access knobs", on page 93.

3.4.1.12 RF input 50 ohm

Provides RF input from a connected device under test (DUT) to the FSWX, which is then analyzed in an RF measurement. Switch on the FSWX before you connect the DUT to one of the RF input connectors on the front panel. Disconnect the RF input before switching off the instrument. Do not overload the input. For maximum allowed values, see the specifications document.



An LED next to the connector lights up when the input connector is activated for a measurement.

For more information on connecting devices to this input, see Section 3.3.8, "Connecting to RF coaxial connectors", on page 25.

See also Section 3.3.5, "Considerations for test setup", on page 22.

3.4.2 Rear panel view

This figure shows the rear panel view of the FSWX. The individual elements are described in more detail in the subsequent sections.

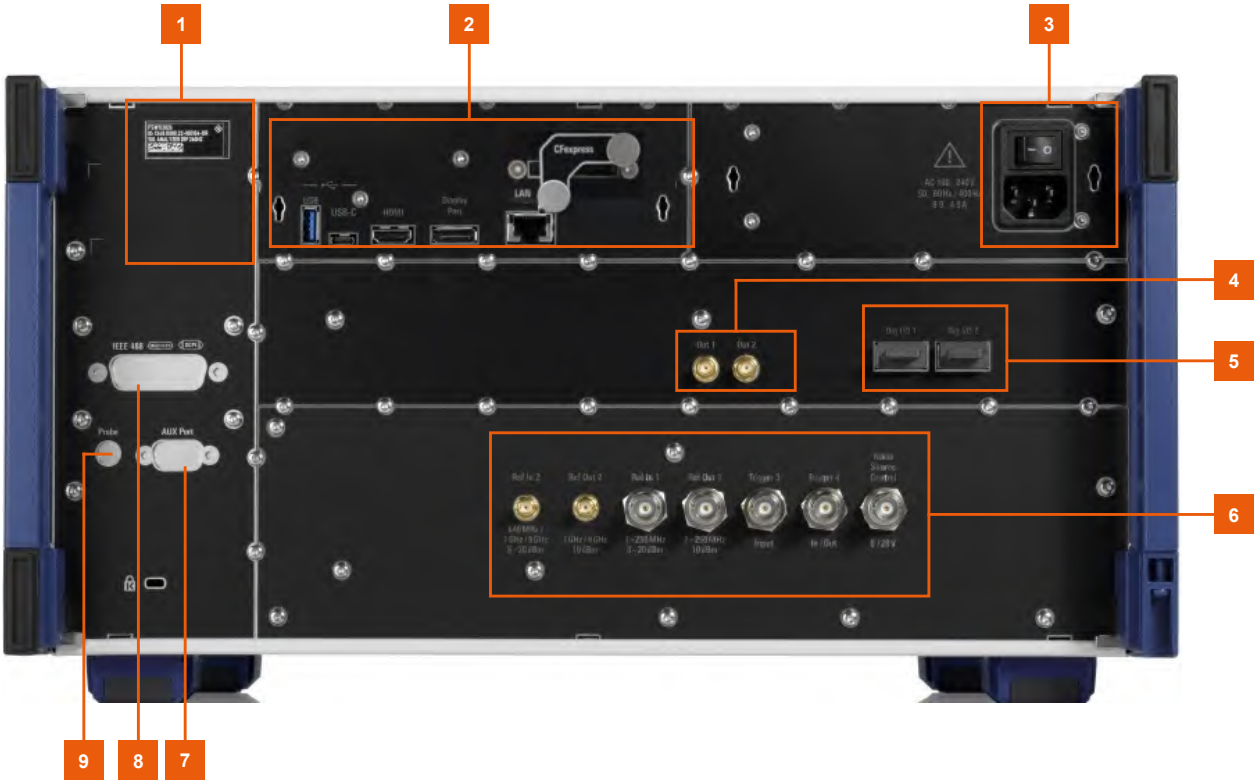


Figure 3-6: Rear panel view

1 = Device ID with serial number and other labels
2 = see Rear panel view - extract 1
3 = AC power supply connection and main power switch
4 = Out 1 / Out 2
5 = Digital I/O, optional, for future use
6 = see Rear panel view - extract 2
7 = AUX Port (Additional interface option)
8 = GPIB IEEE-488 interface (Additional interface option)
9 = Probe (Additional interface option)

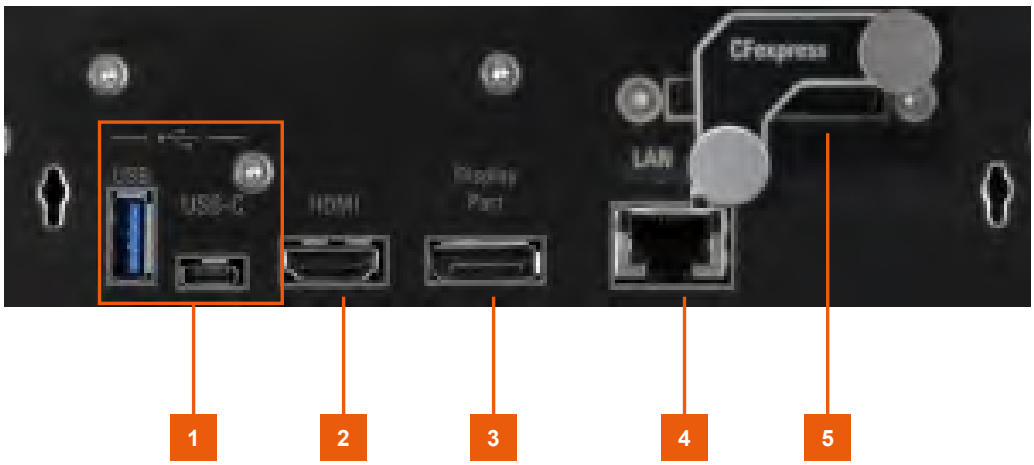


Figure 3-7: Rear panel view - extract 1

1 = USB connectors
2+3 = Display Port and HDMI display connectors
4 = LAN
5 = see (Optional) Removable system hard disk drive (CFexpress)

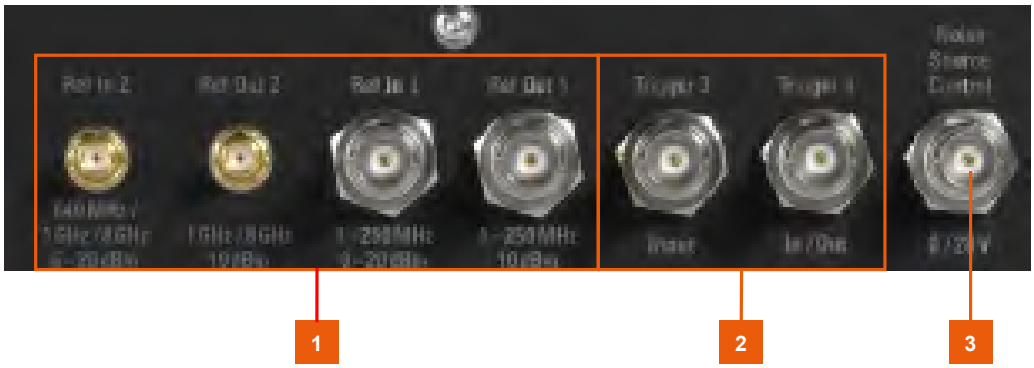


Figure 3-8: Rear panel view - extract 2

1 = Ref Input / Ref Output
2 = Trigger Input/ Output
3 = Noise source control

3.4.2.1 Device ID

The unique device identifier is provided as a barcode sticker on the rear panel of the FSWX.

It consists of the instrument order number and a serial number:



The serial number is used to define the **default instrument name**, which is:
<Type>-<variant>-<serial_number>
For example, `FSWX3-41-123456`.
The instrument name is required to establish a connection to the instrument in a LAN.

Currently, the following variants are available for the instrument type FSWX3:

Instrument model	Order number	Instrument variant
FSWX3026 1RF	1348.0000K21	21
FSWX3026 2RF	1348.0000K22	22

Instrument model	Order number	Instrument variant
FSWX3044 1RF	1348.0000K41	41
FSWX3044 2RF	1348.0000K42	42

3.4.2.2 Labels

The meanings of the labels on the product are described in Section 1.2, "Labels on the product", on page 10.

3.4.2.3 AC power supply connection and main power switch

An AC power supply connector and main power switch are located in a unit on the rear panel of the instrument.

Main power switch function:

Position 1: The instrument can be started via the Power key on the front panel.

The (optional) OCXO reference frequency is warmed up.

Position O: The entire instrument is disconnected from the AC power supply.

For details, refer to "Connecting to power" on page 9 and Section 3.3.6, "Connecting the AC power", on page 23.

The power supply does not have a replaceable fuse. If the product is connected to the mains but cannot be started, contact Rohde & Schwarz customer support for troubleshooting help.

3.4.2.4 Out 1 / Out 2

Two female SMA connectors can provide various outputs:

- Intermediate frequency (IF) output
- Video output (1V)

You define which output is provided in the software ([Input / Output] key).

This function is currently not yet available.

3.4.2.5 USB

The rear panel provides two additional female USB (one USB-A, one USB-C) connectors to connect devices like a keyboard, a mouse or a memory stick (see also Section 3.4.1.6, "USB", on page 37).

All USB connectors support standard 3.2 generation 1.

3.4.2.6 Display Port and HDMI display connectors

You can connect an external monitor or other display device to the FSWX to provide an enlarged display. A "Display Port" and a "HDMI" display connector are provided for this purpose:

For details, see Section 3.3.13, "Connecting an external monitor", on page 29.

3.4.2.7 LAN

The FSWX is equipped with a 1 Gbit Ethernet IEEE 802.3u network interface with Auto-MDI(X) functionality. The assignment of the RJ-45 connector supports twisted-pair category 5 UTP/STP cables in a star configuration (UTP stands for *unshielded twisted pair*, and STP for *shielded twisted pair*).

For details, see Section 4.13.1, "Remote control interfaces and protocols", on page 480.

3.4.2.8 (Optional) Removable system hard disk drive (CFexpress)

The (optional) removable system hard disk ("CFexpress") contains all operating system, firmware, measurement and user data from the FSWX, allowing you to store the data securely in an external location.

The removable system hard disk drive replaces the default internal solid state drive. Only one or the other can be installed in the same instrument.

3.4.2.9 SFP+

Two connectors for 10G Ethernet SFP+ LAN connections to the host PC.

These connectors require the Enhanced Computing Power (R&S FSW3-B114) option.

3.4.2.10 Ref Input / Ref Output

The "Ref Input" connectors are used to provide an external reference signal to the FSWX.

The "Ref Output" connectors can be used to provide an external reference signal (or the optional OCXO reference signal) from the FSWX to other devices that are connected to this instrument.

Various connectors are provided for different reference signals:

Connector	Reference signal	Usage
"Ref In 1"	1 Hz to 250 MHz 0 dBm to 20 dBm	To provide an external reference signal on the FSWX.
"Ref Out 1"	10 MHz / 100 MHz 10 dBm	To provide the internal reference signal from the FSWX to another device continuously. Also used to provide OCXO reference signal to another device.
"Ref In 2"	640 MHz / 1 GHz / 8 GHz 6 dBm to 20 dBm	To provide an external reference signal on the FSWX.
"Ref Out 2"	1 GHz / 8 GHz 10 dBm	To provide a 1 GHz / 8 GHz reference signal from the FSWX to another device.

3.4.2.11 Trigger Input/ Output

Use the female "Trigger Input" connector to input an additional external trigger or gate data. Thus, you can control the measurement using an external signal. The voltage levels can range from 0.5 V to 3.5 V. The default value is 1.4 V. The typical input impedance is 10 kΩ.

Use the female BNC "Trigger Input / Output" connector to receive an additional external signal or to provide a signal to another device. The signal is TTL compatible (0 V / 5 V). You control the connector usage in the "Trigger In/Out" settings ([Trigger] key).

3.4.2.12 Noise source control

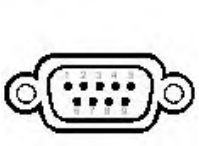
The noise source control female connector is used to provide the supply voltage for an external noise source. For example, use it to measure the noise figure and gain of amplifiers and frequency converting devices.

Conventional noise sources require a voltage of +28 V to be switched on and 0 V to be switched off. The output supports a maximum load of 100 mA.

For smart noise sources, use the Lemosa "Noise Source Control" / "Power Sensor" connector.

For details on noise source control, see "Noise Source control" on page 232.

3.4.2.13 AUX Port



The "AUX Port" is a 9-pole D-Sub male connector used to provide low-voltage TTL control signals (max. 5 V). You can use the output signals to control external devices.

This interface is part of the "Additional Interfaces" hardware option.

3.4.2.14 GPIB IEEE-488 interface

The GPIB interface is in compliance with IEEE-488 and SCPI. You can connect a computer for remote control via this interface. To set up the connection, a shielded cable is recommended.

This interface is part of the "Additional Interfaces" hardware option.

For more details, refer to Section 4.13.6, "How to set up a network and remote control", on page 526.

3.4.2.15 Probe

Connector for supply voltages of +15 V to -12 V and ground for active probes and preamplifiers. A maximum current of 140 mA is available. This connector is suitable as a power supply for high-impedance probes.

This interface is part of the "Additional Interfaces" hardware option.

For details on configuring and using probes, see Section 4.2.4.2, "Probe settings", on page 203.

3.4.2.16 OCXO option

The optional oven-controlled crystal oscillator (OCXO) generates a 10-MHz reference signal with a very precise frequency. If installed, and if no external signal is used, this signal is used as an internal reference. It can also be used to synchronize other connected devices via the REF Output 10 MHz connector.

Warm-up time for OCXO

When the instrument is switched on, the OCXO requires an extended warm-up time.

3.5 Trying out the instrument

This section introduces the most important functions and settings of the FSWX step by step. The complete description of the functionality and its usage is given in the FSWX user manual. Basic instrument operation is described in Section 3.6, "Operating the instrument", on page 66.

Prerequisites

- The instrument is set up, connected to the mains system, and started up as described in Section 3.3, "Preparing for use", on page 18.

For these first measurements, you use the internal calibration signal, so you do not need any additional signal source or instruments. Try out the following:

- Measuring a basic signal....47
- Displaying a spectrogram....49
- Activating additional application instances....50
- Performing sequential measurements....54
- Setting and moving a marker....54
- Displaying a marker peak list....56
- Zooming into the display....57
- Zooming into the display permanently....60
- Saving settings....63
- Printing and saving results....65

3.5.1 Measuring a basic signal

We will start out by measuring a basic signal, using the internal calibration signal as the input.

To display the internal 100 MHz calibration signal

1. Select [Preset] to start out in a defined instrument configuration.
2. Select [Setup] > "Service & Support" > "Calibration Signal".
3. Select "Calibration Signal": "CAL". Leave the frequency at the default 100 MHz.

   The calibration signal is now sent to the RF input of the FSWX. By default, a continuous frequency sweep is performed, so that the spectrum of the calibration signal is now displayed in the standard level versus frequency diagram.

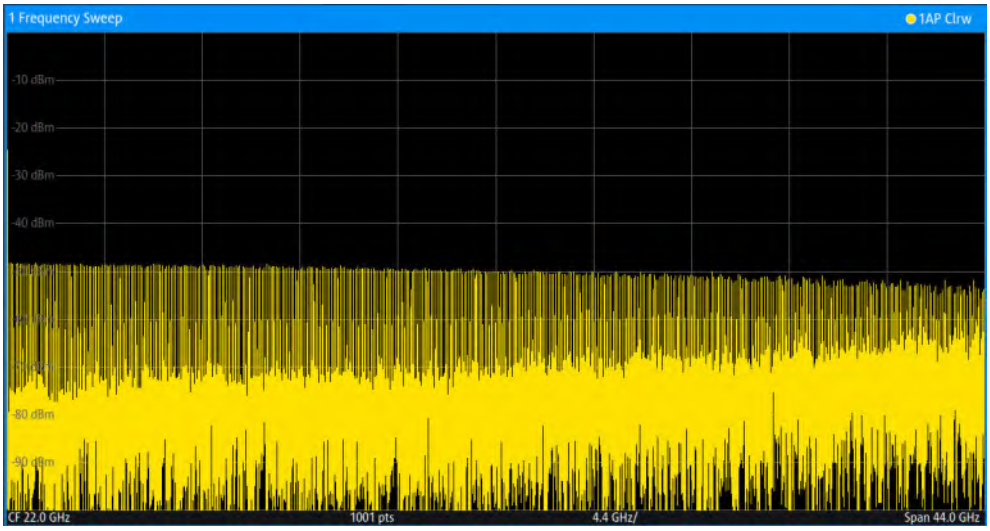


Figure 3-9: Calibration signal as RF input

Instrument warm-up time

Note that the instrument requires an initial warm-up time after you switch it on. A message in the status bar ("Instrument warming up...") indicates that the operating temperature has not yet been reached. Wait until this message is no longer displayed before you start a measurement to obtain accurate results.

To optimize the display

To optimize the display for the calibration signal, we will adjust the main measurement settings.

1. Set the center frequency to the calibration frequency:
   a) Select "Overview" to display the configuration "Overview".
   b) Select "Frequency".
   c) Select "Center Frequency".
   d) Enter *100* on the numeric pad on the front panel.
   e) Select "MHz" on the numeric pad.
2. Reduce the span to 20 MHz:
   a) Select "Span".
   b) Enter *20 MHz*.
   c) Close the "Frequency" dialog.
3. Set the reference level to -40dBm:
   a) In the configuration "Overview", select "Amplitude".
   b) Select "Reference level".
   c) Enter *-40 dBm*.

   The display of the calibration signal is now improved. The maximum at the center frequency (=calibration frequency) of 100 MHz becomes visible.

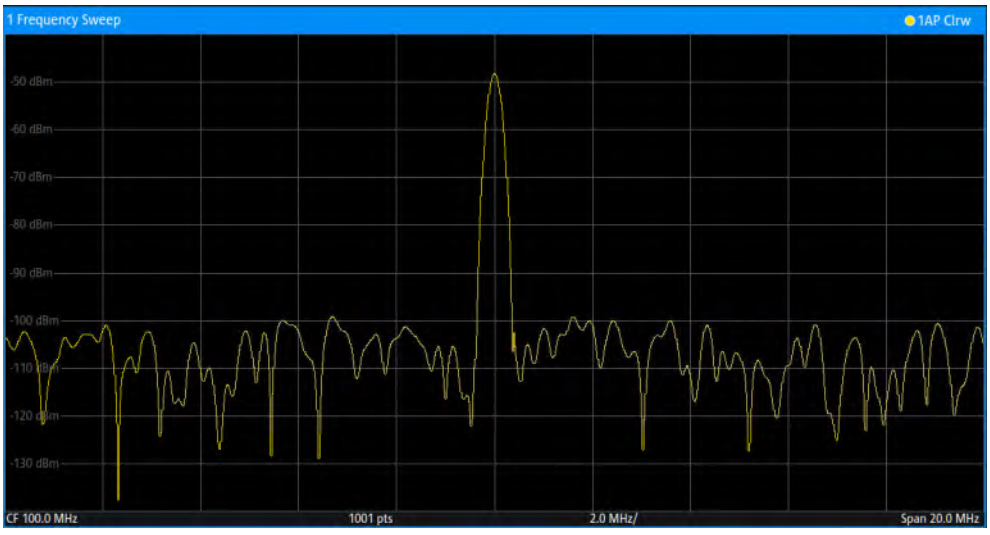
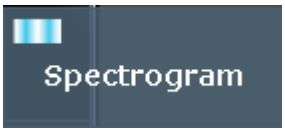


Figure 3-10: Calibration signal with optimized display settings

3.5.2 Displaying a spectrogram

In addition to the standard "Frequency Sweep" display, the FSWX also provides a "Spectrogram" display of the measured data. A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

1. Select "Overview" to display the general configuration dialog.
2. Select "Display Config".

   The "Display Configuration" mode is activated, and the evaluation bar with the available evaluation methods is displayed.
3. 

   Drag the "Spectrogram" from the evaluation bar to the diagram area. The blue area indicates that the new diagram would replace the previous "Frequency Sweep" display. Since we do not want to replace the "Frequency Sweep", drag the icon to the lower half of the display to add an additional window instead.



Figure 3-11: Adding a Spectrogram to the display

Drop the icon.

4. Close the "Display Configuration" mode by tapping the "Close" icon at the top of the "Display Configuration" menu.

   You see the "Spectrogram" compared to the standard "Frequency Sweep" display. Since the calibration signal does not change over time, the color of the frequency levels does not change over time, i.e. vertically. The legend in the window title bar describes the power levels that the colors represent.

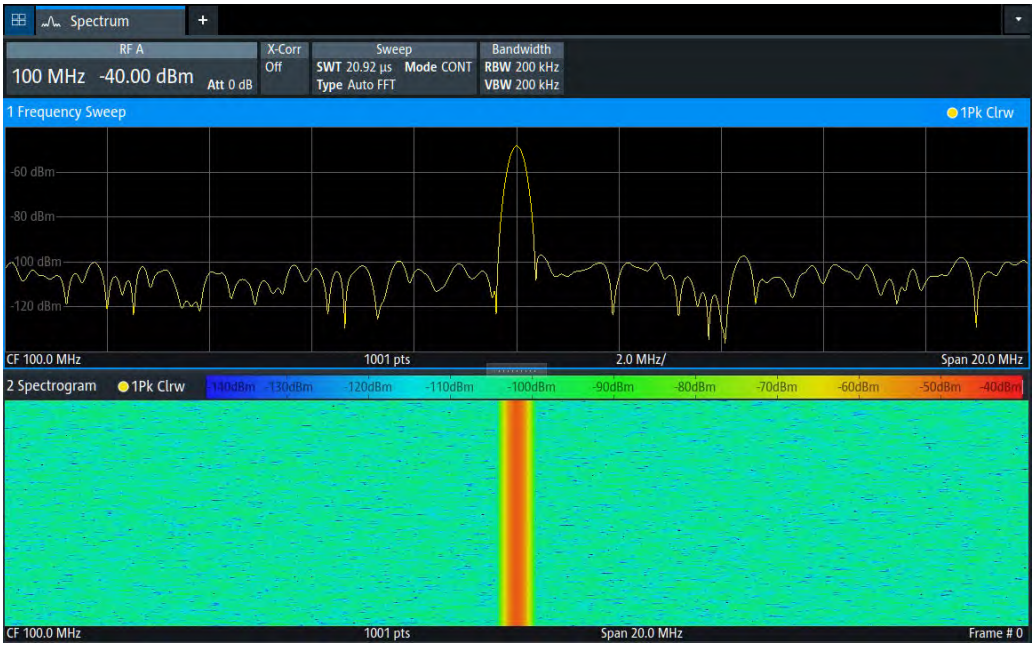


Figure 3-12: Spectrogram of the calibration signal

3.5.3 Activating additional application instances

The FSWX features multiple application instances, i.e. you can define several measurement configurations in parallel. Then the FSWX can switch between the application instances automatically to perform the measurements sequentially. We will demonstrate this feature by activating additional application instances for a different frequency range, a zero span measurement, and an I/Q analysis.

To activate additional application instances

1. Select [Mode].

   The "Mode" dialog is displayed with all available applications.

2. On the "New Application" tab, select "Spectrum".

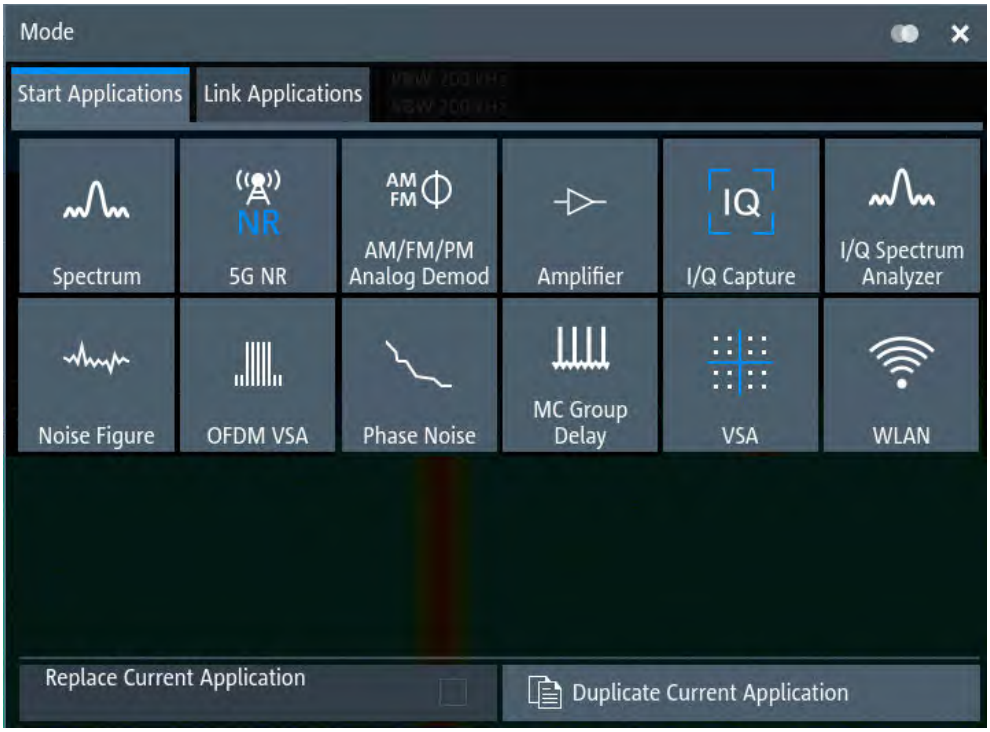


Figure 3-13: Adding a new measurement application instance

3. Change the frequency range for this "Spectrum" application:
   In the "Frequency" dialog, set the "Center Frequency" to *500 MHz* and the "Span" to *1 GHz*.

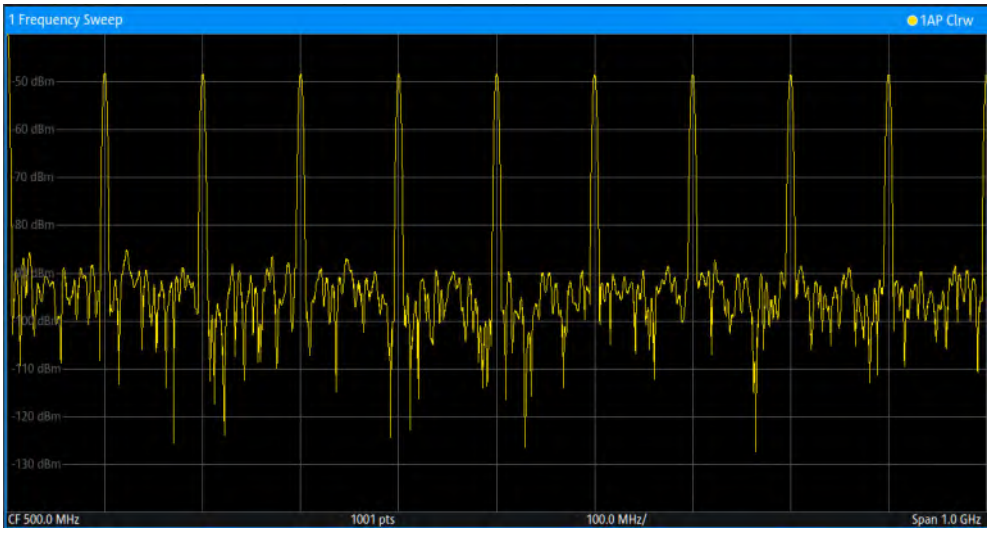
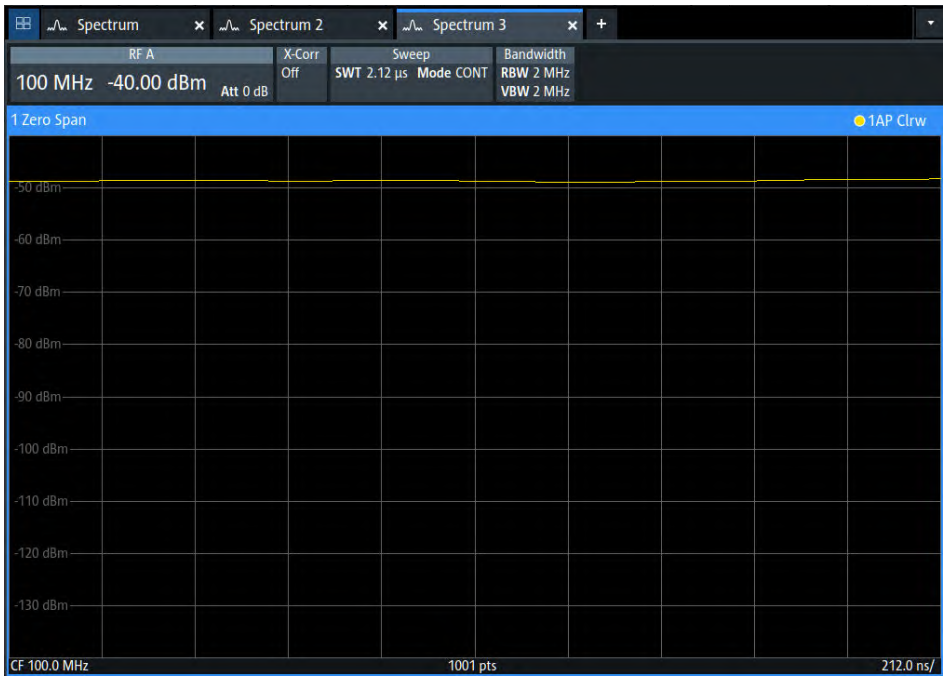


Figure 3-14: Frequency spectrum of the calibration signal with a larger span

4. Repeat the previous steps to activate a third "Spectrum" application instance.
   Change the frequency range for this "Spectrum" application:
   a) In the "Frequency" dialog, set the "Center Frequency" to *100 MHz*.

b) Select "Set to Zero Span".



As the calibration signal does not vary over time, the level versus time diagram displays a straight line.

5. Create a new application instance for I/Q data capture:

   a) Select [Mode].
   b) Select "I/Q Capture" to activate an application instance for the "I/Q Capture" application.

   The "I/Q Capture" application instance displays the power vs. time (Magnitude) and power vs. frequency (Spectrum) diagrams of the captured I/Q data.



To display the MultiView tab

An overview of all active application instances is provided in the "MultiView" tab. This tab is always displayed and cannot be closed.

► Open the MultiView mode by tapping the "MultiView" icon at the top-left corner.





Figure 3-15: The "MultiView" tab

3.5.4 Performing sequential measurements

Although only one measurement can be performed at any one time, the measurements configured in the active application instances can be performed sequentially, that means: one after the other, automatically, either once or continuously.



1. Select the "Sequencer" icon in the toolbar.

2. Toggle the Sequencer in the "Sequencer" menu to "On".

   A continuous sequence is started, i.e. each application instance measurement is performed one after the other until the Sequencer is stopped.



Figure 3-16: "MultiView" tab with active Sequencer



In Figure 3-16, the "IQ Capture" measurement is currently active (indicated by the "application instance active" icon in the tab label).

3. Stop the "Sequencer" by tapping the "Sequencer" icon again.

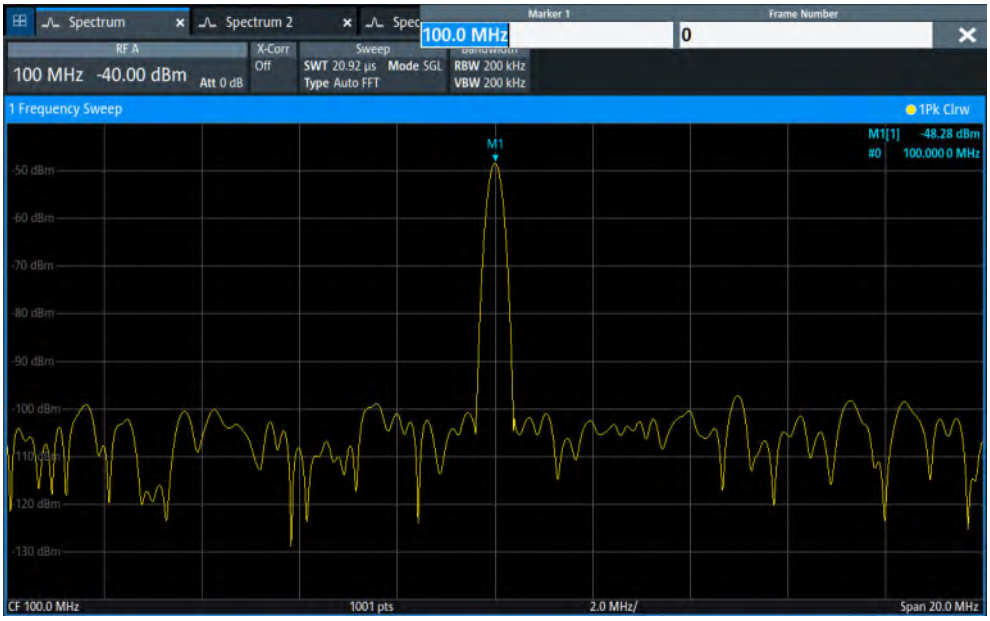
3.5.5 Setting and moving a marker

Markers are useful to determine the position of particular effects in the trace. The most common use is to determine a peak, which is the default setting when you activate a marker. We will set a marker on the peak in our first "Spectrum" application.

1. In the "MultiView" tab, double-click the "Spectrum" window ("Frequency Sweep" with "Spectrogram" display) to return to the "Spectrum" application instance.

2. Select the "Frequency Sweep" diagram to set the focus on that window.
3. Double-click the "Frequency Sweep" window to maximize it, as we currently do not need the "Spectrogram" display.
4. Select "Run Single" on the front panel to perform a single sweep so we have a fixed trace to set a marker on.
5. Select [Marker] on the front panel to display the "Marker" menu.

   Marker 1 is activated and automatically set to the maximum of trace 1. The marker position and value is indicated in the diagram area as M1[1].



6. Now you can move the marker by tapping and dragging it to a different position. The current position is indicated by a dotted blue line. Notice how the position and value change in the marker area of the diagram.



3.5.6 Displaying a marker peak list

The marker peak list determines the frequencies and levels of peaks in the spectrum automatically. We will display a marker peak list for the "Spectrum 2" application instance.

1. Select "Spectrum 2" tab.
2. Select "Run Single" on the front panel to perform a single sweep for which we will determine the peaks.
3. Select "Display Configuration" icon in the toolbar to activate "Display Configuration" mode.
4. Drag the "Marker Peak List" icon from the evaluation bar to the lower half of the display to add a new window for the peak list.
5. Close the "Display Configuration" mode.
6. To obtain a more conclusive peak list that does not contain noise peaks, for example, define a threshold that is higher than the noise floor:
   a) On the front panel, select [Marker].
   b) On the "Marker" menu, select "Marker Search".
   c) In the "Threshold" field, enter *-80 dBm*.
   d) Enable the "Threshold": "State" to enable its use.
   Only peaks that are larger than -80 dBm are included in the peak list.

   The marker peak list displays the determined peaks that are above the defined threshold.



Figure 3-17: Marker Peak List

3.5.7 Zooming into the display

To analyze the areas around the peak levels in more detail, we will zoom into the top 3 peaks.



1. Select "Multi-Zoom" icon in the toolbar.

   The icon is highlighted blue to indicate that multiple zoom mode is active.

2. Select a diagram near the second peak and drag your finger to the opposite corner of the zoom area. A white rectangle is displayed from the point where you tapped to the current position.

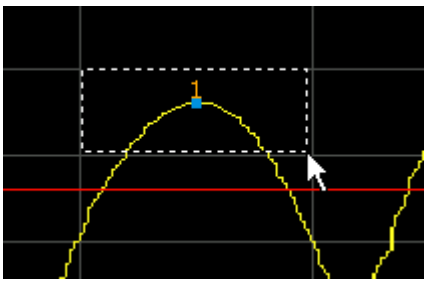


Figure 3-18: Defining the zoom area

When you remove your finger, the zoom area is enlarged in a second (sub-)window.

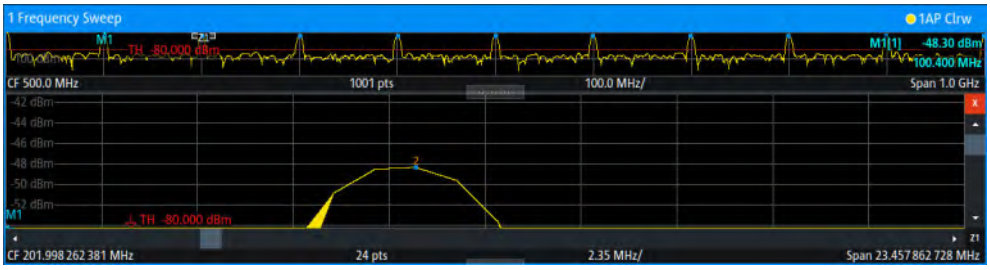


Figure 3-19: Zoomed display around a peak

3. In Figure 3-19, the enlarged peak is represented by a very thick trace. This is due to the insufficient number of sweep points. The missing sweep points for the zoomed display are interpolated, which provides poor results. To optimize the results, we will increase the number of sweep points from the default 1001 to 32001.

   a) On the front panel, select [Sweep].
   b) On the "Sweep" menu, select "Sweep Configuration".
   c) In the "Sweep Points" field, enter *32001*.
   d) Select [Run Single] on the front panel to perform a new sweep with the increased number of sweep points.

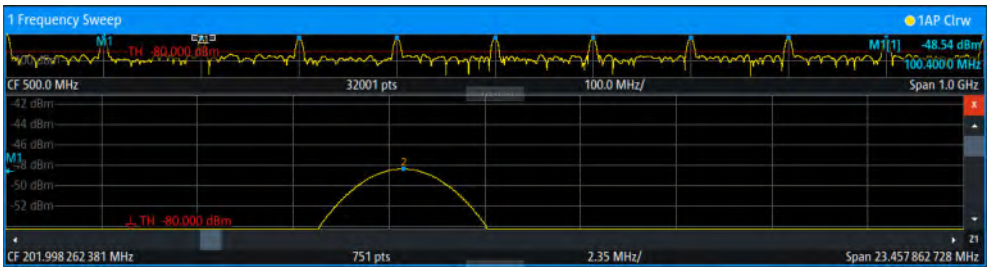


Figure 3-20: Zoomed peak with increased number of sweep points

Note that the trace becomes much more precise.



4. Select "Multi-Zoom" icon in the toolbar again and define a zoom area around markers M4, M5 and M6.

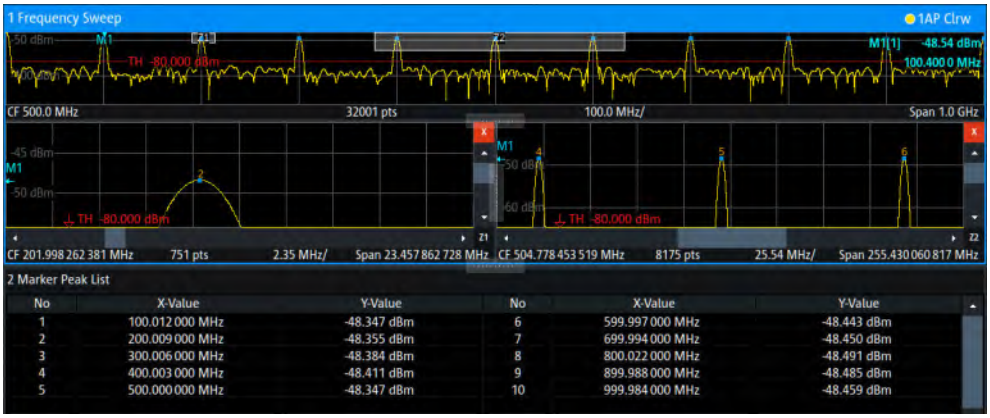
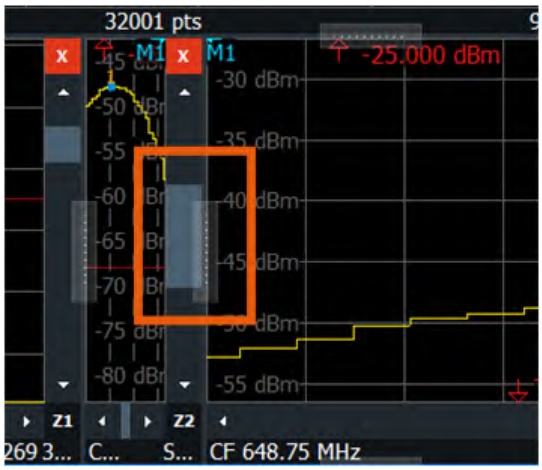


Figure 3-21: Multiple zoom windows



5. Select "Multi-Zoom" icon in the toolbar again and define a zoom area around marker M8.

6. To increase the size of the third zoom window, drag the "splitter" between the windows to the left or right or up or down.



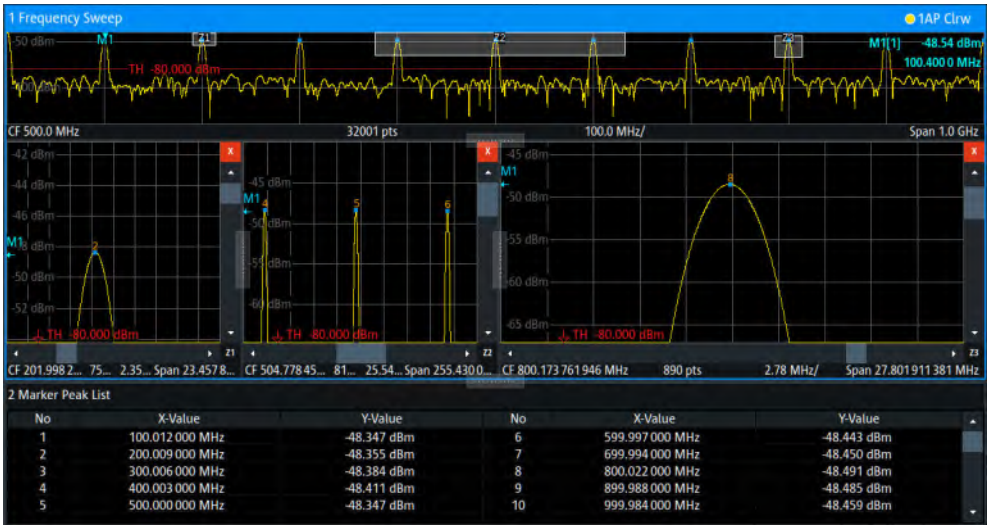


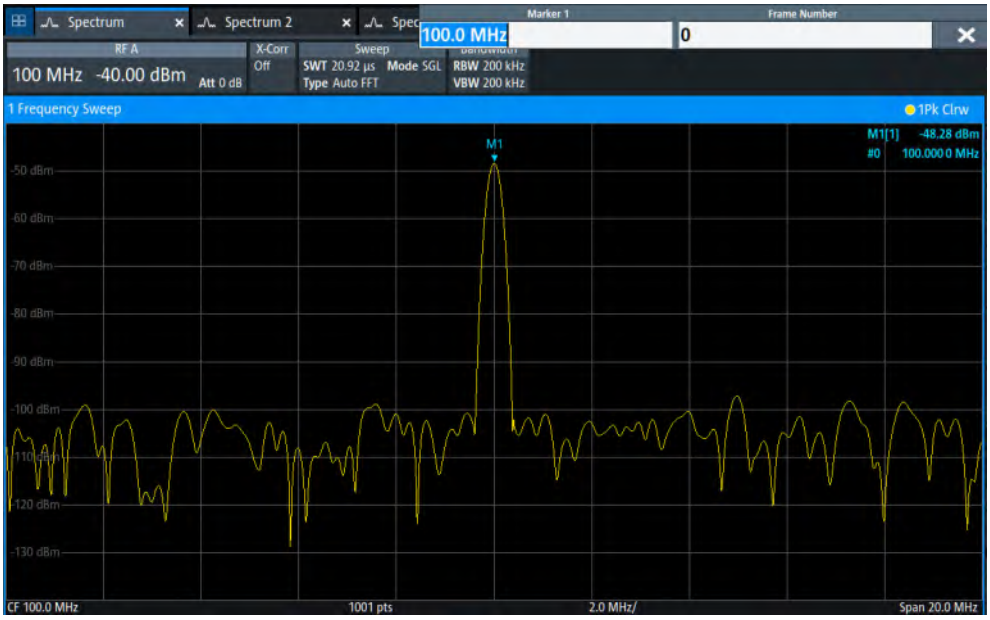
Figure 3-22: Enlarged zoom window

3.5.8 Zooming into the display permanently

The zoomed results from Section 3.5.7, "Zooming into the display", on page 57 were only graphical changes to the display. Now we would like to change the measurement settings such that the zoomed result is maintained permanently. We will demonstrate this in the "Spectrum" application instance.

1. Select the "Spectrum" tab.
2. On the front panel, select [Marker ->].
3. On the "Marker ->" menu, select "Set to Peak".

   A peak marker (M1) is inserted at the detected peak.





4. Select the (graphical) zoom icon on the toolbar.

   Any subsequent touch gestures define the zoom area for the zoom display.

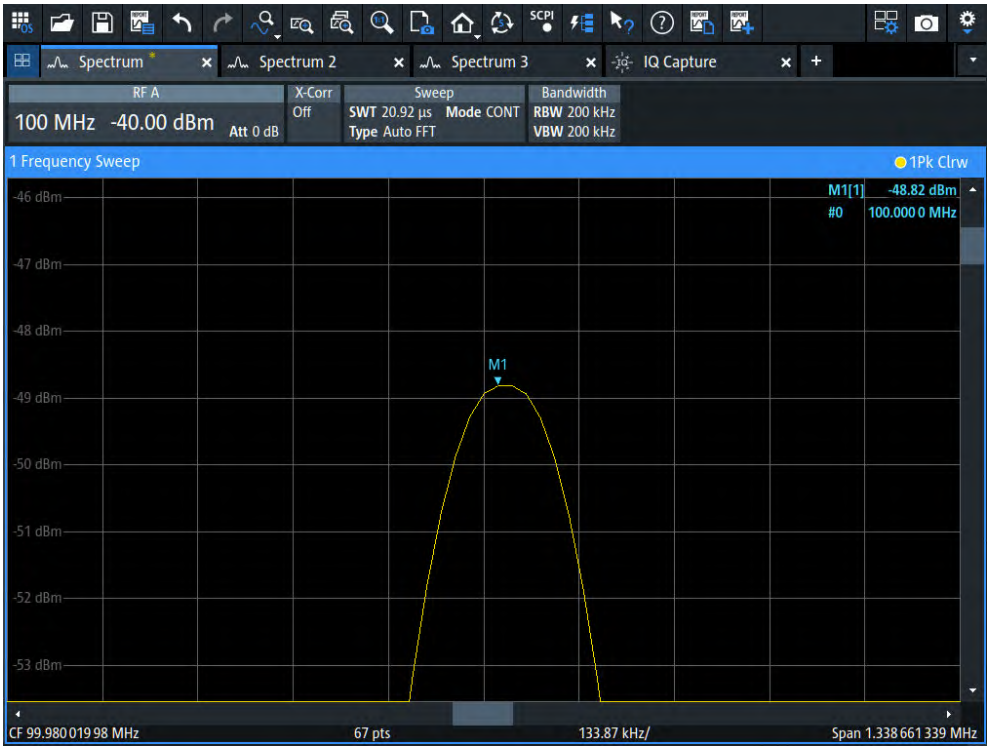
5. Place two fingers on the diagram, to the left and right of the marker, and stretch them apart.



   The area around the marker is enlarged in the result display.

6. When the area has the size you require, remove your fingers from the display.

The displayed span and the number of displayed sweep points is smaller than before, all other measurement settings remain unchanged.



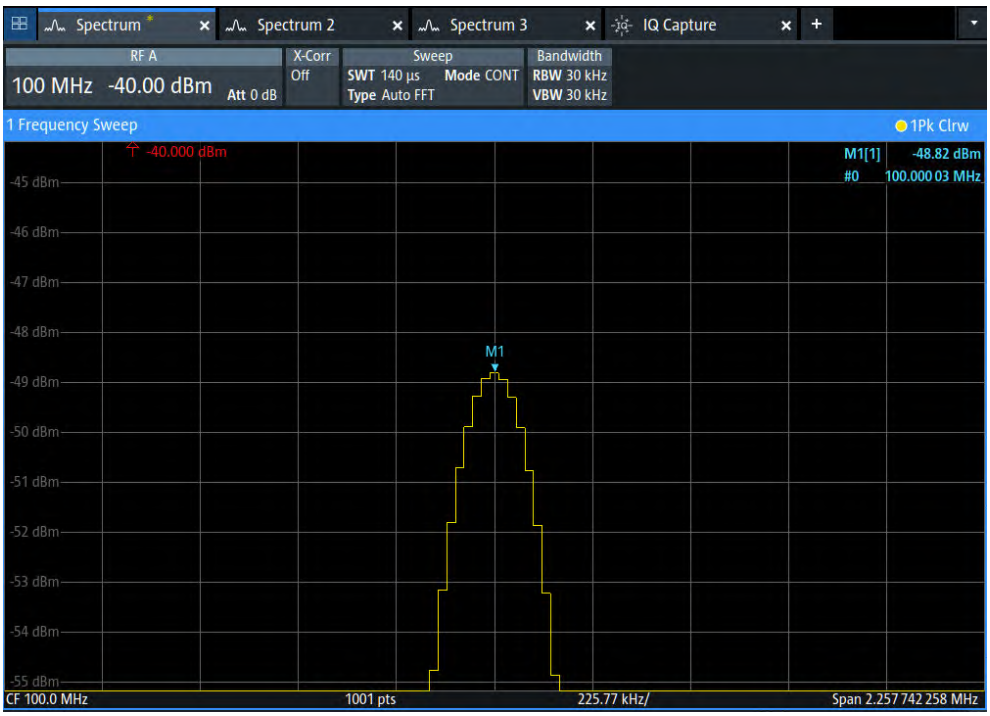


7. Select "Measurement Zoom" icon on the toolbar for a second or so.

   A context menu with further options is displayed.

8. Select "Adapt Measurement to Zoom (selected diagram)".

   The span of the measurement is changed, and due to the automatic coupling of the span to the sweep time, RBW and VBW, those values are also changed. The number of sweep points is restored to the default 1001. The range of the trace is the same as in the graphical zoom. However, due to the smaller RBW filter, the peak is narrower.



3.5.9 Saving settings

To restore the results of our measurements later, we will store the instrument settings to a file.

To save the instrument settings to a file



1. On the toolbar, select "Save".
2. In the "Save" dialog, select "Save Instrument with all Application Instances" to store the configuration of all application instances.
3. Select "Save".
4. In "File Name", enter *MyMultiViewSetup* using the external or on-screen keyboard.

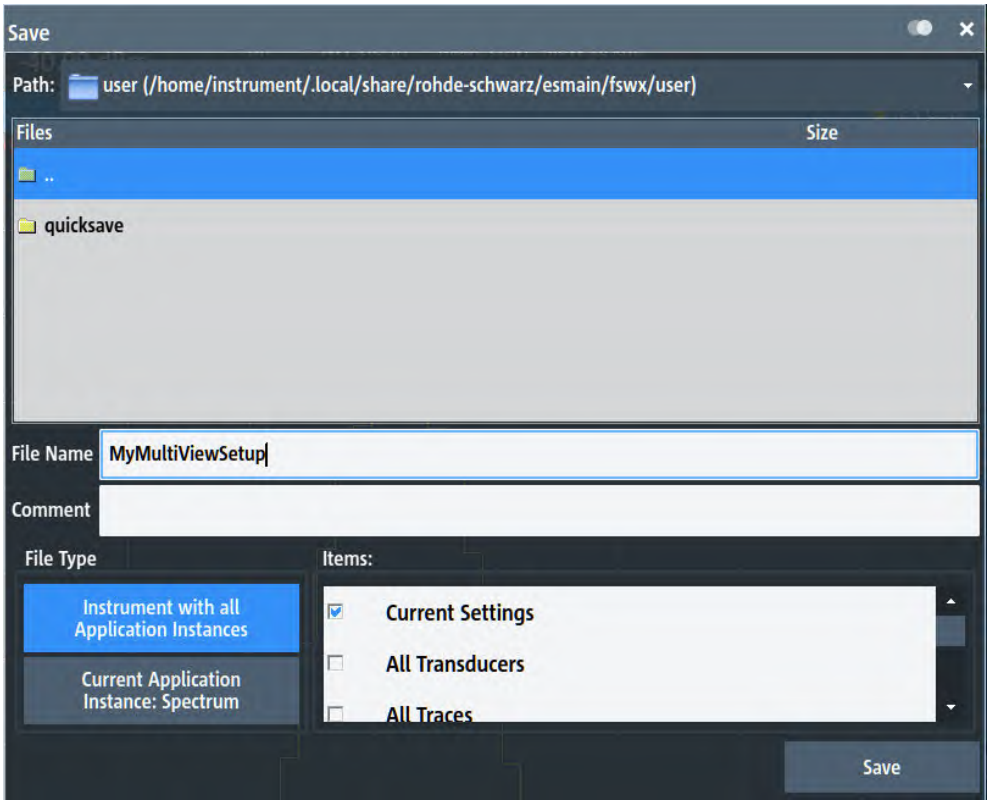


Figure 3-23: Saving the instrument settings to a file

5. Select "Save".

   The file `MyMultiViewSetup.dfl` is stored in the default directory `home/instrument/.local/share/rohde-schwarz/esmain/fswx`.

To recall stored instrument settings

You can restore the settings to the instrument at any time using the settings file.

1. Select [Preset] to restore the default instrument settings so you can check that the stored user settings are actually restored afterwards.



2. On the toolbar, select "Open"

3. In the "Recall" dialog, select "From File".
4. Select the `MyMultiViewSetup.dfl` file in the default directory home/instrument/.local/share/rohde-schwarz/esmain/fswx.
5. Select "Recall".

   All instrument settings are restored and the display should resemble Figure 3-22, which shows the instrument display right before the settings were stored.

3.5.10 Printing and saving results

Finally, after a successful measurement, we will document our results. First we will export the numeric trace data, then we will create a screenshot of the graphical display.

To export the trace data

1. On the front panel, select [Trace].
2. Select "Export & Import".
3. Select "Trace & Data Export".
4. Select "Export to ASCII File".
5. Enter the filename *MyPeakResults* using the external or on-screen keyboard.

   The trace data is stored to `home/instrument/.local/share/rohde-schwarz/esmain/fswx/MyPeakResults.DAT`.

To create a screenshot of the display



1. On the toolbar, select "SnapShot".

   A screenshot of the current display is created. Note that the colors on the screen are inverted in the screenshot to improve printout results.
2. In the "Save Hardcopy as Portable Network Graphics (PNG)" dialog, enter a filename, e.g. *MyPeakDisplay*.

   The screenshot is stored to `home/instrument/.local/share/rohde-schwarz/esmain/fswx/MyPeakDisplay.png`.

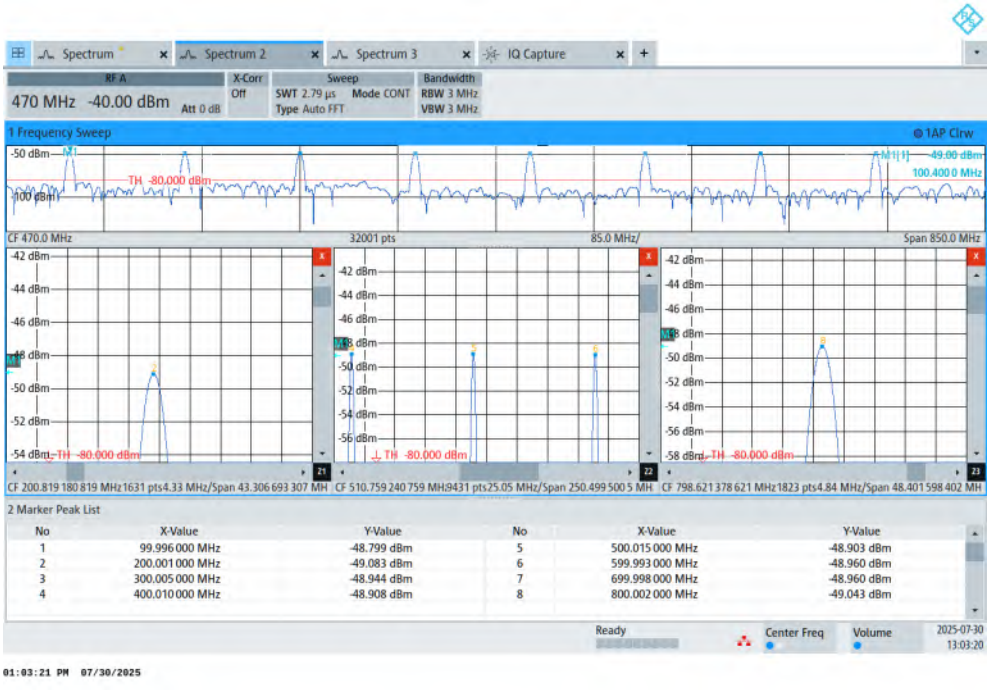


Figure 3-24: Screenshot of the current display

3.6 Operating the instrument

This section provides an overview on basic operating tasks. There are three ways to operate the FSWX.

Manual operation

Use the touchscreen, keys and rotary knobs, or an optional mouse and/or keyboard. The principles of manual operation are explained in this section.

Remote control

Create programs to automatize repeating settings, tests, and measurements. The instrument is connected to a computer that runs the program.

Remote operation

To monitor and operate the instrument remotely, a VNC server is installed on the FSWX. You need a LAN connection to the computer, and a VNC client or browser to connect to the instrument.

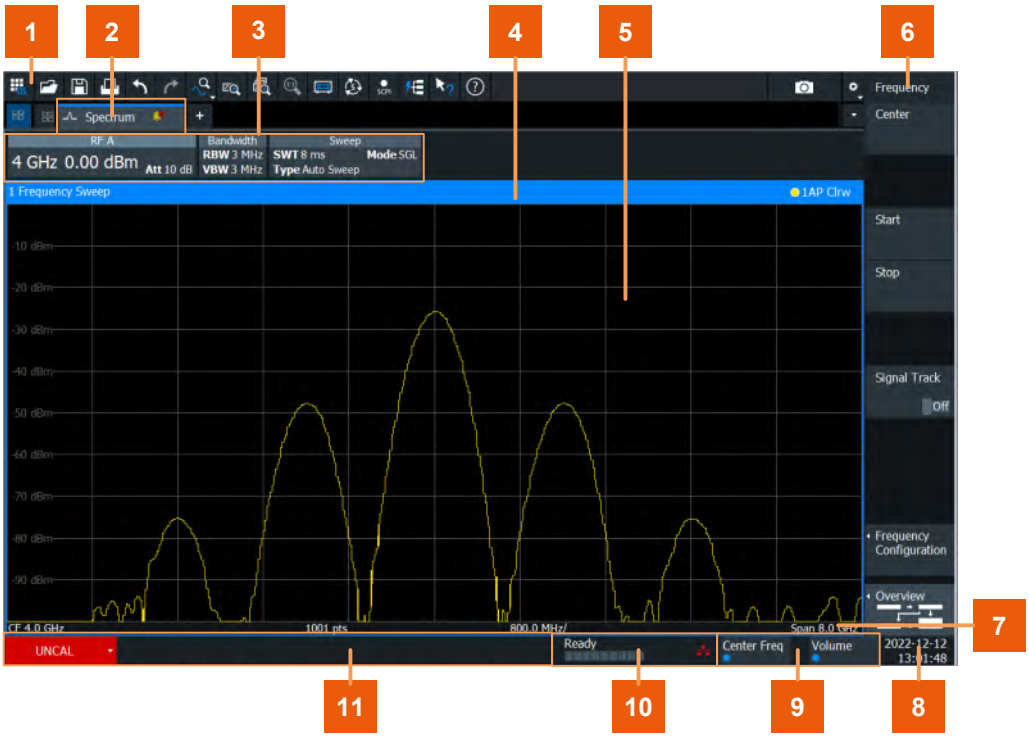
How to operate and control the instrument remotely is described in the FSWX user manual, in "Network operation and remote control".

The following sections show how to operate the instrument manually.

- Understanding the display information....67
- Enabling and disabling application instances....75
- Displaying results....77
- Means of manual interaction....86
- Accessing the functionality....87
- Entering data....97
- Unit shortcuts....99
- Getting help....100

3.6.1 Understanding the display information

The following figure shows a measurement diagram in "Spectrum" mode. All different information areas are labeled. They are explained in more detail in the following sections.



1 = Toolbar with standard application functions, e.g. print, save/open file etc.
2 = Application instance tab
3 = Application info panel with measurement settings
4 = Window title bar with diagram-specific (trace) information
5 = Diagram area with Marker information
6 = Softkeys for function access
7 = Diagram footer with diagram-specific information, depending on measurement application
8 = Date/time display
9 = Fast access functions for Fast access knobs
10+11 = Instrument, status and error information with error messages, progress bar

Hiding elements in the display

You can hide some of the elements in the display, for example the status bar or application info panel, to enlarge the display area for the measurement results. ("Setup" > "Display" > "Displayed items")

For details, see Section 4.11.6, "Display configuration", on page 425.

- Application info panel 68
- Window title bar 70
- Marker information 71
- Diagram footer 73
- Instrument, status and error information 73

3.6.1.1 Application info panel

Using the FSWX you can handle several different measurement tasks (applications) at the same time, although they can only be performed asynchronously. For each application instance, a separate tab is displayed on the screen. To switch from one application instance display to another, simply select the corresponding tab.



Application name

The application instances are labeled with their default name. If that name already exists, a sequential number is added. You can change the name of the application instance by double-tapping the name in the application info panel and entering a new name.

For an overview of default names, see Table 4-54.

Application name restrictions

Application names can have a maximum of 31 characters.

Application names usually consist of the following characters:

- (Lowercase) alphanumeric characters
- Underscores, hyphens, periods
  Do not begin an application name with a hyphen.

Other special characters such as ":", "*", "?", "$", "%" or brackets, have special meanings in the operating system and can cause problems. Do not use them in application names to avoid problems.

Remote command:

`INSTrument:RENAme` on page 543

Application-specific settings

Beneath the application name, important settings for the application instance are displayed in the application info panel. If you select a setting in the application info panel, the corresponding settings dialog or links to the corresponding settings are displayed.

Application information varies depending on the active application. See the application documentation for more information.

Icons in the application info panel

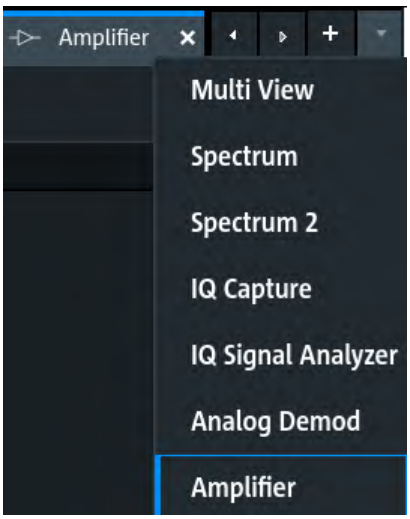
The following icons can be displayed in the application info panel.



Switching tabs
If more tabs are active than can be displayed at once, use the arrows to see more tabs.



Application tab list
Tap the tab selection list icon at the right end of the application info panel to select the application instance you want to switch to from the list.



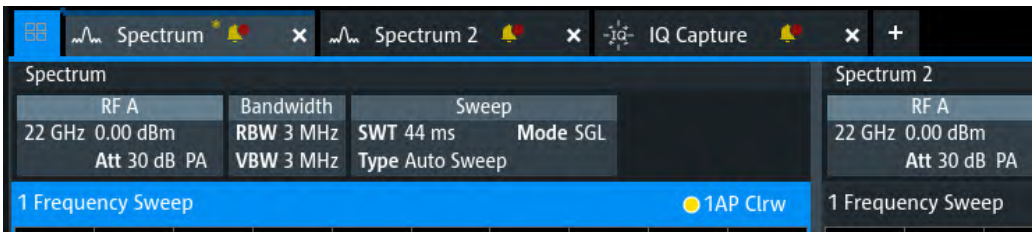


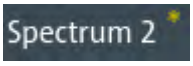
Additional application tab
To add an application instance quickly, select the "+" icon. The common "Mode" dialog is opened.

For details, see Section 4.1.1, "Multiple measurement tasks - application instances", on page 102.



MultiView tab
An additional tab ("MultiView") provides an overview of all active application instances at a glance. In the "MultiView" tab, each application instance is displayed in a separate window, and each window contains its own application info panel. Double-tap any window to switch to the corresponding application instance quickly.





Inconsistent data display
The yellow star icon on the tab label (sometimes referred to as a "dirty flag") indicates that invalid or inconsistent data is displayed. That means the trace no longer matches the displayed instrument settings. For example, after you change the measurement bandwidth, the displayed trace is still based on the old bandwidth. As soon as a new measurement is performed or the display is updated, the icon disappears.



Outdated data display
"IQ" is displayed when the displayed I/Q data no longer matches the data currently available in the capture buffer. In this case, the refresh functionality is not available until you perform a new measurement.



Error or warning occurred
The alarm bell icon indicates that an error or warning occurred for that application instance. The color of the icon indicates the (highest) severity of the notification.

Table 3-3: Notification icon - color coding

Color	Type	Description
Red	Error	An error occurred at the start or during a measurement, e.g. due to missing data or wrong settings, so that the measurement cannot be started or completed correctly.
Orange	Warning	An irregular situation occurred during measurement, e.g. the settings no longer match the displayed results, or the connection to an external device was interrupted temporarily.
Green	Measurement successful	Some applications visualize that the measurement was successful by showing a message.



Active Sequencer measurement
The moving blue ring indicates the currently active application instance during an automatic measurement sequence ("Sequencer" functionality).



CrossACT conflict
Indicates that a "CrossACT" settings conflict occurred.

See Section 4.1.2.4, "Restrictions and limitations of CrossACT", on page 113.

3.6.1.2 Window title bar

Each application instance in the FSWX display can contain several windows. Each window can display either a graph or a table as a result of the measurement. Which type of result evaluation is displayed in which window is defined in the display config-

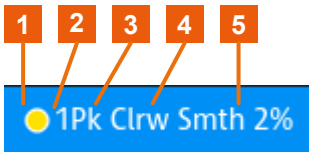
uration (see Section 3.6.3, "Displaying results", on page 77). The window title bar indicates which type of evaluation is displayed.

Double-tap the window title bar to enlarge the window temporarily. Double-tap it again to restore the original size.

See also Section 3.6.3.3, "Switching between a split and maximized window display", on page 84.

Trace information in window title bar

Information on the displayed traces is indicated in the window title bar.



(1) **Trace color**		Color of trace display in diagram
(2) **Trace no.**		Trace number (1 to 6)
(3) **Detector**	"AP"	"Auto Peak" detector
	"Pk"	"Positive Peak" detector
	"Mi"	"Negative Peak" detector
	"Sa"	"Sample" detector
	"Av"	"Average" detector
	"Rm"	"RMS" detector
	"RMS X-Corr"	"RMS X-Corr" detector
(4) **Trace Mode**	"Clrw"	"Clear Write"
	"Max"	"Max Hold"
	"Min"	"Min Hold"
	"Avg"	"Average" (Lin/Log/Pwr)
	"View"	"View"
	"D"	"Density"
(5) **Smoothing factor**	"Smth"	Smoothing factor, if enabled. (See "Removing anomalies: Trace smoothing" on page 288)
Norm/NCor		Correction data is not used.

3.6.1.3 Marker information

Marker information is provided either in the diagram grid or in a separate marker table, depending on the configuration.

Marker information in diagram grid

Within the diagram grid, the x-axis and y-axis positions of the last two markers or delta markers that were set are displayed, if available. The value in the square brackets after the marker index indicates the trace to which the marker is assigned. For example, "M2[1]" defines marker 2 on trace 1. For more than two markers, a separate marker table is displayed beneath the diagram by default.

Marker information in marker table

In addition to the marker information displayed within the diagram grid, a separate marker table can be displayed beneath the diagram. This table provides the following information for all active markers.

Type
Marker type
- "N": normal
- "D": delta
- "T": temporary (internal)
- "PWR": power sensor

Ref
Reference (for delta markers)

Trc
Trace to which the marker is assigned

X-Value
X-value of the marker

Y-Value
Y-value of the marker

Function
Enabled marker or measurement function

Function Result
Result of the active marker or measurement function

The functions are indicated with the following abbreviations:
- "FXD": Fixed reference marker
- "PhNoise": Phase noise measurement
- "Count": Signal count
- "Noise": Noise measurement
- "MDepth": AM modulation depth
- "n DB": N-dB down measurement
- "n dB down BW": N-dB down bandwidth
- "Q Factor": N-dB down measurement Q-Factor
- "Band Power": Band power measurement (with frequency span)
- "TOI": Third order intercept measurement
- "TD Pow RMS": Time domain power measurement

3.6.1.4 Diagram footer

The information in the diagram footer (beneath the diagram) depends on the current application, measurement, and result display.

For a default measurement in the "Spectrum" mode, the "Diagram" result display contains the following information, for example:

Table 3-4: Frequency domain display

Label	Information
"CF / Span" or none (first / last value)	Center frequency / Frequency span or Start frequency / Stop frequency (Depending on how the range was defined)
"Pts"	Number of sweep points or (rounded) number of currently displayed points in zoom mode
"MHz/"	Span per division

Table 3-5: Time domain display

Label	Information
"CF"	Center frequency
"Pts"	Number of sweep points or (rounded) number of currently displayed points in zoom mode
"ms/"	Time per division

3.6.1.5 Instrument, status and error information

Global instrument settings and functions, the instrument status and any irregularities are indicated in the status bar beneath the diagram.



In the "MultiView" tab, the status bar always displays the information for the currently selected measurement.

The following information is displayed:

Instrument status

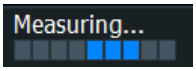
EXT REF The instrument is configured for operation with an external reference.

The instrument is connected to a LAN.

Select the status icon to open the corresponding configuration dialog.

Progress

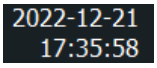
The progress of the current operation is displayed in the status bar.



In the MultiView tab, the progress bar indicates the status of the currently selected measurement, not the measurement a "Sequencer" is currently performing, for example.

Date and time

The date and time settings of the instrument are displayed in the status bar.



Select the date and time to open the system settings "Date Time" dialog.

See Section 4.12.3.1, "Date and time", on page 463.

Messages and error information

If errors or irregularities occur, an icon and a message, if available, are displayed in the status bar.

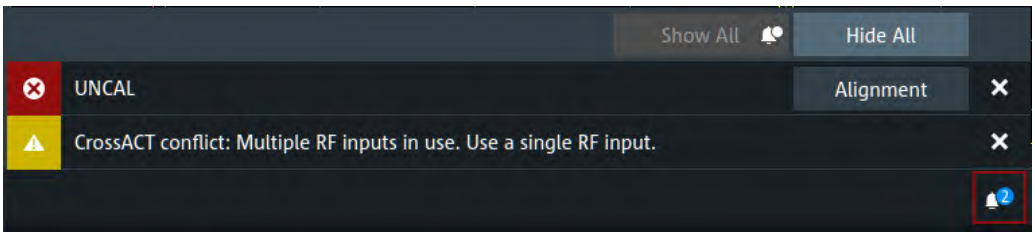


The color of the icon indicates the severity of the message.

Table 3-6: Status bar information - color coding

Color	Type	Description
Red	Error	An error occurred at the start or during a measurement, e.g. due to missing data or wrong settings, so that the measurement cannot be started or completed correctly.
Orange	Warning	An irregular situation occurred during measurement, e.g. the settings no longer match the displayed results, or the connection to an external device was interrupted temporarily.
Gray	Information	Information on the status of individual processing steps.
Green	Measurement successful	Some applications visualize that the measurement was successful by showing a message.
No color	No errors	No message displayed - normal operation.

If multiple messages are available, only the most severe message is visible. New but less severe messages are displayed shortly, then the most severe message returns. An icon indicates further messages. Select the icon to display a list of all messages.



Additional action buttons

The status bar can also contain a button if the displayed status information requires a specific action. For example, if the "UNCAL" error is displayed, an "Alignment" button allows you to open the self-alignment configuration dialog to solve the issue directly.

If any error information is available for an application instance, an alarm bell is displayed next to the application instance name ( ). This is particularly useful when the "MultiView" tab is displayed, as the status bar in the "MultiView" tab always displays the information for the currently selected measurement only.

Furthermore, a status bit is set in the `STATus:QUEStionable:EXTended:INFO` register for the application concerned, see "STATus:QUEStionable:EXTended:INFO register" on page 498. You can query messages of a specific type using the `SYST:ERR:EXT?` command, see `SYSTem:ERRor:EXTended` on page 860. Some errors also change particular status bits in other registers, as indicated in Table 7-2.

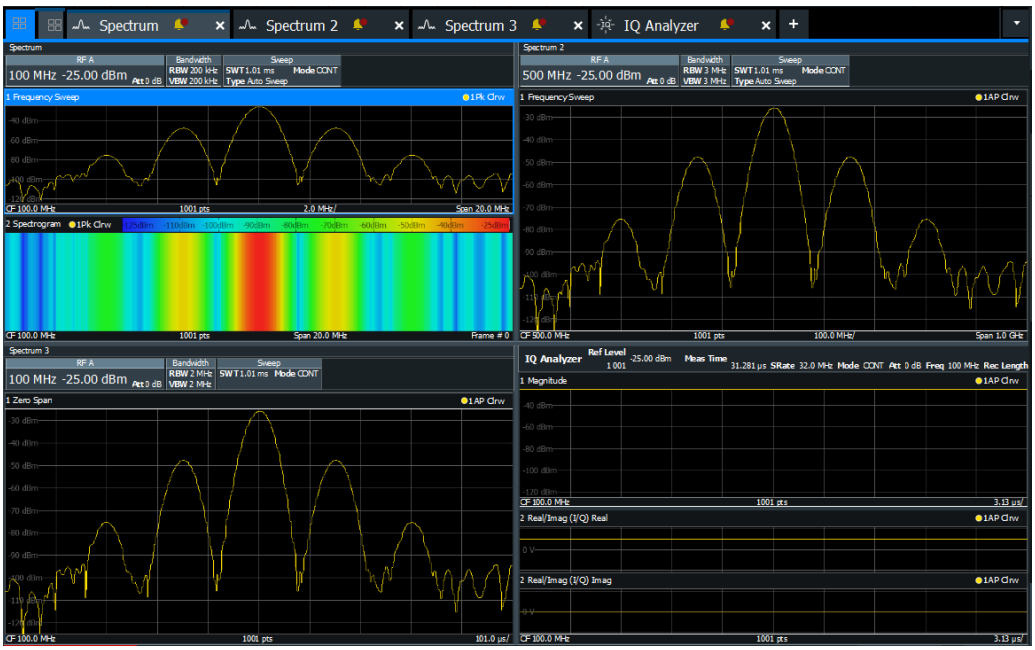
For more information, see Section 4.13.3, "Status reporting system", on page 491.

3.6.2 Enabling and disabling application instances

When you enable an application, a new application instance is created which determines the measurement settings for that application. You can enable the same application with different measurement settings by creating several application instances for the same application. Whenever you switch application instances, the FSWX restores the corresponding measurement settings. Each application instance is displayed in a separate tab on the screen.

An additional tab ("MultiView") provides an overview of all currently active application instances at once.

Only one measurement can be performed at any time, namely the one in the currently active application instance. However, to perform the configured measurements consecutively, a "Sequencer" function is provided.



To start a new application instance

1. Select the [Mode] key.
2. In the "Mode" dialog, select the required application.
   A new tab is displayed for the new application instance.

Remote command:

`INSTrument:CREate[:NEW]` on page 541/`INSTrument:CREate:DUPLicate` on page 541

To change the application in an active application instance

1. Select the tab of the application instance that you want to change.
2. Select the [Mode] key.
3. In the "Mode" dialog, select "Replace Current Application".
4. Select the new application to display.
   The selected application is displayed in the current application instance.

Remote command:

`INSTrument:CREate:REPLace` on page 542

To duplicate the application in an active application instance

1. Select the tab of the application instance that you want to duplicate.
2. Select the [Mode] key.
3. In the "Mode" dialog, select "Duplicate Current Application".

A second application instance with the same settings as the selected instance is displayed in a second tab.

To close an application instance

► 

Select the "Close" icon on the tab of the application instance.

The tab is closed, any running measurements are aborted, and all results for that application instance are deleted.

Remote command:

`INSTrument:DELete` on page 543

3.6.3 Displaying results

The FSWX provides several instrument applications for different analysis tasks and different types of signals, e.g. I/Q analysis or basic spectrum analysis. For each application, a new application instance is created and displayed in a separate tab on the screen.

The results of an application instance can be evaluated in many different ways, both graphically and numerically. For each evaluation method, the results are displayed in a separate window in the tab.

The FSWX allows you to configure the display to suit your specific requirements and optimize analysis.

3.6.3.1 Laying out the result display

You can evaluate measurement results in many different ways, for example graphically, as a summary table or statistical evaluations. Each type of evaluation is displayed in a separate window in the application tab. Each application instance, that is: each tab, can display up to 16 individual windows. To arrange the diagrams and tables on the screen, the Rohde & Schwarz "Display Configuration" function helps you find the target position simply and quickly.

Principally, the layout of the windows on the screen is based on an underlying grid. However, the grid is dynamic and flexible, allowing for many different layout possibilities. The "Display Configuration" functionality provides the following basic features:

- Windows can be arranged in columns or in rows, or in a combination of both.
- Windows can be arranged in up to four rows and four columns.
- Windows are moved simply by dragging them to a new position on the screen, possibly changing the layout of the other windows, as well.
- All evaluation methods available for the currently selected measurement are displayed as icons in the evaluation bar. If the evaluation bar contains more icons

than can be displayed at once on the screen, it can be scrolled vertically. The same evaluation method can be displayed in multiple windows simultaneously.

- New windows are added by dragging an evaluation icon from the evaluation bar to the screen. The position of each new window depends on where you drop the evaluation icon in relation to the existing windows.
- You can only change the display layout in "Display Configuration" mode. In "Display Configuration" mode, the evaluation bar replaces the current softkey menu display. When you close the "Display Configuration" mode, the previous softkey menu is restored.

- Background information: the Display Configuration principle 78
- Basic evaluation methods 79
- How to enable Display Configuration mode 82
- How to add a new result window 82
- How to close a result window 83
- How to arrange the result windows 83

Background information: the Display Configuration principle

Display Configuration display

During any positioning action, the underlying grid is displayed. Different colors and frames indicate the possible new positions. The position in the grid where you drop the window determines its position on the screen.

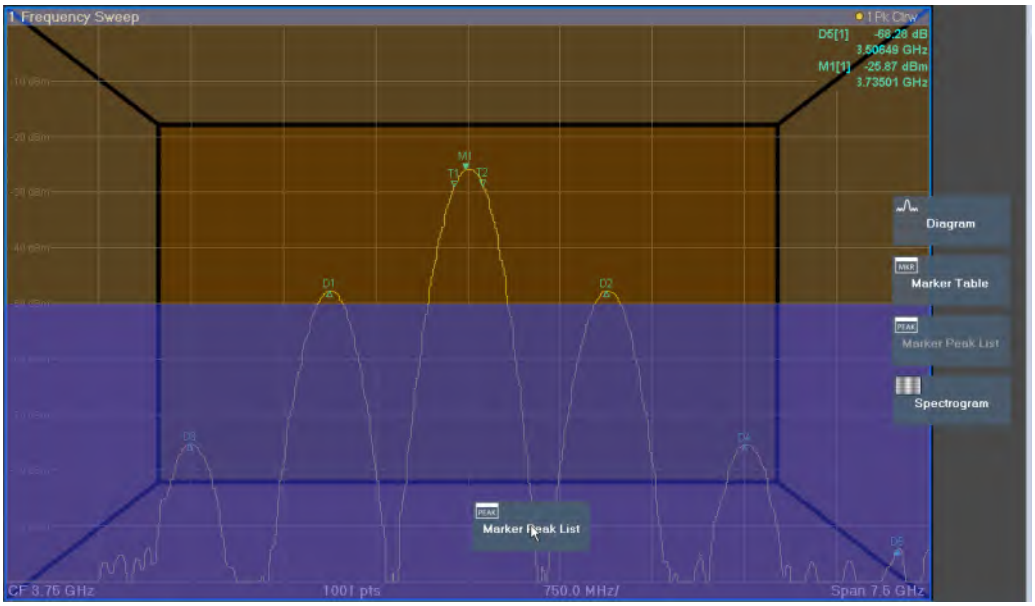


Figure 3-25: Moving a window in Display Configuration mode

The brown area indicates the possible "drop area" for the window, i.e. the area in which the window can be placed. A blue area indicates the (approximate) layout of the window if you drop the icon at the current position. The frames indicate the possible destinations of the new window in relation to the existing windows: above/below, right/

left or replacement (as illustrated in Figure 3-26). If an existing window would be replaced, the drop area is highlighted in a darker color shade.

Positioning the window

The screen can be divided into up to four rows. Each row can be split into up to four columns, where each row can have a different number of columns. However, rows always span the entire width of the screen and cannot be interrupted by a column. A single row is available as the drop area for the window in the grid. The row can be split into columns, or a new row can be inserted above or below the existing row (if the maximum of 4 has not yet been reached).

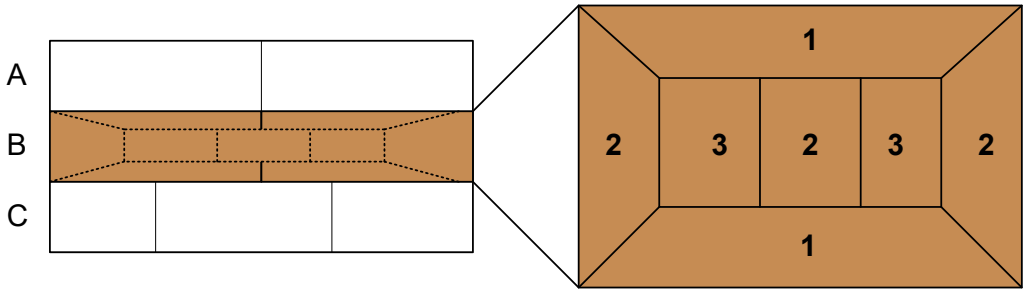


Figure 3-26: Display Configuration window positions

1 = Insert row above or below the existing row
2 = Create a new column in the existing row
3 = Replace a window in the existing row

Display Configuration functions

Once the evaluation icon has been dropped, icons in each window provide delete and move functions.

The "Move" icon allows you to move the position of the window, possibly changing the size and position of the other displayed windows.

The "Delete" icon allows you to close the window, enlarging the display of the remaining windows.

Basic evaluation methods

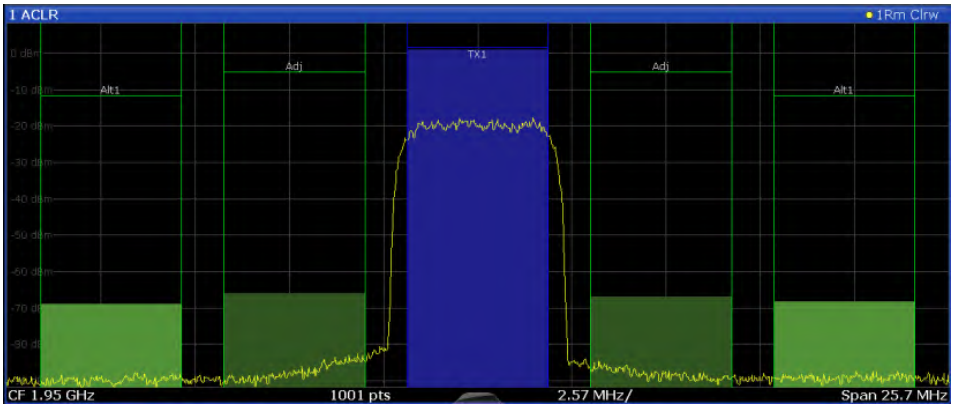
The applications on the FSWX can display and evaluate measurement results using various different methods, also at the same time. Depending on the currently selected measurement, in particular when using optional firmware applications, not all evaluation methods are available.

The evaluation methods described here are available for most measurements in the "Spectrum" application.

Diagram....80
Marker Table....80
Marker Peak List....80
Result Summary....81
Spectrogram....81

Diagram
Displays a basic level vs. frequency or level vs. time diagram of the measured data to evaluate the results graphically. This is the default evaluation method. Which data is displayed in the diagram depends on the trace settings. You can configure the scaling for the y-axis.

See Section 4.8.1.1, "Impact of the trace settings", on page 278 and Section 5.2.3.1, "Scale configuration", on page 964.



Remote command:
`LAY:ADD? '1',RIGH, DIAG`, see`LAYout:ADD[:WINDow]?` on page 656
Results:
`TRACe<n>[:DATA]` on page 688

Marker Table
Displays a table with the current marker values for the enabled markers.

This table is displayed automatically if configured accordingly.

See "Show Marker Table" on page 1186.

2 Marker

Type	Ref	Trc	Stimulus	Response	Function	Function Result
N1		1	13.197 GHz	-25.87 dBm	Count	13.19705
D1	N1	1	-7.942 GHz	-49.41 dB		
D2	N1	2	-3.918 GHz	-21.90 dB		
D3	N1	3	4.024 GHz	-21.99 dB		

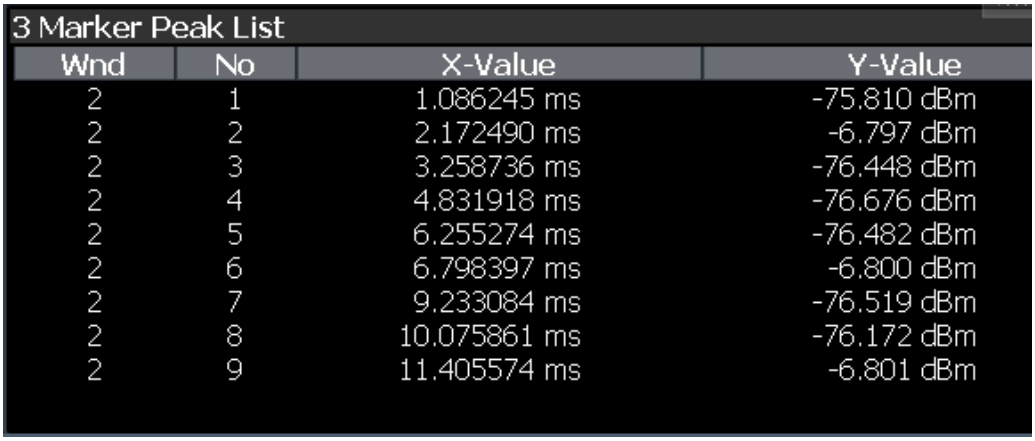
For details, see Table 4-26.

Remote command:
`LAY:ADD? '1',RIGH, MTAB`
Results:
`CALCulate<n>:MARKer<m>:X` on page 703
`CALCulate<n>:MARKer<m>:Y?` on page 718

Marker Peak List
The marker peak list determines the frequencies and levels of peaks in the frequency or time domain. You can define how many peaks to display, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. You can also export the peak list to a file for analysis in an external application.

You can define search and sort criteria to influence the results of the analysis.

For more information, see Section 5.4.2.2, "Marker search settings", on page 1188.



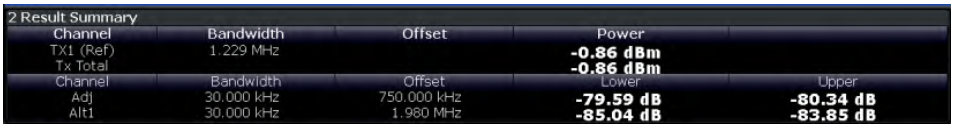
3 Marker Peak List

Wnd	No	X-Value	Y-Value
2	1	1.086245 ms	-75.810 dBm
2	2	2.172490 ms	-6.797 dBm
2	3	3.258736 ms	-76.448 dBm
2	4	4.831918 ms	-76.676 dBm
2	5	6.255274 ms	-76.482 dBm
2	6	6.798397 ms	-6.800 dBm
2	7	9.233084 ms	-76.519 dBm
2	8	10.075861 ms	-76.172 dBm
2	9	11.405574 ms	-6.801 dBm

Tip: To navigate within long marker peak lists, simply scroll through the entries with your finger on the touchscreen.

Remote command:
`LAY:ADD? '1',RIGH, PEAK`
Results:
`CALCulate<n>:MARKer<m>:X` on page 703
`CALCulate<n>:MARKer<m>:Y?` on page 718

Result Summary
Result summaries provide the results of specific measurement functions in a table for numerical evaluation. The contents of the result summary vary depending on the selected measurement function. See the description of the individual measurement functions for details.



2 Result Summary

Channel	Bandwidth	Offset	Power	
TX1 (Ref)	1.229 MHz		-0.86 dBm	
Tx Total			-0.86 dBm	
Channel	**Bandwidth**	**Offset**	**Lower**	**Upper**
Adj	30.000 kHz	750.000 kHz	-79.59 dB	-80.34 dB
Alt1	30.000 kHz	1.980 MHz	-85.04 dB	-83.85 dB

Tip: To navigate within long marker tables, simply scroll through the entries with your finger on the touchscreen.

Remote command:
`LAY:ADD? '1',RIGH, RSUM`, see `LAYout:ADD[:WINDow]?` on page 656

Spectrogram
A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the measurement time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

For details, see "Working with spectrograms" on page 290.

Remote command:
`LAY:ADD? '1',RIGH, SGR`, see `LAYout:ADD[:WINDow]?` on page 656

How to enable Display Configuration mode

You can only change the display layout in "Display Configuration" mode. In "Display Configuration" mode, the evaluation bar replaces the current softkey menu display. When you close the "Display Configuration" mode, the previous softkey menu is restored.

► To enable "Display Configuration" mode, do one of the following:

- 

  From the toolbar, select the "Display Configuration" icon.
- In the configuration "Overview", select "Display Config".
- Select [Meas Config] > "Display Config".

The "Display Configuration" functions and the evaluation bar are displayed.

To close the Display Configuration mode

► Select "Close", or press any key.

The "Display Configuration" functions are no longer available and the previous softkey menu is restored.

How to add a new result window

Each type of evaluation is displayed in a separate window. Each application instance (tab) can display up to 16 individual windows.

1. Enable "Display Configuration" mode.

   All evaluation methods available for the currently selected measurement are displayed as icons in the evaluation bar.
2. Select the icon for the required evaluation method from the evaluation bar.
   If the evaluation bar contains more icons than fit on the screen at once, you can scroll it vertically. Touch the evaluation bar between the icons and move it up or down until the required icon appears.
3. Drag the required icon from the evaluation bar to the grid that is displayed in the diagram area, and drop it at the required position.

See "How to arrange the result windows" on page 83 for more information on positioning the window.

Remote command:

`LAYout:ADD[:WINDow]?` on page 656 / `LAYout:WINDow<n>:ADD?` on page 661

How to close a result window

To close a window

1. Enable "Display Configuration" mode.
2. Select "Delete" for the window.

Remote command:

`LAYout:WINDow<n>:REMove` on page 661

How to arrange the result windows

1. Enable "Display Configuration" mode.
2. Select an icon from the evaluation bar or the "Move" icon for an existing result window.
3. Drag the window over the grid.
   A blue area shows where the window will be placed.
4. Move the window until a suitable area is indicated in blue.
5. Drop the window in the target area.

   The windows are rearranged to the selected layout, and "Delete" and "Move" icons are displayed in each window.
6. To remove a window, select the corresponding "Delete" icon.

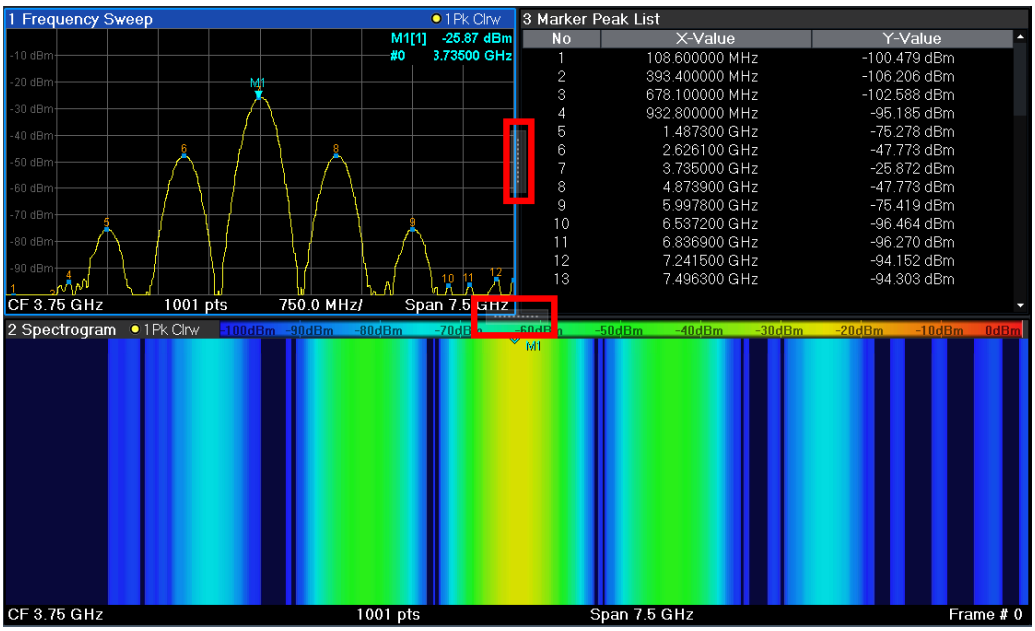
Remote command:

`LAYout:REPLace[:WINDow]` on page 659 /

`LAYout:MOVE[:WINDow]` on page 658

3.6.3.2 Changing the size of windows

Each application tab can contain several windows to evaluate the measurement results using different methods. A splitter allows you to change the size of neighboring windows.



The splitters are not available in "Display Configuration" mode.

► To change the size of two neighboring windows, drag the splitter between the windows in either direction.

3.6.3.3 Switching between a split and maximized window display

To get an overview of the results, displaying several windows at the same time can be helpful. However, the individual windows can become rather small. In this case it is useful to maximize an individual window to the entire screen temporarily to analyze the results in more detail.

To switch between a split and a maximized display without having to close and re-open windows, double-tab the title bar of a window. In maximized display, the currently focused window is maximized. In split display, all active windows are displayed.

3.6.3.4 Switching between a tabbed and custom multi-result window display

Some applications can process data from multiple input sources and combine the results in one window (multi-result display). The display contains multiple traces, one for each source. You can configure each trace individually. Thus, you can easily compare the results from different sources.

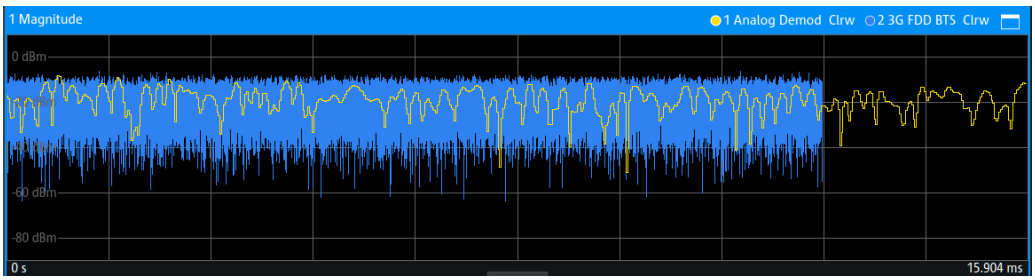


Figure 3-27: Custom multi-result display

As an alternative to this custom multi-result display, some applications provide a tabbed display. In this case, each trace from each input source is displayed in a separate tab of the window. Thus, you can analyze the results from an individual input source more closely. In addition, an overview tab with all traces in one window is provided, similar to the custom multi-result display. In tabbed view, all traces in all windows share the same configuration.

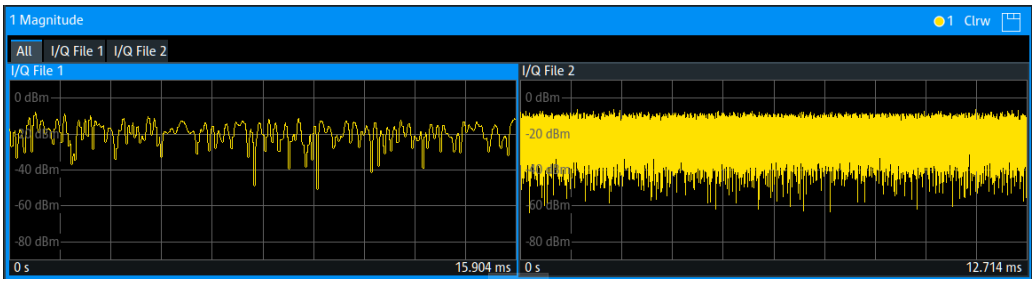


Figure 3-28: Tabbed multi-result display

To switch between the different displays, if available, select the icon in the window title bar.



3.6.3.5 Changing the display

You can optimize the display for your individual needs. The following display functions are available and are described in detail in Section 4.11.6.1, "Display settings", on page 425 and Section 4.8.6, "Zoomed displays", on page 333.

- Displaying a simulation of the entire front panel of the instrument on the screen ("Front Panel")
- Displaying the main function hardkeys in a separate window on the screen ("Mini Front Panel")
- Hiding or showing various screen elements
- Selecting a display theme and colors

- Changing the display update rate
- Activating or deactivating the touch-sensitivity of the screen
- Zooming into the diagram

3.6.4 Means of manual interaction

The FSWX supports several methods to perform a task interactively at the instrument.

Touchscreen

Touchscreen operation is the most direct way to interact. Almost all control elements and actions on the screen are based on the standard operating system concept. You can tap any user interface element to set parameters in dialogs, enter data, scroll within a dialog etc., as if working with a mouse pointer.

Tapping the screen works like clicking mouse buttons:

- Touch quickly = click
  Selects a parameter or provokes an action.
- Touch and hold = right-click
  Opens a context-sensitive menu.
- Touch and drag = drag&drop
  Moves a window (dialog or graphic) by dragging it to a new position on the screen.
- Touch and swipe = drag
  Scrolls through the contents of a display element larger than the screen, e.g. a list or a table.
- Spread or pinch two fingers = zoom out, zoom in
  Increases or decreases the size of an area in a graphical display as it works on your smartphone.

Touch gestures in diagrams change measurement settings

When you change the display using touch gestures, the corresponding measurement settings are adapted. This is different to selecting an area on the screen in zoom mode, where merely the resolution of the displayed trace points is changed temporarily (graphical zoom).

Function keys and rotary knob

The front panel provides nearly all functions and controls to operate the instrument in the classic way, without a touchscreen.

Pressing the rotary knob has the same effect as the [ENTER] key.

Optional mouse and/or keyboard

These devices work as on a common PC. The navigation keys on the front panel correspond to the keys on the keyboard.

This manual describes manual interaction with the instrument via the touchscreen. It mentions the alternative methods using the keys on the instrument or the on-screen

keypads if they deviate from the standard operating procedures. The usage of the touchscreen and navigation keys is described in Section 3.6.5, "Accessing the functionality", on page 87.

Meaning of the term "select"

Throughout the manual, the term "select" refers to any of the following methods:

- Using a finger on the touchscreen
- Using a mouse pointer in the display
- Using a key on the instrument or on a keyboard

3.6.5 Accessing the functionality

You can operate all instrument functions using this user interface.

For most tasks, there are at least 2 alternative methods to perform them:

- Using the touchscreen
- Using other controls provided by the front panel, e.g. the keypad, rotary knob, or arrow and position keys.

You can access the measurement and instrument functions and settings by selecting one of the following elements:

- System and function keys on the front panel of the instrument
- Softkeys on the touchscreen
- Context menus for specific elements on the touchscreen
- Icons on the toolbar in the touchscreen
- Displayed setting on the touchscreen

Changing the focus

Any interaction using the keypad, scrollbar or knobs always affects the currently focused element in the display, e.g. a dialog field, diagram, or table row. The currently focused element is indicated by a blue frame (diagram, window, table) or is otherwise highlighted (softkey, marker etc.). To move the focus, select the element on the touchscreen.

- Toolbar 87
- Softkeys 90
- Dialogs 91
- Context menus 92
- On-screen keyboard 93
- Fast access knobs 93

3.6.5.1 Toolbar

You can perform common functions using the icons in the toolbar at the top of the screen.

You can hide the toolbar display, e.g. when using remote control, to enlarge the display area for the measurement results (Setup > "Display" > "Displayed items").

You can also configure which icons are displayed in the toolbar.

See Section 4.11.1, "Toolbar configuration", on page 397.



The following functions are available by default:

Standard application functions in the toolbar

Operating System
Displays the application menu of the operating system.

For details, see Section 4.12, "System settings and functions", on page 461.

Open
Opens a file from the instrument.

For details, see Section 4.10.3, "Storing and recalling instrument settings and measurement data", on page 358.

Save
Saves data on the instrument.

For details, see Section 4.10.3, "Storing and recalling instrument settings and measurement data", on page 358.

Undo
Reverts last operation.

For details, see "Undo/Redo keys" on page 37.

Redo
Repeats previously reverted operation.

For details, see "Undo/Redo keys" on page 37.

Measurement Zoom
Allows you to select a display to zoom.

In the selected display, a dotted rectangle is shown in the diagram. Expand it by dragging the cursor to define the zoom area. The selected diagram is replaced by a new diagram that displays the selected extract of the trace with adapted measurement settings.

The tool also provides a context menu to determine the firmware behavior for touch gestures:

- "Level-Lock"
  (Default:) The reference level (and thus the attenuation) remains unchanged during touch gestures on the screen.
- "X-Lock"

The x-axis of the diagram is not changed during subsequent touch gestures.

- "Y-Lock"
  The y-axis of the diagram is not changed during subsequent touch gestures.
- "Adapt Measurement to Zoom (selected diagram)"
  Automatically adapts the measurement settings to the currently zoomed display.

For details, see Section 4.8.6, "Zoomed displays", on page 333.



(Graphical) Zoom mode
Allows you to select a display to zoom.

In the selected display, a dotted rectangle is shown in the diagram. Expand it by dragging the cursor to define the zoom area. The selected diagram is replaced by a new diagram that displays the selected extract of the trace, without changing the measurement settings.

For details, see Section 4.8.6, "Zoomed displays", on page 333.

This function changes the behavior of finger gestures such as dragging or stretching a finger.



(Graphical) Multi-Zoom mode
Allows you to select a display to enlarge several different areas of the trace simultaneously.

In the selected display, a dotted rectangle is shown in the diagram. Expand it by dragging the cursor to define the zoom area. A subwindow in the selected diagram displays the selected extract of the trace, without changing the measurement settings. The original diagram indicates the zoom area.

For details, see Section 4.8.6, "Zoomed displays", on page 333.

This function changes the behavior of finger gestures such as dragging or stretching a finger.



Zoom Off
Displays the diagram in its original size.

This function only restores graphically zoomed displays. Measurement zooms, for which measurement settings were adapted, remain untouched.

For details, see Section 4.8.6, "Zoomed displays", on page 333.



Screenshot
Defines print settings.

For details, see Section 4.10.6, "Screenshots of current measurement results and settings", on page 381.



Configure Sequencer
Opens the "Configure Sequencer" menu to perform consecutive measurements.

For details, see Section 4.6.3, "Running a sequence of measurements", on page 270.



SCPI Recorder
Opens a dialog to record SCPI commands during operation.

For details, see Section 4.13.4, "Automating tasks with remote command scripts", on page 504.

Event Based Actions
Opens a dialog to configure actions based on specific events.

For details, see Section 4.9, "Event-based actions", on page 340.

Context Help
Allows you to select an object for which context-specific help is displayed.

For details, see Section 3.6.8, "Getting help", on page 100.

Help
Displays a context-sensitive help topic for the currently selected element.

For details, see Section 3.6.8, "Getting help", on page 100.

Display Configuration
Opens "Display Configuration" mode to configure the screen layout.

For details, see Section 3.6.3.1, "Laying out the result display", on page 77.

Take Screenshot
Prints the current display (screenshot) as configured.

For details, see Section 4.10.6, "Screenshots of current measurement results and settings", on page 381.

Edit Toolbar
Allows you to edit the toolbar.

For details, see Section 4.11.1, "Toolbar configuration", on page 397.

Exit Display Configuration mode
In "Display Configuration" mode only

For details, see Section 3.6.3.1, "Laying out the result display", on page 77.

3.6.5.2 Softkeys

Softkeys are virtual keys provided by the software. Thus, more functions can be provided than can be accessed directly via the function keys on the instrument. Softkeys are dynamic, i.e. depending on the selected function key, a different list of softkeys is displayed on the right side of the screen.

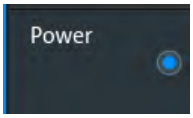
A list of softkeys for a certain function key is also called a menu. Softkeys can either perform a specific function or open a dialog.

You can hide the softkey display, e.g. when using remote control, to enlarge the display area for the measurement results (Setup > "Display" > "Displayed items"). See the user manual for details.

Recognizing the softkey status by color

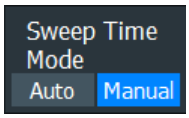


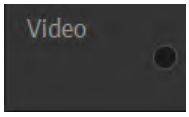
Light gray with blue line at the bottom
Associated dialog is open.



Blue
Associated function is active;

For toggle keys: currently active state





Gray
Instrument function is temporarily not available due to a specific setting or missing option.

3.6.5.3 Dialogs

Dialogs combine the settings for a specific topic, e.g. data acquisition or data export.

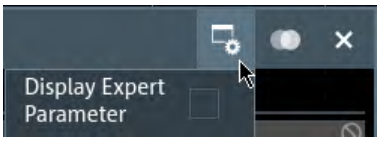
Basic vs. expert parameter display

Some dialogs initially provide only basic parameters to improve readability. If further (expert) parameters are available, an icon is displayed in the dialog title bar.

The basic dialog contains the most important, frequently required settings.

The expert parameters are required for very specific measurement tasks.

Select the icon to display or hide the expert parameters.





If the expert parameters are displayed, the icon is highlighted blue.

Once enabled, the expert settings are displayed in *all* dialogs until you disable the setting again.

You can also enable the expert parameter display by default in the general display settings.

For details, see "Display Expert Parameters" on page 426.

Transparent dialogs

You can change the transparency of the dialogs to see the results in the windows behind the dialog. Thus, you can see the effects that the changes you make to the settings have on the results immediately.

To change the transparency, select the transparency icon at the top of the dialog. A slider is displayed. To hide the slider, select the transparency icon again.



Particularities in system dialogs

Sometimes, e.g. if you want to install a printer, common system dialogs are used. In these dialogs, the rotary knob and function keys do not work. Use the touchscreen instead.

3.6.5.4 Context menus

Several items in the diagram area have context menus, such as traces, markers, softkeys, or settings in the application info panel. If you right-click on one of these items (or tap it for about 1 second), a menu is displayed with context-specific menu items for the selected item.

If SCPI Recording is available, the context menu contains a link to the SCPI recorder functions and a link to a help topic for the specific item.

For details, see Section 4.13.4.1, "Context-sensitive SCPI command menu", on page 505.

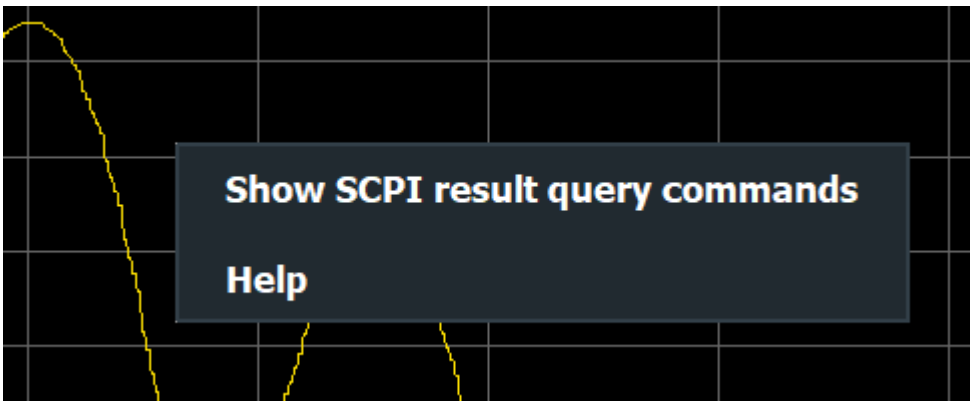


Figure 3-29: Context menu for a result display with SCPI Recorder functions

If SCPI Recorder functions are not available, for example for application info panel settings or in some applications, the context menu contains functions for the selected item. These functions correspond to the functions also provided for the item in softkey menus. This is useful, for example, when the softkey display is hidden.

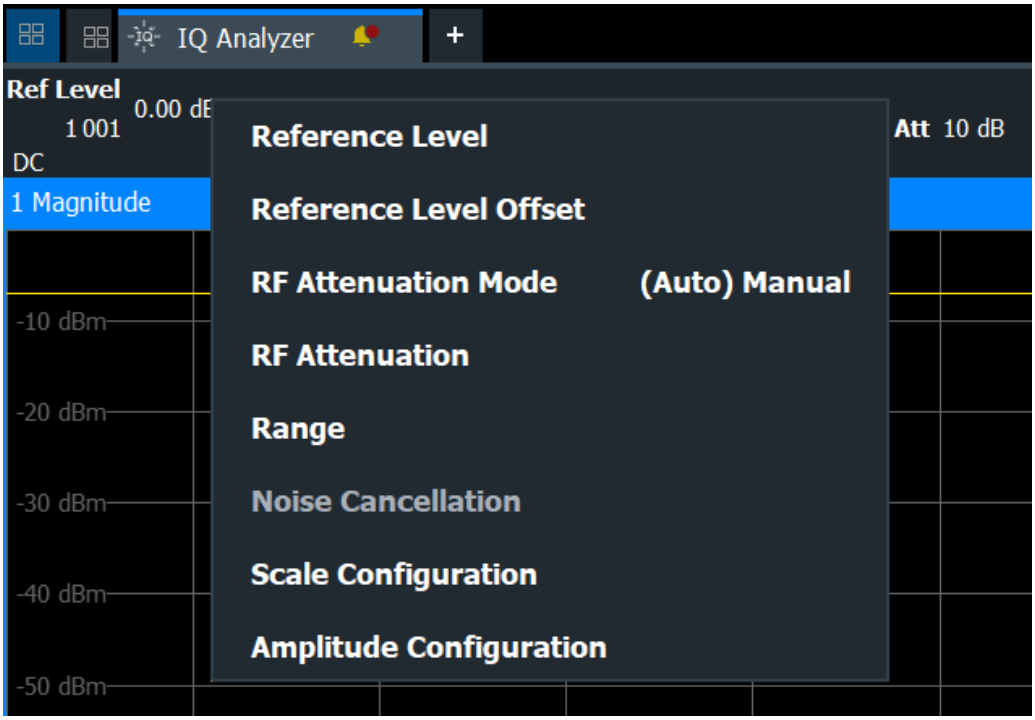
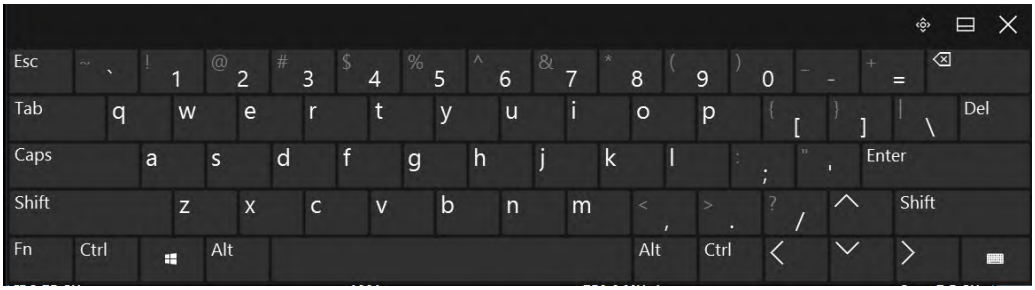


Figure 3-30: Context menu for application info panel setting

3.6.5.5 On-screen keyboard

The on-screen keyboard is an alternative method of entering alphanumeric characters and navigating in dialogs without having to connect an external keyboard.



You can hide or show the on-screen keyboard display using the system key.

You can use the [TAB] key on the on-screen keyboard to move the focus from one field to another in dialogs.

3.6.5.6 Fast access knobs

Two rotary knobs on the front panel of the FSWX are labeled "Knob 1" and "Knob 2" (see Section 3.4.1.11, "Fast access knobs", on page 39).

These knobs provide fast access to a user-configurable set of settings. You can assign several different functions to each knob. The currently active assigned function is indicated on the button above the knobs on the touchscreen. You scroll through the different functions by pressing the knob repeatedly.

For the selected function, the knobs work like the common rotary knob. For example, for the "RF Attenuation" function, turning the fast access knob changes the attenuation by a certain amount. The parameter step size is the same as for the common rotary knob. The difference is that you do not have to navigate to the attenuation parameter through the function menus, but simply turn the knob. In addition, you are able to see the result diagrams the whole time, without dialogs blocking the view.

Since you can assign multiple functions to each knob, you possibly have to select the required function first. The selected function only applies to the currently active application.

If multiple input sources are available, the function only applies to the input source that you most recently selected for editing. The selected source is indicated above the function. You can select the input source first using the "Select Input" function on one of the fast access knobs, if assigned. Both access knobs apply to the same input source.

Example: Steps necessary to change the attenuation without the fast access knobs

1. Press the [Ampt / Scale] key.
2. Select "Amplitude Configuration".
3. Select "RF Attenuation".
4. Turn the rotary knob or enter the attenuation manually to change the attenuation.
5. To change the attenuation again, repeat the procedure.

   During this process, the result displays are blocked by a dialog.

Example: Steps necessary to change the attenuation using the fast access knobs

1. If multiple functions are assigned to the knob:
   Press the fast access knob repeatedly until "Att" is indicated above the knob.
2. Turn the fast access knob to increase or decrease the attenuation.
   To change the attenuation again, simply turn the knob.

   The results on the screen remain visible during this process.

In the factory presettings, a predefined function is assigned to each knob, depending on the application. For example, in the "Spectrum" application, one knob changes the center frequency, and the other changes the volume for audio output. However, you can change the functions.

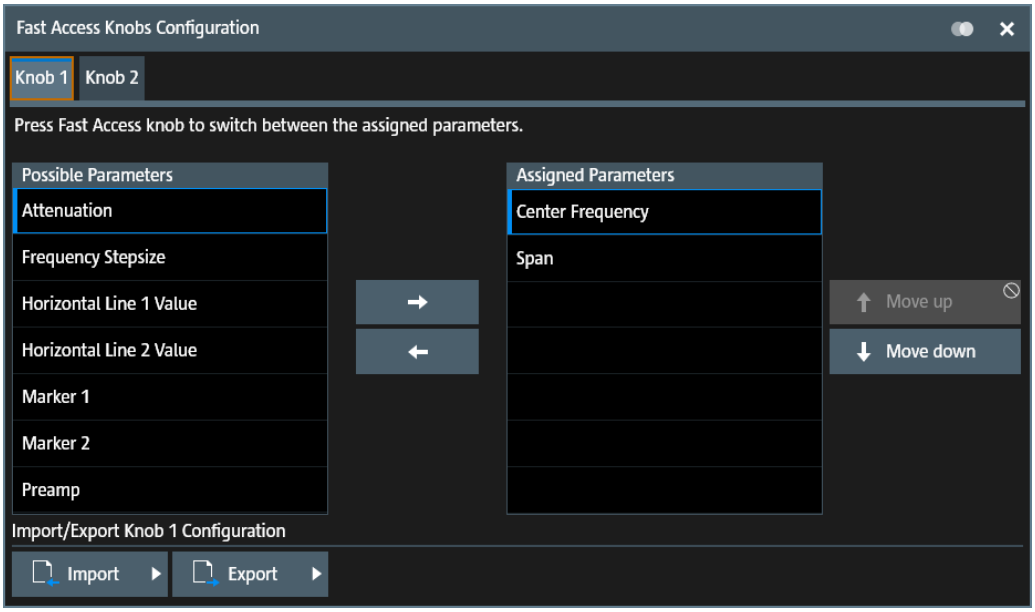
- Fast access knob configuration 95
- Working with fast access knobs 96

Fast access knob configuration



Access: Buttons above the knobs on the touchscreen.

You can assign several different functions to each fast access knob. The same settings are available for each knob, on different tabs.



Possible Parameters....95
Assigned Parameters....95
Assign parameter....95
Remove parameter....95
Move up/ Move down....95
Export....95
Import....96

Possible Parameters
The available parameters depend on the currently active application.

Assigned Parameters
Parameters that are already accessible via the selected fast access knob.

Assign parameter
Assigns the selected function in the "Possible Parameters" list to the knob.

Remove parameter
Removes the selected function in the "Assigned Parameters" list from the knob.

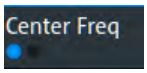
Move up/ Move down
Changes the order of the "Assigned Parameters" for a knob.

Export
Saves the fast access knob configuration to a file.

Import
Restores the fast access knob configuration from a file.

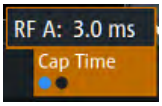
Working with fast access knobs

To select a fast access knob function



1. For each assigned function, a dot is displayed on the button. The currently active function is indicated by a blue dot.
   Press the fast access knob repeatedly until the required function is indicated.
2. Turn the knob to change the parameter value.

   The selected function only applies to the currently active application and to the input source that you most recently selected for editing. If multiple input sources are available, the selected source is indicated above the function.



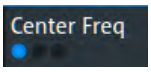
To assign functions to the fast access knobs

1. Select the button above the knob that you want to configure.



   The "Fast Access" configuration dialog opens. You configure each knob on a separate tab.
   The available parameters depend on the currently active application.
2. To assign an additional function to the knob, select one of the "Possible Parameters" on the left and select "move to right".

   The button above the fast access knob shows an additional dot.



3. To remove a function from the knob, select one of the "Assigned Parameters" on the right and select "move to left".

   The dot is removed.
4. To change the order of the "Assigned Parameters" for a knob, select an item and then "Move up"/ "Move down".
5. Optionally, export the fast access knob configuration to a file and import it on a different instrument.

3.6.6 Entering data

You can enter data in dialogs using any of the following methods:

- Using the operating controls provided by the front panel, e.g. the keypad, rotary knob, or navigation keys
- Using the touchscreen and the on-screen keyboard
- Using a connected external keyboard

To enter numeric parameters using the touchscreen and the front panel operating controls

The easiest way to change a parameter value is using the touchscreen and the front panel operating controls.

1. Tap the parameter to change.

   The parameter value becomes editable.

2. Enter the parameter value using the keypad.
   As an alternative, change the currently used parameter value by a specified increment using the rotary knob (small steps) or the [arrow up] or [arrow down] keys (large steps).

   Tip: For a quick entry, you can enter a value in an exponential representation, for example *1e7* for *10000000*.
   See also Section 3.6.7, "Unit shortcuts", on page 99.

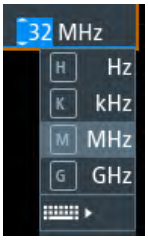
3. Press the corresponding unit key to complete the entry.
   The unit is added to the entry.

4. If the parameter does not require a unit, confirm the entered value by pressing the [ENTER] key or any of the unit keys.

To enter values using a mouse cursor

1. Select the parameter to change.

   The parameter value becomes editable.

2. Select the icon to open the on-screen numeric keypad.



The on-screen numeric keypad provides the same functions as the numeric keypad on the instrument.

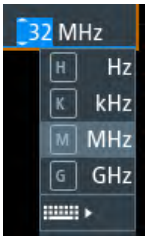
3. Select the required value. The existing value is overwritten.
4. Select the required unit, if applicable.
5. Select ↵ to close the input field and apply the value.

To edit individual digits of a value using a mouse cursor

By default, when you enter a numeric value in an input field, you overwrite the existing value. Some input fields allow you to edit individual digits quickly using a mouse cursor.

1. Select the parameter to change.

   The parameter value becomes editable.



2. Select the digit that you want to edit.
   If a keyboard is connected, use the left and right arrow keys to scroll through the individual digits of the indicated value.



   To add a further digit, scroll left past the first digit.

3. Change the required digit using the numeric keypad or the mouse wheel.
4. To add a digit between existing digits:

   a) Press the [Insert] key.
   The cursor switches to an insert cursor.



b) Enter the new digit using the (on-screen) keypad.
c) Press the [Insert] key again.
The cursor switches back to an editing cursor for the digit to the right.



5. Select the required unit, if applicable.
6. Select ↵ to close the input field and apply the value.

To enter alphanumeric values

If a field requires alphanumeric input, you can use a connected keyboard or the on-screen keyboard to enter letters and characters including special characters.

1. Select the key on the front panel to open the on-screen keyboard.
2. Enter the required input.
3. Press the [ENTER] key or the rotary knob to complete the entry.

To abort the entry

► Press the [ESC] key.
The dialog is closed without changing the settings.

To correct an entry

1. Using the arrow keys, move the cursor to the right of the entry you want to delete.
2. Press the [BACKSPACE] key.
The entry to the left of the cursor is deleted.
3. Enter your correction.

3.6.7 Unit shortcuts

When specifying units or quantities during data entry via a connected keyboard, the FSWX supports the following shortcuts for simplified input.

Further shortcuts can be indicated in the unit selection dropdown box on the front panel, where applicable.



In this case, the shortcuts are only available as long as the unit selection is displayed.

Shortcut	Unit	Factor
f, e-15	femto	10^{-15}
p, e-12	pico	10^{-12}
n, e-9	nano	10^{-9}
u, e-6	micro	10^{-6}
m, e-3	milli	10^{-3}
c	centi	10^{-2}
d	deci	10^{-1}
k, e3	kilo	10^{3}
M, e6	mega	10^{6}
G, e9	giga	10^{9}
T, e12	tera	10^{12}
P, e15	peta	10^{15}

3.6.8 Getting help

If any questions or problems concerning the FSWX arise, an extensive online help system is provided on the instrument and can be consulted at any time. The help system is context-sensitive and provides information specifically for the current operation or setting to be performed. In addition, general topics provide an overview on complete tasks or function groups as well as background information.

The online help can be opened at any time by selecting one of the "Help" icons on the toolbar or by pressing [F1] on an external or the on-screen keyboard.

To call context-sensitive help

► To display the "Help" dialog for the currently focused screen element, e.g. a softkey or a setting in an opened dialog, select the "Help" icon on the toolbar.



The "Help" dialog "View" tab is displayed. A topic containing information about the focused screen element is displayed.
If no context-specific help topic is available, a more general topic or the "Content" tab is displayed.

To display a help topic for a screen element not currently focused



1. Select the "Help" pointer icon on the toolbar.
   The pointer changes its shape to a "?" and an arrow.
2. Select the screen element to change the focus.

   A topic containing information about the selected (now focused) screen element is displayed.

4 General functionality

General functionality is available for all or most applications on the FSWX. It is described only once, for the base unit. For the applications, refer to this description.

4.1 Basic concepts

Some background knowledge on basic terms and concepts in signal and spectrum analysis, in particular using the FSWX, is provided here for a better understanding of the required configuration settings.

- Multiple measurement tasks - application instances 102
- Cross-Application Control and Triggering (CrossACT) 108
- Configuration overview 114
- Basics on data input 114
- Basics on signal splitting and cross-correlation 156
- Methods of correcting the trace 163

4.1.1 Multiple measurement tasks - application instances

The FSWX allows you to perform all sorts of different analysis tasks on different types of signals, for example, communication signals, I/Q analysis or basic spectrum analysis. Depending on the task or type of signal, a different set of measurement functions and parameters are required. Therefore, the FSWX provides various applications - some of which are included in the base unit, others are optional. The default application when you start the FSWX is "Spectrum", for basic spectrum analysis measurements on any type of signal.

You can configure the same application with different measurement settings by creating several instances of the same application. You can also configure multiple different applications at the same time, by creating different application instances. Each application instance is displayed in a separate tab on the screen. By default, each application instance operates independently of the others, measuring and analyzing its own distinct data. The maximum number of application instances is only limited by the available memory on the instrument.



By default, the instrument can only perform one specific measurement at any time, namely the one in the currently active application instance.

Special functionality allows for sequential or simultaneous measurements, see:

- Section 4.1.1.2, "Running a sequence of measurements - the Sequencer concept", on page 103
- Section 4.1.2, "Cross-Application Control and Triggering (CrossACT)", on page 108

- Working with multiple application instances....103
- Running a sequence of measurements - the Sequencer concept....103
- Available applications....105

4.1.1.1 Working with multiple application instances

Access: [Mode]

The default application when you start the FSWX is "Spectrum".

When you activate an application, a new application instance is created which determines the measurement settings for that application. Each application instance is displayed in a separate tab on the screen.

Application tab names

The application tabs are labeled with the default application name. If that name already exists, a sequential number is added. You can change the name of the application instance by double-tapping the tab and entering a new name.

For an overview of default names see Table 4-54.

Application parameters

When you activate a new application instance, a set of parameters is passed on from the current application instance to the new one:

- Center frequency and frequency offset
- Reference level and reference level offset
- Attenuation

When you switch application tabs, the parameters for the application instance are stored, and restored when you return to the application tab. Thus, you can switch between application instances quickly and easily.

Application preset

The [App Preset] key allows you to restore all measurement settings *in the current application instance* to their default values.

To close all application instances on the FSWX (except for the default application instance), select the [Preset] key.

4.1.1.2 Running a sequence of measurements - the Sequencer concept

The instrument can only perform one specific measurement at any time, namely the one in the currently active application instance. However, to perform the configured measurements in the application instances consecutively, the FSWX provides a "Sequencer" function. The "Sequencer" function changes the application instance of the instrument as required. If activated, the measurements configured in the currently defined application instances are performed one after the other, in the order of the tabs.

For each individual measurement, the configured sweep count is considered. Thus, each measurement can consist of several sweeps. The currently active measurement is indicated by a ⚙ symbol in the tab label.

The result displays of the individual application instances are updated in the tabs as the measurements are performed. Sequential operation itself is independent of the currently *displayed* tab.

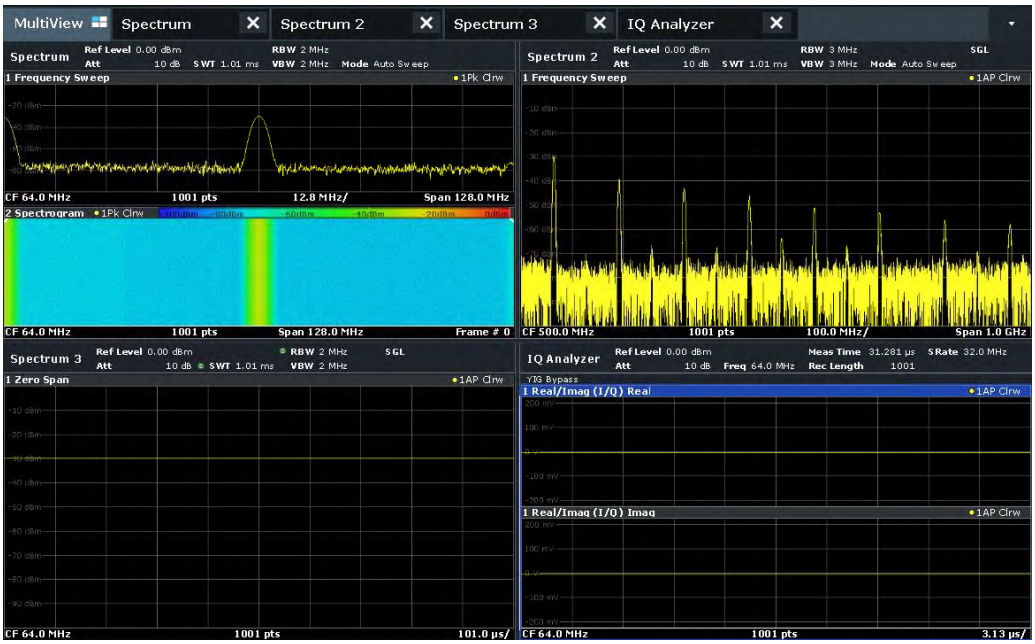
Sequencer modes

Three different "Sequencer" modes are available:

- **"Single Sequence"**
  Similar to single sweep mode; each measurement is performed once, until all measurements in all defined application instances have been performed.
- **"Continuous Sequence"**
  Similar to continuous sweep mode; the measurements in each defined application instance are performed one after the other, repeatedly, in the same order, until sequential operation is stopped. This is the default "Sequencer" mode.
- **"Channel-defined Sequence"**
  First, a single sequence is performed. Then, only application instances in continuous sweep mode are repeated continuously.

Example: Sequencer procedure

Assume the following active application instance definition:



Tab name	Application	Sweep mode	Sweep count
"Spectrum"	"Spectrum"	Cont. Sweep	5
"Spectrum 2"	"Spectrum"	Single Sweep	6

Tab name	Application	Sweep mode	Sweep count
"Spectrum 3"	"Spectrum"	Cont. Sweep	2
"IQ Capture"	"I/Q Capture"	Single Sweep	7

For **"Single Sequence"**, the following sweeps are performed:

5x "Spectrum", 6x "Spectrum 2", 2 x "Spectrum 3", 7x "IQ Capture"

For **"Continuous Sequence"**, the following sweeps are performed:

5x "Spectrum", 6x "Spectrum 2", 2 x "Spectrum 3", 7x "IQ Capture"

5x "Spectrum", 6x "Spectrum 2", 2 x "Spectrum 3", 7x "IQ Capture"

...

For **"Channel-defined Sequence"**, the following sweeps are performed:

5x "Spectrum", 6x "Spectrum 2", 2 x "Spectrum 3", 7x "IQ Capture"

5x "Spectrum", 2 x "Spectrum 3",

5x "Spectrum", 2 x "Spectrum 3",

...

Run Single/Run Cont and Single Sweep/Sweep Continuous keys

While the "Sequencer" is active, the [Run Single] and [Run Cont] keys control the "Sequencer", not individual sweeps. [Run Single] starts the "Sequencer" in single mode, while [Run Cont] starts the "Sequencer" in continuous mode.

The "Single Sweep" and "Continuous Sweep" *softkeys* control the sweep mode for the currently selected application instance only. The sweep mode only has an effect the next time the "Sequencer" activates that application instance, and only for a channel-defined sequence. In this case, the "Sequencer" sweeps an application instance in single sweep mode only once. An application instance in continuous sweep mode is swept repeatedly.

4.1.1.3 Available applications

Access: [Mode]

The default application when you start the FSWX is "Spectrum", for basic spectrum analysis measurements on any type of signal. Optional applications require additional licenses. The application selection in the "Mode" dialog box depends on which licenses are available.

Spectrum 106
I/Q Capture 106
5G NR 106
Amplifier 106
AM/FM/PM Modulation Analysis 107
I/Q Spectrum Analyzer 107
Noise Figure 107
OFDM Signal Analysis (OFDM VSA) 107

Phase Noise....107
Vector Signal Analysis (VSA)....108
WLAN....108

Spectrum
In the "Spectrum" application, the provided functions correspond to a conventional spectrum analyzer. The analyzer measures the frequency spectrum of the RF input signal over the selected frequency range with the selected resolution and sweep time. For a fixed frequency, it displays the waveform of the video signal. This application is used in the initial configuration.

For details, see Section 5.3, "RF measurements", on page 985.

Remote command:
`INST:CRE:NEW SAN, 'Spectrum'`, see `INSTrument:CREate[:NEW]` on page 541

I/Q Capture
Basic I/Q data capturing application. Provided as part of the FSWX base unit.

The "I/Q Capture" application allows you to capture signals from multiple connectors simultaneously. For details, see Section 4.1.4.3, "Multi-input and combined input", on page 154. You can store the captured data to a file for evaluation in other applications.

For details, see Section 6.1, "Welcome to the I/Q Capture application", on page 1451.

For I/Q analysis, see the optional I/Q Spectrum Analyzer.

Remote command:
`INST:CRE:NEW IQC, 'I/Q Capture'`, see `INSTrument:CREate[:NEW]` on page 541

5G NR
The optional 5G NR application requires an instrument equipped with one of the 5G NR Measurements licenses (downlink or uplink).

For details, see the user manuals for the 5G NR downlink and uplink measurement application.

Remote command:
`INST:CRE:NEW NR5G, '5G NR'`, see `INSTrument:CREate[:NEW]` on page 541

Amplifier
The optional "Amplifier" measurement application requires an instrument equipped with the Amplifier Measurements (R&S FSW3-KM118) license. This application provides measurements to measure the efficiency of traditional amplifiers and amplifiers that support envelope tracking with the FSWX.

An additional license provides Direct DPD Measurements (R&S FSW3-KM120).

For details, see the R&S FSW3-KM118 Amplifier user manual.

Remote command:
`INST:CRE:NEW AMPL, 'Amplifier'`, see `INSTrument:CREate[:NEW]` on page 541

AM/FM/PM Modulation Analysis
The optional AM/FM/PM Modulation Analysis application requires an instrument equipped with the AM/FM/PM Modulation Analysis (R&S FSW3-KM107) license. This application provides measurement functions for demodulating AM, FM, or PM signals.

For details, see the R&S FSW3-KM107 AM/FM/PM Modulation Analysis user manual.

Remote command:
`INST:CRE:NEW ADEM, 'Analog Demod'`, see `INSTrument:CREate[:NEW]` on page 541

I/Q Spectrum Analyzer
The optional "I/Q Spectrum Analyzer" application provides comprehensive data capture, measurement and display functions for I/Q data. The "I/Q Spectrum Analyzer" application requires the I/Q Spectrum Analyzer (R&S FSW3-KM100) license.

For details, see the R&S FSW3-KM100 I/Q Spectrum Analyzer user manual.

Remote command:
`INST:CRE:NEW IQS, 'I/Q Spectrum Analyzer'`, see `INSTrument:CREate[:NEW]` on page 541

Noise Figure
The optional Noise Figure application requires an instrument equipped with the Noise Figure Measurements (R&S FSW3-KM125) license. This application provides noise figure measurements.

For details, see the R&S FSW3-KM125 Noise Figure user manual.

Remote command:
`INST:CRE:NEW NOISE, 'Noise'`, see `INSTrument:CREate[:NEW]` on page 541

OFDM Signal Analysis (OFDM VSA)
The optional "OFDM VSA" application requires the OFDM Signal Analysis Measurements (R&S FSW3-KM112) license to be installed. This application provides measurements and evaluations for OFDM vector signal analysis.

For details, see the FSWX-KM112 OFDM Signal Analysis user manual.

Remote command:
`INST:CRE:NEW OFDMVSA, 'OFDM VSA'`, see `INSTrument:CREate[:NEW]` on page 541

Phase Noise
The Phase Noise application requires an instrument equipped with the Phase Noise Measurements (R&S FSW3-KM129) license. This application provides measurements for phase noise tests.

For details, see the R&S FSW3-KM129 Phase Noise user manual.

Remote command:
`INST:CRE:NEW PNOISE, 'Phase Noise'`, see `INSTrument:CREate[:NEW]` on page 541

Vector Signal Analysis (VSA)
The optional "VSA" application requires an instrument equipped with the Vector Signal Analysis (R&S FSW3-KM101) license. This application provides measurements and evaluations for single carrier digitally modulated signals.

For details, see the R&S FSW3-KM101 Vector Signal Analysis user manual.

Remote command:
`INST:CRE:NEW DDEM, 'VSA'`, see `INSTrument:CREate[:NEW]` on page 541

WLAN
The optional WLAN application requires an instrument equipped with the WLAN Measurements (R&S FSW3-KM410) license. This application provides measurements and evaluations according to the WLAN IEEE 802.11 standards.

For details, see the R&S FSW3-KM410 WLAN user manual.

Remote command:
`INST:CRE:NEW WLAN, 'WLAN'`, see `INSTrument:CREate[:NEW]` on page 541

4.1.2 Cross-Application Control and Triggering (CrossACT)

"Cross-Application Control and Triggering" ("CrossACT") allows multiple applications to measure jointly. "CrossACT" is not a separate application, but rather a general feature of the FSWX instrument. It requires the CrossACT (R&S FSW3-KM135) license.

"CrossACT" features:

- Synchronous data capture between multiple application instances, e.g.to analyze LTE and 5G carriers simultaneously
- Synchronous data capture between multiple application instances at different RF inputs, e.g. from different hardware paths
- Synchronous evaluation of time-aligned data in different applications, e.g. multiple carriers being demodulated in different applications
- Evaluation of time-aligned data using different measurement settings (frequency, sample rate etc.), e.g. to measure interference between WLAN and radar signals
- Common display of all data captures for multiple inputs in the "CrossACT" group ("CrossACT visualization")
- Easy configuration of "CrossACT" groups via drag&drop

Not all applications support the "CrossACT" feature. In particular, only I/Q-based applications can be part of a "CrossACT" group. For more information, see Section 4.1.2.4, "Restrictions and limitations of CrossACT", on page 113.

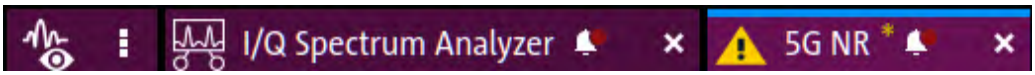
- Defining a CrossACT group 109
- CrossACT display information 109
- Processing CrossACT measurements 111
- Restrictions and limitations of CrossACT 113

4.1.2.1 Defining a CrossACT group

A "CrossACT" group can contain multiple applications or multiple instances of the same application. All members of a "CrossACT" group perform a measurement at the same time, using the same trigger.

The easiest way to define a group is by dragging and dropping the tabs of active applications that support the feature on top of each other. While dragging, applications that support the "CrossACT" feature are highlighted. You can also create a group and add further applications or instances via the "Mode" dialog box. For details, see Section 4.6.4.3, "How to control and trigger linked applications", on page 275.

A "CrossACT" group is indicated by a common color on the tabs and a preceding icon.



To remove an application instance from a "CrossACT" group, simply drag it outside the group area. If the remaining group contains only one application instance, the group is dissolved and the colored area is removed.

See also Section 4.1.2.2, "CrossACT display information", on page 109.

Order of CrossACT members

The order of the applications within the "CrossACT" group is relevant. The first application instance from the left is referred to as the *primary* application. It determines which parameters are used if conflicts arise. When you initially drag an application instance onto another to create a "CrossACT" group, the left-most application instance becomes the primary application in the group. If you drag an application instance into an existing group, it is placed where you drop it. You can change the position within the group simply by dragging and dropping.

4.1.2.2 CrossACT display information

Figure 4-1 shows the default display when you create a "CrossACT" group.

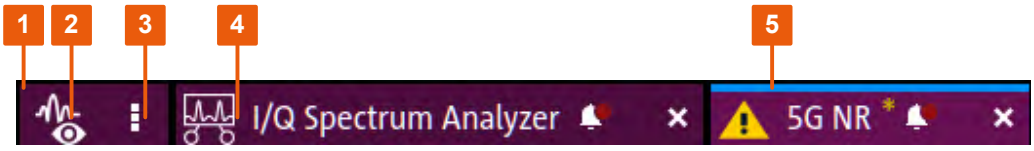


Figure 4-1: Screen elements for a CrossACT group

1 = "CrossACT" colored group area
2 = "CrossACT" data capture visualization
3 = "CrossACT" function menu, see Section 4.6.4, "Linking measurements (CrossACT)", on page 271
4 = Primary application
5 = Currently displayed (active) application

CrossACT group colored group area

A colored area indicates which applications belong to the "CrossACT" group. The left-most application controls the data capturing process.

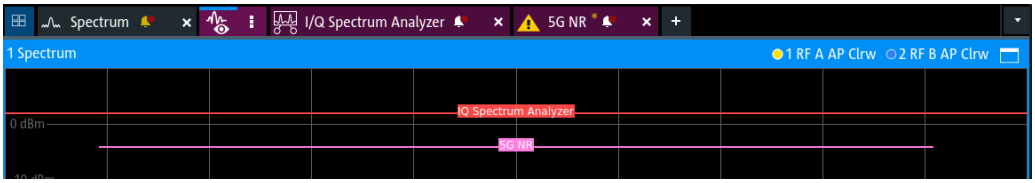
The group colors are also shown in the "MultiView" display.



CrossACT data capture visualization

The data captured by the "CrossACT" group is displayed in a common "Spectrum" display. For multiple inputs, each input is assigned to a different trace. If discrete frequency ranges are measured, the display indicates the ranges for the individual applications.

Optionally, you can switch to tabbed view to display the spectra for the individual frequency ranges in separate windows. See also Section 3.6.3.4, "Switching between a tabbed and custom multi-result window display", on page 84.



The "CrossACT" "Spectrum" display does not support markers, trace configuration or manual scaling.

If the "CrossACT" data capture visualization window is active, you cannot use the "Save" > "Save current application instance" function to save the application-specific data. Save the data in the individual application instances.

I/Q export for the whole "CrossACT" group is not supported.

4.1.2.3 Processing CrossACT measurements

The main goal of "Cross-Application Control and Triggering" is to have a time-aligned data basis for analysis. Thus, all "CrossACT" applications use the same trigger, possibly considering a specified capture offset.

Joint trigger

A joint trigger allows you to capture data from different input connectors at the same time, referred to as *synchronous capturing*. Thus, you can analyze effects in signals that are correlated in time. Using different input connectors allows you to optimize leveling, bandwidth and frequency parameters for the different signals. For example, you can determine the EVM for a modulated signal before and after an amplifier. In this setup, each application controls exactly one input connector.

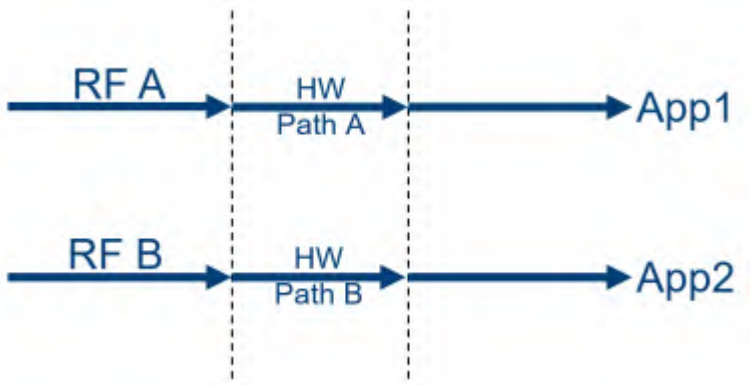


Figure 4-2: Joint trigger on different input connectors

Joint trigger configuration

Initially, the trigger source defined by the primary (left-most) application in the group triggers the data capture for all application instances in the "CrossACT" group. For all secondary applications in the group, the "Trigger" is set to "Follow". If you change the trigger source for one application instance, it is used for the whole "CrossACT" group. For all other applications in the group, the "Trigger" is set to "Follow".

Example:

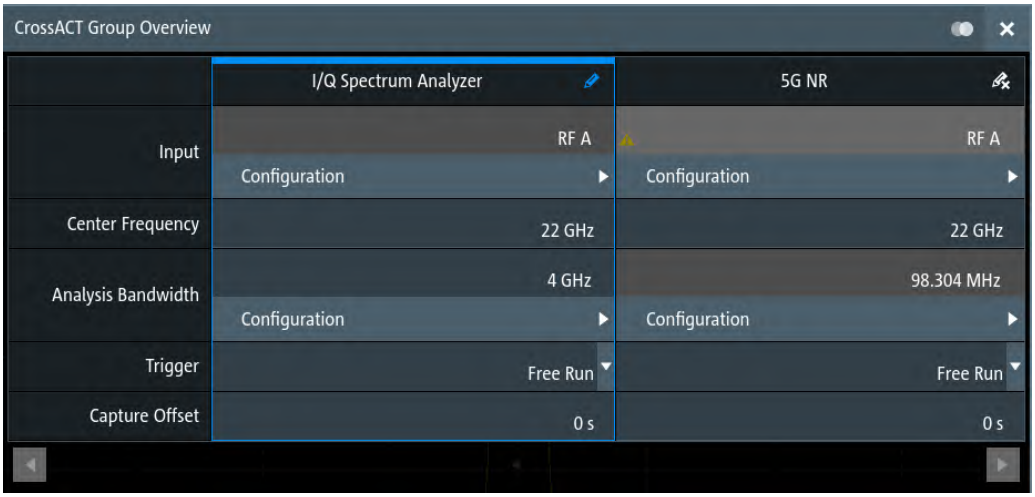


Figure 4-3: Joint trigger in a CrossACT group

In Figure 4-3, the "VSA" application defines the trigger. For the "I/Q Capture" application, the trigger is set to "Follow". When the "VSA" application is triggered, the "I/Q Capture" application is also triggered, it follows the primary trigger. If you change the trigger for the "I/Q Capture" application, the "I/Q Capture" trigger becomes the primary trigger. The trigger source for the "VSA" application is set to "Follow".

Any other parameters of the application instances in the group are not changed when you change the setting for one member.

Group measurement

When you start a measurement for one of the "CrossACT" members, for example using Run Single or Run Cont, the FSWX triggers a synchronous data capture for all applications in the group. All "CrossACT" applications capture the data from the different input connectors at the same time. Based on the synchronous data capture, the applications then analyze the data individually. The captured data is shown in a special "CrossACT" visualization window. See "CrossACT data capture visualization" on page 110.

If you select any function key other than Run Single or Run Cont, the function is applied to the currently active application instance, not to the whole "CrossACT" group.

When you define a new "CrossACT" group, or add an application instance to an existing group, all currently running measurements are aborted. Any existing measurement results are cleared. Thus, all application instances are in a known state before they are linked. The measurement mode of the currently active application instance determines the subsequent behavior of the whole "CrossACT" group. Thus, if the active instance is in Run Cont mode when you add it to the group, the whole group will start a continuous measurement. If the active instance is in Run Single mode when you add it to the group, the whole group will stop and wait for a new measurement start.

Conflicting parameters in CrossACT

If multiple "CrossACT" members use the same input source, a conflict arises. In this case, the following rules apply:

1. Only the left-most application instance in the group that uses the duplicate input source performs a measurement.
2. Any application instance with conflicting parameters does not take part in the measurement. The application instance remains in the "CrossACT" group.

Refer to the status messages if conflicts arise.

4.1.2.4 Restrictions and limitations of CrossACT

The following restrictions and limitations apply to "CrossACT":

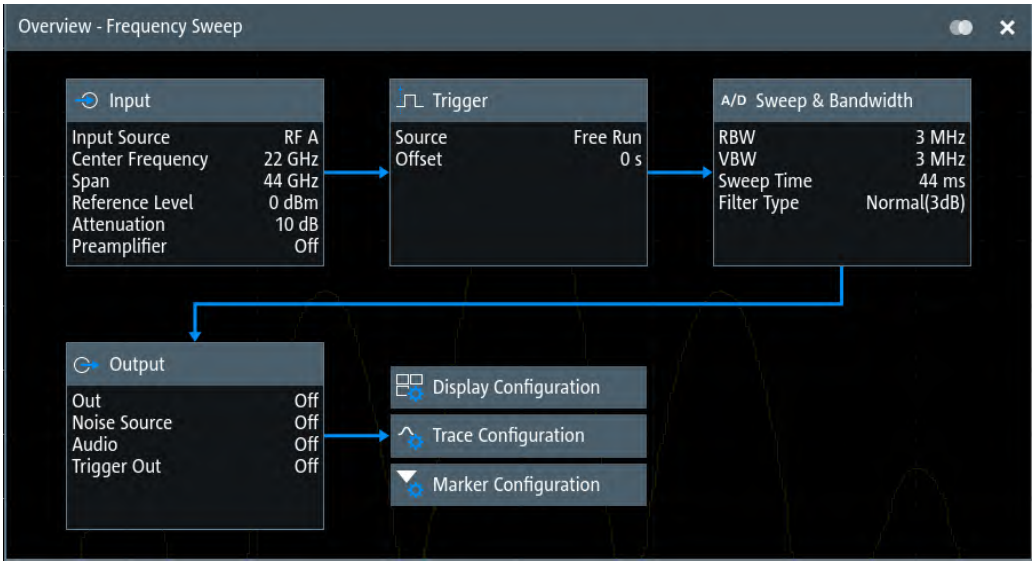
- You can define both linked and independent applications at the same time, but the same application *instance* can only be linked *or* independent.
- You can define only a single "CrossACT" group at a time.
- A "CrossACT" group must contain 2 application instances. The instances can be of the same application type or different types.
- Not all applications support the "CrossACT" feature. In particular, only I/Q-based applications can be part of a "CrossACT" group. Currently, the following applications can be part of a "CrossACT" group:
  - "5G NR" (I/Q measurement only)
  - "I/Q Capture"
  - "I/Q Spectrum Analyzer"
- Measurements based on file input cannot be measured in a "CrossACT" group.
- Each application instance in the "CrossACT" group can only use a single input source.
- Each input source can only be used by a single application instance within a "CrossACT" group.
- Measurements that require multiple data captures cannot be performed in a "CrossACT" group, for example:
  - Multi-sweep measurements
  - Statistics measurements
  - Gated measurements
  - Pre-measurements for auto functions
  - Noise correction
- Trace averaging (sweep count > 1) is not supported.
- Cross-correlation functionality is not supported.

If a "CrossACT" settings conflict occurs, a conflict icon is displayed in the tab of the conflicting application instance and for the conflicting parameter in the "CrossACT" group overview. Click the icon or see the status message bar for details on the conflict.

4.1.3 Configuration overview



Each application instance provides an overview of the most important currently defined settings and access to the most important configuration dialog boxes for the particular measurement. This overview is available via the "Overview" icon, which is displayed in all menus.



Using this overview, you can easily configure an entire application from input over processing to output and analysis, by stepping through the dialog boxes as indicated.

4.1.4 Basics on data input

Some background knowledge on basic terms and concepts concerning data input, in particular using the FSWX, is provided here for a better understanding of the required configuration settings.

- Basics on RF input 114
- Basics on I/Q data input and output 116
- Multi-input and combined input 154

4.1.4.1 Basics on RF input

To analyze a radio frequency (RF) signal from a connected device under test (DUT), you provide the RF input to the FSWX via one of the 50-Ω RF input connectors. You must define which input source is used for the application instance.

An LED next to the connector lights up when the input connector is activated for a measurement.

RF input protection

Protect the RF input connectors of the FSWX against signal levels that exceed the ranges defined in the specifications document. The FSWX is equipped with an overload protection mechanism for DC and signal frequencies up to 30 MHz. This mechanism becomes active as soon as the power at the input mixer exceeds the specified limit. It ensures that the connection between RF input and input mixer is cut off.

When the overload protection is activated, an error message is displayed in the status bar ("INPUT OVLD"), and a message box informs you that the RF input was disconnected. Furthermore, a status bit (bit 3) in the `STAT:QUES:POW` status register is set. In this case, you must decrease the level at the RF input connector and then close the message box. Then measurement is possible again. Reactivating the RF input is also possible via the remote command `INPut<ip>:ATTenuation:PROTection:RESet` on page 553.

If necessary, define an attenuation to protect the input mixer from high RF input levels. High input levels cannot only damage the instrument, they can also lead to incorrect measurement results. See also Section 4.3.2.2, "Sensitivity of the hardware: RF attenuation", on page 239.

AC/DC coupling

You can couple the RF input to the DUT by alternating current (AC) or direct current (DC). AC coupling blocks any DC voltage from the input signal. AC coupling is the default setting to prevent damage to the instrument. However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the specifications document.

Maximum pulse power at the RF input

When you apply a pulsed signal at the RF input of the FSWX, you need to check the maximum pulse power. Consider the following values in the specifications document.

- CW RF power, which is the mean power at the RF input
- Max. pulse voltage
- Max. pulse energy for a pulse of a specified duration (width)

Example: Calculating the required attenuation for a pulsed signal

Assume a pulsed signal with the following characteristics:

- Pulse power: 100 W
- Pulse duration: 100 µs

How do you calculate how much external attenuation is required so the signal does not damage the instrument?

Assume the following values for the instrument (these values are an example only, check the specifications document for exact values of the FSWX):

- CW RF power (with ≥10 dB RF attenuation): 30 dBm (= 1 W)

- Max. pulse voltage (with ≥10 dB RF attenuation): 150 V
- Max. pulse energy for a pulse duration of 10 µs (with ≥10 dB RF attenuation): 1 mWs

For a pulse power of 100 Watt and 50 Ω impedance, the input voltage is 70 V_{eff} or 100 V_{peak}. The maximum pulse voltage of 150 V is not exceeded.

The pulse energy is calculated as:

*E = P*t*

In this example: 100 W * 100 µs = 10 mWs. The maximum pulse energy exceeds the specified limit of 1 mWs. Thus, we need an external attenuation of 10 dB to reduce the energy at the RF input.

As a rule of thumb, the maximum pulse energy decreases by a factor of 2 for an increase in pulse length by a factor of 10. In our example, the max. pulse energy for a pulse duration of 100 µs (=10*10 µs) increases to 2 mWs.

The 100 us pulse with 100 Watts (=10 mWs) needs at least 3 dB external attenuation, as the instrument can handle 5 mWs at 100 us pulse length.

Using this external attenuation, we need to check the mean input power.

P_{mean}=(P/ <attenuation>)(<pulse_width>/<pulse_repetition_interval>)*

In our example, the following must apply:

*(100 W/10 dB)*100 µs / <pulse_repetition_interval> ≤1 W*

Thus, for a pulse repetition interval larger than 100 ms, the pulse signal does not exceed the limits.

4.1.4.2 Basics on I/Q data input and output

For modulated signals, the baseband data is usually modulated on a carrier frequency. If the baseband signal contains complex (or: *I/Q*) data, it consists of an imaginary (I) and a real (Q) component.

How I/Q data is processed

In modern phone systems and in radiocommunication, the baseband data is modulated on a carrier frequency, which is then transmitted. The receiver must demodulate the data based on the carrier frequency. When using modern modulation methods (e.g. QPSK or QAM), the baseband signal becomes complex. Complex data (or: *I/Q* data) consists of an imaginary (I) and a real (Q) component.

Sweep vs sampling

Traditionally, a spectrum analyzer performs analog sweeps across a defined frequency range. The FSWX digitally samples the individual I and Q components of the complex signal. The sampled data is then processed via FFT to determine the spectral components. The entire frequency range supported by the instrument can be processed in a multiple digital sweeps. Filter banks are used for preselection. The FFT is performed

on multiple subspans. Since the individual subspans can be processed in parallel, digital processing is much faster than an analog sweep.

Note that in the "Spectrum" mode of the FSWX, you cannot store the raw I/Q data. You can only export the processed (trace) data of the spectral results.

- Processing analog I/Q data from RF input 117
- Impact of the FFT parameters 117

Processing analog I/Q data from RF input

The basic "I/Q Capture" application captures I/Q data on the FSWX. By default, it assumes that the I/Q data is modulated on a carrier frequency and input via the "RF Input" connector on the FSWX.

The A/D converter samples the IF signal at a rate of 200 MHz. The subsequent components convert the digital signal down to the complex baseband, apply a lowpass filter, and reduce the sample rate. The analog filter stages in the FSWX cause a frequency response, which adds to the modulation errors. An **equalizer filter** before the **resampler** compensates for this frequency response. An optimal decimation filter resamples at a continuously adjustable sample rate, and thus provides the required sample rate.

The FSWX contains a dedicated memory (**capture buffer**) for a maximum of 400 Msamples (400*1000*1000) of complex samples (pairs of I and Q data). You can define the number of complex samples to capture (for restrictions refer to "Sample rate and maximum usable I/Q bandwidth for RF input" on page 123).

The block diagram in Figure 4-4 shows the FSWX hardware from the IF section to the processor.

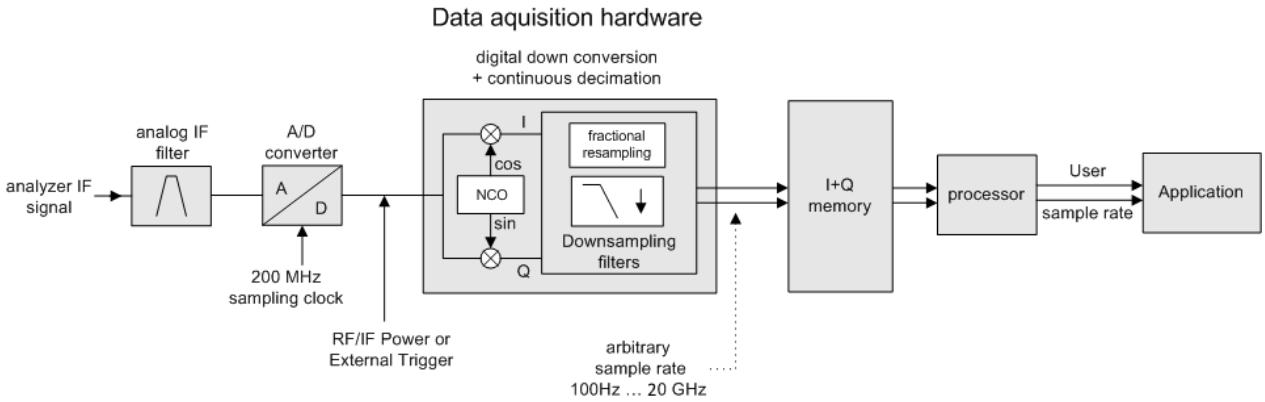
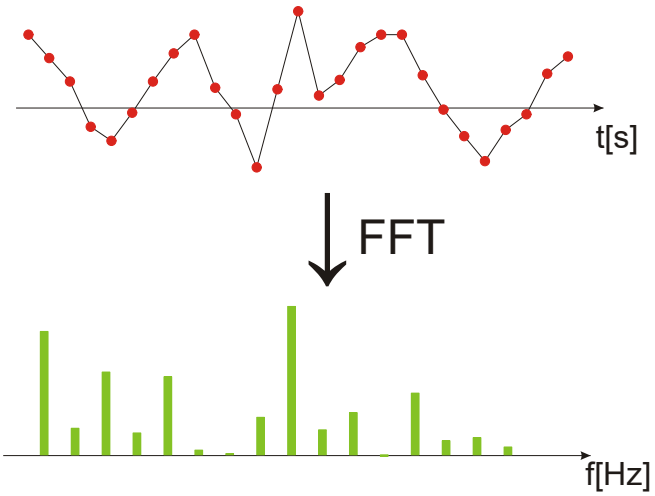


Figure 4-4: Block diagram illustrating the FSWX signal processing for analog I/Q data (without bandwidth extension options)

Impact of the FFT parameters

The FSWX measures the power of the signal input over time. To convert the time domain signal to a frequency spectrum, theFSWX performs an FFT (fast Fourier transform). The FFT converts a vector of input values into a discrete spectrum of frequencies.



Window functions

The FSWX does not perform the Fourier transformation on the entire captured data in one step. It uses only a limited number of samples to calculate an individual result. This process is called windowing.

After sampling in the time domain, the FSWX multiplies each window with a specific window function. Windowing helps minimize the discontinuities at the end of the measured signal interval. Thus, the effect of spectral leakage is reduced, increasing the frequency resolution.

The FSWX provides various different window functions to suit different input signals. Each of the window functions has specific characteristics, including some advantages and some trade-offs. Consider these characteristics to find the optimum solution for the measurement task.

Ignoring the window function - rectangular window

The rectangular window function is in effect not a function at all, it maintains the original sampled data. This function can be useful to minimize the required bandwidth. However, if the window does not contain exactly one period of your signal, heavy sidelobes can occur, which do not exist in the original signal.

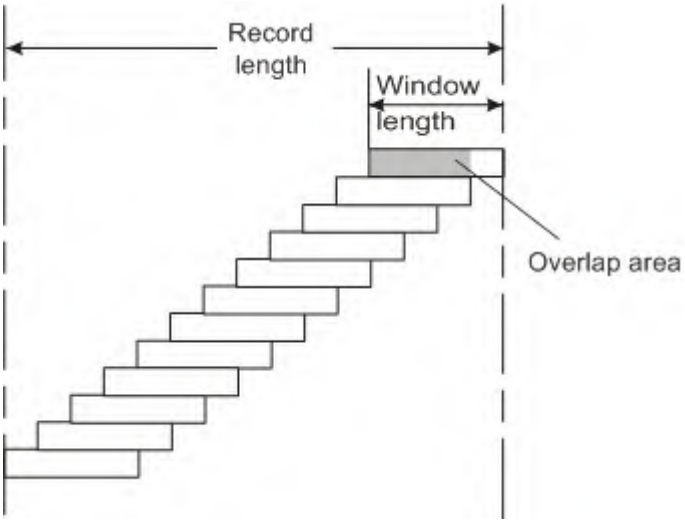
Table 4-1: Characteristics of typical FFT window functions

Window type	Frequency resolution	Magnitude resolution	Sidelobe suppression	Measurement recommendation
Rectangular	Best	Worst	Worst	No function applied. Separation of two tones with almost equal amplitudes and a small frequency distance
Blackman-Harris (default)	Good	Good	Good	Harmonic detection and spurious emission detection
Gauss (Alpha = 0.4)	Good	Good	Good	Weak signals and short duration

Window type	Frequency resolution	Magnitude resolution	Sidelobe suppression	Measurement recommendation
Flattop	Worst	Best	Good	Accurate single tone measurements
5-Term	Good	Good	Best	Measurements with very high dynamic range

Overlapping

The FSWX calculates multiple FFTs per measurement by dividing one captured record into several windows. Furthermore, the FSWX allows consecutive windows to overlap. Overlapping "reuses" samples that were already used to calculate the preceding FFT result.



In advanced FFT mode with averaging, you can define the overlapping factor. The higher the overlap factor, the more windows are used. Overlapping leads to more individual results and improves detection of transient signal effects. However, it also extends the duration of the calculation. You can define the size of the window manually according to the capture length, the overlap factor, and the FFT length.

An FFT overlap of 67%, for example, means that the second FFT calculation uses the last 67% of the data of the first FFT. It uses only 33% new data. The third FFT still covers 33% of the first FFT and 67% of the second FFT, and so on.

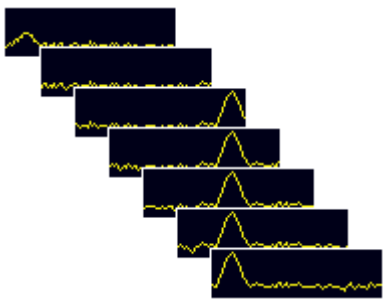


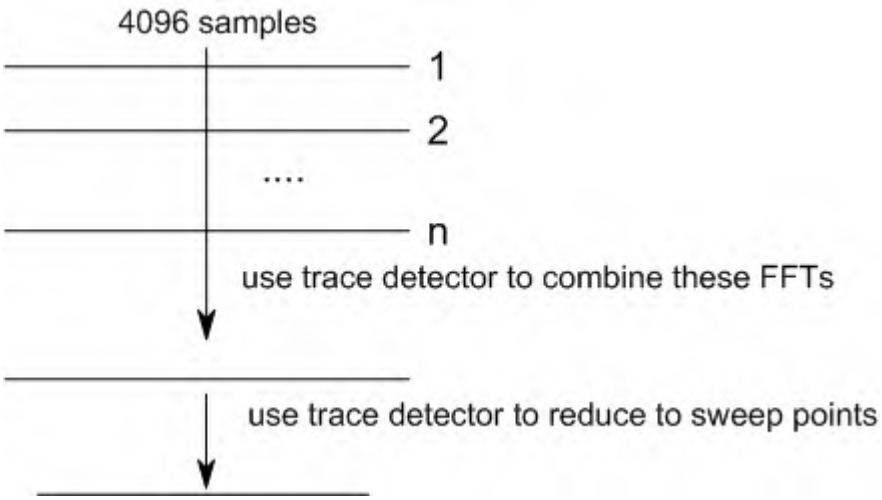
Figure 4-5: Overlapping FFTs

In FFT mode, an FFT length of 4096 and a window length of 4096 (or the capture length, if shorter) is used to calculate the spectrum.

Combining results - trace detector

If the capture length permits, the FSWX calculates multiple overlapping windows and combines them to create the final spectrum using the selected trace detector. If necessary, the trace detector also reduces the number of calculated frequency points (defined by the FFT length) to the defined number of sweep points. By default, the "Autopeak" trace detector is used.

Since the detector reduces the frequency points to the number of sweep points, using a detector other than "Auto Peak" and fewer than 4096 sweep points can lead to false level results.



Dependencies between FFT parameters

FFT analysis in the FSWX is highly configurable. You can define several parameters, including the resolution bandwidth, capture length, and FFT length. Note, however, that several parameters are correlated and cannot be configured independently of the others.

Capture length

Defines the number of I/Q samples to capture. By default, the number of sweep points is used. The capture length is calculated as the measurement time multiplied by the sample rate.

If you change the capture length, the measurement time is automatically changed, as well.

For FFTs using only a single window ("Single" mode), the capture length (which is then identical to the FFT length) must not exceed 512k.

FFT length

Defines the number of frequency points determined by each FFT calculation. The more points are used, the higher the resolution in the spectrum becomes, but the longer the calculation takes.

In basic FFT mode, an FFT length of 4096 is used.

In advanced FFT mode, you can define the FFT length manually. If you use the arrow keys or the rotary knob to change the FFT length, the value is incremented or decremented by powers of 2. If you enter the value manually, any integer value from 3 to 524288 is available.

If the FFT length is longer than the FFT window length, the sample data is filled up with zeros up to the FFT length. The FFT is then performed using interpolated frequency points.

For an FFT length that is not a power of 2, a DFT (discrete Fourier transform) is performed, which requires more time for calculation, but avoids the effects of interpolation.

In advanced FFT mode, to display all calculated frequency points (defined by the FFT length), the number of sweep points is set to the FFT length automatically.

Window length

Defines the number of samples to be included in a single window in averaging mode. In single mode, the window length corresponds to the capture length.

Values from 3 to 4096 are available in basic mode. In "Advanced" FFT mode, values from 3 to 524288 are available. However, the window length must not be longer than the FFT length.

If the window length is shorter than the FFT length, the sample data is filled up with zeros up to the FFT length.

If the window length is longer than the capture length (that is, not enough samples are available), a window length the size of the capture length is used for calculation.

The window length and the FFT window overlap determine how many FFT calculations must be performed for each record in averaging mode.

Frequency resolution of FFT results - RBW

The **resolution bandwidth** defines the minimum frequency distance at which the individual components of a spectrum can be distinguished. Small values result in high precision, as the distance between two distinguishable frequencies is small. Higher values decrease the precision, but increase measurement speed.

The RBW is determined by the following equation:

$$RBW = Normalized\,Bandwidth * \frac{Sample\ Rate}{Window\ Length}$$

Equation 4-1: Definition of RBW

Note: The normalized bandwidth is a fixed value that takes the noise bandwidth of the window function into consideration.

If a higher spectral resolution is required, increase the number of samples by using a higher sample rate or longer capture length.

The minimum achievable RBW depends on the sample rate and capture length, according to the following equation:

$$RBW_{min} = \frac{NormalizedBandwidth * Sample\ Rate}{min(4096, Record\ Length)}$$

To simplify operation, some parameters are coupled and automatically calculated, such as capture length and RBW.

RBW mode

Depending on the selected RBW mode, the resolution bandwidth is either determined automatically, or you can define it manually.

Auto mode:

The default mode in the "I/Q Capture" application. The RBW is determined automatically depending on the sample rate and FFT window length. The window length corresponds to the capture length, or a maximum of 4096.

If the capture length is larger than the window length, multiple windows are combined; the FFT length is 4096.

A Flatop window function is used.

Manual mode:

The RBW is user-definable.

The FFT window length is adapted to comply with Equation 4-1. Only window lengths with integer values are supported. Thus, the sample rate is adapted, if necessary, to obtain an integer window length value.

If the capture length is larger than the window length, multiple windows are combined; the FFT length is 4096.

A Flatop window function is used.

FFT calculation methods

The FFT can be calculated using different methods.

Single

In single mode, one FFT is calculated for the entire capture length. That means the window length is identical to the capture length.

If the defined FFT length is larger than the capture length, zeros are appended to the captured data to reach the FFT length.



Figure 4-6: FFT parameters for single FFT calculation

Averaging

In averaging mode, several overlapping FFTs are calculated for each record; the results are combined to determine the final FFT result for the record.

The number of FFTs to be combined is determined by the window overlap and the FFT window length.



Figure 4-7: FFT parameters for averaged FFT calculation

Sample rate and maximum usable I/Q bandwidth for RF input

Definitions

- **Input sample rate (ISR)**: the sample rate of the useful data provided by the input signal source on the FSWX.
- (User, Output) **Sample rate (SR)**: the user-defined sample rate (e.g. in the "Data Acquisition" dialog box in the "I/Q Capture" application) which is used as the basis for analysis or output.
- **Usable I/Q (analysis) bandwidth**: the bandwidth range in which the signal remains undistorted in regard to amplitude characteristic and group delay. The FSWX can only analyze data in this range accurately.
- **Capture length**: the number of I/Q samples to capture during the specified capture time. Calculated as the capture time multiplied by the sample rate.

For the I/Q data acquisition, digital decimation filters are used internally in the FSWX. The passband of these digital filters determines the *maximum usable I/Q bandwidth*. In consequence, signals within the usable I/Q bandwidth (passband) remain unchanged, while signals outside the usable I/Q bandwidth (passband) are suppressed. Usually, the suppressed signals are noise, artifacts, and the second IF sideband. If frequencies of interest to you are also suppressed, try to increase the output sample rate, which increases the maximum usable I/Q bandwidth.

Bandwidth extension options

You can extend the maximum usable I/Q bandwidth provided by the FSWX in the basic installation by adding options. These options can either be included in the initial installation (B-options) or updated later (U-options). The maximum bandwidth provided by the individual option is indicated by its number, for example, B4G extends the bandwidth to 4 GHz.

As a rule, the usable I/Q bandwidth is proportional to the output sample rate. Yet, when the I/Q bandwidth reaches the bandwidth of the analog IF filter (at very high output sample rates), the curve breaks.

- Available bandwidth extension options..... 124
- Relationship between sample rate, capture length and usable I/Q bandwidth..... 124

Available bandwidth extension options

Table 4-2: Available bandwidth extension options

Max. usable I/Q bandwidth	Required B-option
100 MHz	B100
320 MHz	B320
600 MHz	B600
1200 MHz	B1G2
2000 MHz	B2G
4000 MHz	B4G
6000 MHz	B6G
8000 MHz	B8G

Relationship between sample rate, capture length and usable I/Q bandwidth

Up to the maximum bandwidth, the following rule applies:

*Usable I/Q bandwidth = 0.8 * Output sample rate*

Regarding the capture length, the following rule applies:

*capture length = capture time * sample rate*

The maximum capture length, that is the maximum number of samples that can be captured, depends on the installed hardware.

With the default hardware (R&S®FSW3-B114D), the maximum capture length is 130 MSamples.

With R&S®FSW3-B114, Enhanced Computing Power, the maximum capture length is 500 MSamples.

Figure 4-8 and Figure 4-9 show the maximum usable I/Q bandwidths depending on the output sample rates for the standard hardware and different bandwidth extensions.

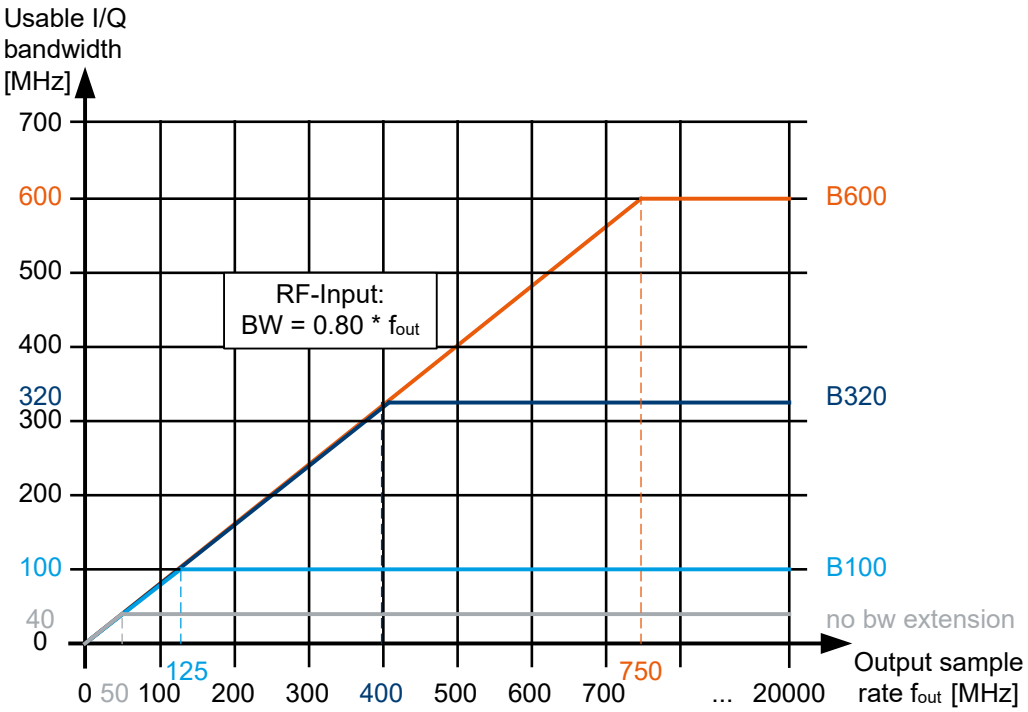


Figure 4-8: Maximum usable I/Q bandwidth for bandwidth extensions up to 600 MHz

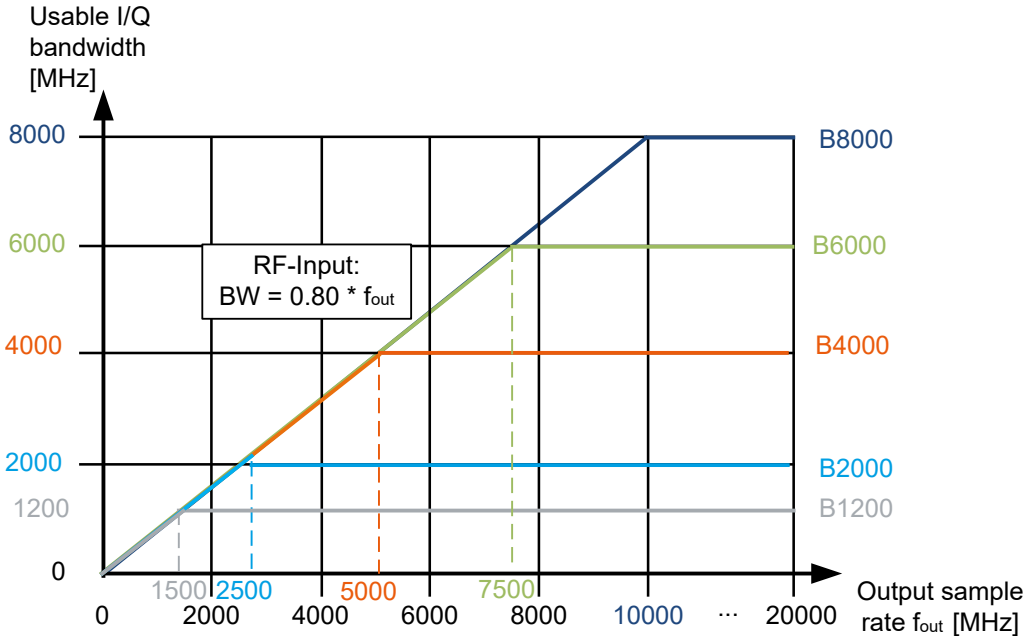


Figure 4-9: Maximum usable I/Q bandwidth for bandwidth extensions larger than 600 MHz

Without additional bandwidth extension options

For activated bandwidth extension options, see the following sections.

Table 4-3: Maximum I/Q bandwidth without I/Q bandwidth extension options

Sample rate	Maximum I/Q bandwidth
100 Hz to 50 MHz	0.8 * sample rate up to maximum 40 MHz
50 MHz to 20 GHz (upsampling)	40 MHz

I/Q bandwidth extension option B100

Table 4-4: Maximum I/Q bandwidth with activated I/Q bandwidth extension option FSWX-B100

Sample rate	Maximum I/Q bandwidth
100 Hz to 125 MHz	0.8 * sample rate up to maximum 100 MHz
125 MHz to 20 GHz (upsampling)	100 MHz

I/Q bandwidth extension option B320

Table 4-5: Maximum I/Q bandwidth with activated I/Q bandwidth extension option FSWX-B320

Sample rate	Maximum I/Q bandwidth
100 Hz to 400 MHz	0.8 * sample rate up to maximum 320 MHz
400 MHz to 20 GHz (upsampling)	320 MHz

I/Q bandwidth extension option B600

Table 4-6: Maximum I/Q bandwidth with activated I/Q bandwidth extension option FSWX-B600

Sample rate	Maximum I/Q bandwidth
100 Hz to 750 MHz	0.8 * sample rate up to maximum 600 MHz
750 MHz to 20 GHz (upsampling)	600 MHz

I/Q bandwidth extension option B1200

Table 4-7: Maximum I/Q bandwidth with activated I/Q bandwidth extension option FSWX-B1200

Sample rate	Maximum I/Q bandwidth
100 Hz to 1500 MHz	0.8 * sample rate up to maximum 1200 MHz
1500 MHz to 20 GHz (upsampling)	1200 MHz

I/Q bandwidth extension option B2000

Table 4-8: Maximum I/Q bandwidth with activated I/Q bandwidth extension option FSWX-B2000

Sample rate	Maximum I/Q bandwidth
100 Hz to 2500 MHz	0.8 * sample rate up to maximum 2000 MHz
2500 MHz to 20 GHz (upsampling)	2000 MHz

I/Q bandwidth extension option B4000

Table 4-9: Maximum I/Q bandwidth with activated I/Q bandwidth extension option FSWX-B4000

Sample rate	Maximum I/Q bandwidth
100 Hz to 5000 MHz	0.8 * sample rate up to maximum 4000 MHz
5000 MHz to 20 GHz (upsampling)	4000 MHz

I/Q bandwidth extension option B6000

Table 4-10: Maximum I/Q bandwidth with activated I/Q bandwidth extension option FSWX-B6000

Sample rate	Maximum I/Q bandwidth
100 Hz to 7500 MHz	0.8 * sample rate up to maximum 6000 MHz
7500 MHz to 20 GHz (upsampling)	6000 MHz

I/Q bandwidth extension option B8000

Table 4-11: Maximum I/Q bandwidth with activated I/Q bandwidth extension option FSWX-B8000

Sample rate	Maximum I/Q bandwidth
100 Hz to 10000 MHz	0.8 * sample rate up to maximum 8000 MHz
10000 MHz to 20 GHz (upsampling)	8000 MHz

I/Q data files

An I/Q-based FSWX application cannot only evaluate data that the application captures itself. You can also load I/Q data as input from a file. The file is then used as the input source for the application.

For example, you can capture I/Q data using the "I/Q Capture" application and store it to a file. Then analyze the signal parameters for that data later using the "VSA" application.



An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

When you import data from an I/Q data file using the import functions, some FSWX applications only store the data in the capture buffer temporarily. The data overwrites the current measurement data and is in turn overwritten by a new measurement.
The current measurement settings in the current application must match the settings that were applied when the measurement results were stored (possibly in a different application).

When you use the data as an input source, however, the stored I/Q data remains available for any number of subsequent measurements. The application ignores the current data acquisition settings (attenuation, center frequency, measurement bandwidth, sample rate). As a result, you cannot change these settings in the current application. You can only reduce the measurement time to perform measurements on an extract of the available data (from the beginning of the file).

For input files that contain multiple data streams from different channels, you can define which data stream to use for the currently selected application instance in the input settings. You can define whether the data stream is used only once, or repeatedly, to create a larger amount of input data.

When using input from an I/Q data file, the [Run Single] function starts a single measurement (i.e. analysis) of the stored I/Q data, while the [Run Cont] function repeatedly analyzes the same data from the file.

Sample iq-tar files

If you have the optional "VSA" application,
some sample `iq.tar` files are provided in the
`home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/vsa/DemoSignals` directory on the FSWX.

Furthermore, you can create your own `iq.tar` files in the "I/Q Capture" application, see Section 4.10.5.2, "How to export and import I/Q data", on page 379.

Pre-trigger and post-trigger samples

Some applications use pre-triggers or post-triggers. If not enough trigger samples are specified in the I/Q data file to satisfy the requirements of the application, the missing pre- or post-trigger values are filled up with zeros. Superfluous samples in the file are dropped, if necessary. For pre-trigger samples, values are filled up or omitted at the beginning of the capture buffer. For post-trigger samples, values are filled up or omitted at the end of the capture buffer.

Supported I/Q file formats

Various file types are supported for I/Q data import and export. The most important characteristics for each format are described here.

For best performance and to ensure that comprehensive metadata is available, use the `iq.tar` format. This file format is widely used by Rohde & Schwarz products.

Table 4-12: Characteristics of data file formats

File format	File extension	Comment
IQ.tar	`.iq.tar`	An `IQ.tar` file contains I/Q data in binary format together with meta information that describes the nature and the source of data, e.g. the sample rate. The objective of the `IQ.tar` file format is to separate I/Q data from the meta information while still having both inside one file. In addition, the file format allows a preview of the I/Q data in a web browser, and inclusion of user-specific data. Several streams of data can be provided in one file.
IQW	`.iqw`	A binary file format containing one channel of complex IQ data. The file contains float32 data in a binary format (interleaved IQIQ or in blocks, IIIQQQ). The file does not contain any additional information as a header. This format requires setting the sample rate and measurement time or record length manually.
CSV	`.csv`	A file containing I/Q data as comma-separated values (CSV). Additional metadata can be included.
Simple CSV	`.csv`	(Import only) Simple CSV contains I/Q data only, without any header or meta data. That is, the file contains only (I,Q) data pairs, separated by commas. Several streams of data can be provided in one file. This format requires setting the sample rate and measurement time or record length manually.
Matlab® v4	`.mat`	A file containing I/Q data in Matlab® file format v4. Channel-related information is stored in matlab variables with names starting with '`ChX_`'. '`X`' represents the number of the channel with a lower bound of 1, e.g. the variable `Ch1_ChannelName` contains the name of the first channel. The corresponding data is contained in `ChX_Data`. Optional user data can be saved to variables named `UserDataX`, where '`X`' starts at 0. The variable `UserData_Count` contains the number of `UserData` variables. For compatibility reasons user data needs to be saved as a 2xN char array, where the first row contains the key of the user data and the second row the actual value. Both rows must have the same column count and are therefore right-padded with white spaces. Variables can be written to the `*.mat` files in arbitrary order. **Limitations**: In general, the file format is limited to a maximum of 2 GB. A maximum of 100000000 values can be stored in a single variable, e.g. 50000000 complex data samples.
Matlab® v7.3	`.mat`	A file containing I/Q data in Matlab® file format v7.3.
Simple Matlab®	`.mat`	(Import only) Simple Matlab® format contains I/Q data only, without any meta data. That is, the file contains only variables (double, double) for the corresponding channel data. This format requires setting the sample rate and measurement time or record length manually.
AMMOS intermediate frequency data format	`.aid`	Format used to transmit real or complex baseband signals. The IF signal is sent along with information that characterizes the datastream and datastream source. All datastreams have a frame-based structure, consisting of a global frame header coupled with a data-type specific frame body (i.e. the frame payload).
wv	`.wv`	(Import only) Proprietary file format used by Rohde & Schwarz signal generators to store waveform data. A waveform file contains a header and raw I/Q samples.

- I/Q data file format (iq-tar)..... 130
- CSV file format..... 137
- IQW file format..... 140

- Matlab® v. 4 / v. 7.3 file format....140
- AID format....143
- WV format....153

I/Q data file format (iq-tar)

I/Q data is packed in a file with the extension `.iq.tar`. An `iq-tar` file contains I/Q data in binary format together with meta information that describes the nature and the source of data, e.g. the sample rate. The objective of the `iq-tar` file format is to separate I/Q data from the meta information while still having both inside one file. In addition, the file format allows you to include user-specific data and to preview the I/Q data in a web browser (not supported by all web browsers).

The `iq-tar` container packs several files into a single `.tar` archive file. Files in `.tar` format can be unpacked using standard archive tools (see http://en.wikipedia.org/wiki/Comparison_of_file_archivers) available for most operating systems. The advantage of `.tar` files is that the archived files inside the `.tar` file are not changed (not compressed) and thus it is possible to read the I/Q data directly within the archive without the need to unpack (untar) the `.tar` file first.

Sample iq-tar files

Some sample `iq-tar` files are provided in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/Demo/` directory on the FSWX.

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

Contained files

An `iq-tar` file must contain the following files:

- **I/Q parameter XML file**, e.g. `xyz.xml`
  Contains meta information about the I/Q data (e.g. sample rate). The filename can be defined freely, but there must be only one single I/Q parameter XML file inside an `iq-tar` file.
- **I/Q data binary file**, e.g. `xyz.complex.float32`
  Contains the binary I/Q data of all channels. There must be only one single I/Q data binary file inside an `iq-tar` file.

Optionally, an `iq-tar` file can contain the following file:

- **I/Q preview XSLT file**, e.g. `open_IqTar_xml_file_in_web_browser.xslt`
  Contains a stylesheet to display the I/Q parameter XML file and a preview of the I/Q data in a web browser (not supported by all web browsers).
  A sample stylesheet is available at http://www.rohde-schwarz.com/file/open_IqTar_xml_file_in_web_browser.xslt.

- I/Q parameter XML file specification....131
- I/Q data binary file....135

I/Q parameter XML file specification

The content of the I/Q parameter XML file must comply with the XML schema `RsIqTar.xsd` available at: http://www.rohde-schwarz.com/file/RsIqTar.xsd.

In particular, the order of the XML elements must be respected, i.e. `iq-tar` uses an "ordered XML schema". For your own implementation of the `iq-tar` file format make sure to validate your XML file against the given schema.

The following example shows an I/Q parameter XML file. The XML elements and attributes are explained in the following sections.

Sample I/Q parameter XML file: xyz.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl"
href="open_IqTar_xml_file_in_web_browser.xslt"?>
<RS_IQ_TAR_FileFormat fileFormatVersion="1"
xsi:noNamespaceSchemaLocation="RsIqTar.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <Name>FSWX</Name>
  <Comment>Here is a comment</Comment>
  <DateTime>2011-01-24T14:02:49</DateTime>
  <Samples>68751</Samples>
  <Clock unit="Hz">6.5e+006</Clock>
  <Format>complex</Format>
  <DataType>float32</DataType>
  <ScalingFactor unit="V">1</ScalingFactor>
  <NumberOfChannels>1</NumberOfChannels>
<DataFilename>xyz.complex.float32</DataFilename>
<UserData>
  <UserDefinedElement>Example</UserDefinedElement>
</UserData>
  <PreviewData>...</PreviewData>
</RS_IQ_TAR_FileFormat>
```

Minimum data elements

The following data elements are the minimum required for a valid `iq-tar` file. They are always provided by an `iq-tar` file export from a Rohde & Schwarz product. If not specified otherwise, it must be available in all `iq-tar` files used to import data to a Rohde & Schwarz product.

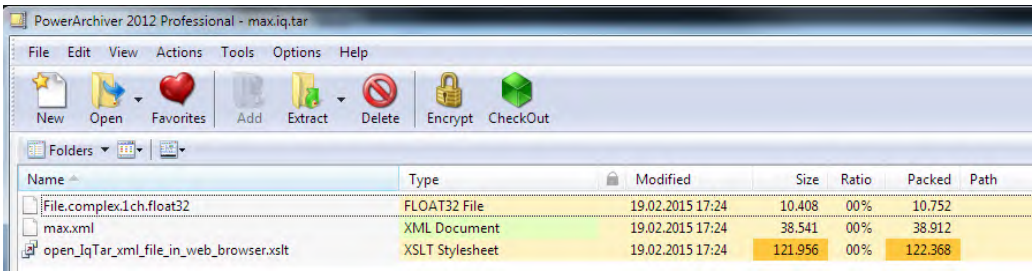
Element	Possible Values	Description
`<RS_IQ_TAR_FileFormat>`	-	The root element of the XML file. It must contain the attribute `fileFormatVersion` that contains the number of the file format definition.
`<Name>`	string	Optional: describes the device or application that created the file.
`<Comment>`	string	Optional: contains text that further describes the contents of the file.

Element	Possible Values	Description
<DateTime>	yyyy-mm-ddThh:mm:ss	Contains the date and time of the creation of the file. Its type is xs:dateTime (see RsIqTar.xsd).
<Samples>	integer	Contains the number of samples of the I/Q data. For multi-channel signals all channels have the same number of samples. One sample can be: ● A complex number represented as a pair of I and Q values ● A complex number represented as a pair of magnitude and phase values ● A real number represented as a single real value See also <Format> element.
<Clock>	double	Contains the clock frequency in Hz, i.e. the sample rate of the I/Q data. A signal generator typically outputs the I/Q data at a rate that equals the clock frequency. If the I/Q data was captured with a signal analyzer, the signal analyzer used the clock frequency as the sample rate. The attribute unit must be set to "Hz".
<Format>	complex | real | polar	Specifies how the binary data is saved in the I/Q data binary file (see <DataFilename> element). Every sample must be in the same format. The format can be one of the following: ● complex: Complex number in cartesian format, i.e. I and Q values interleaved. I and Q are unitless ● real: Real number (unitless) ● polar: Complex number in polar format, i.e. magnitude (unitless) and phase (rad) values interleaved. Requires DataType = float32 or float64
<DataType>	int8 | int16 | int32 | float32 | float64	Specifies the binary format used for samples in the I/Q data binary file (see <DataFilename> element and "I/Q data binary file" on page 135). The following data types are allowed: ● int8: 8 bit signed integer data ● int16: 16 bit signed integer data ● int32: 32 bit signed integer data ● float32: 32 bit floating point data (IEEE 754) ● float64: 64 bit floating point data (IEEE 754)
<ScalingFactor>	double	Optional: describes how the binary data can be transformed into values in the unit Volt. The binary I/Q data itself has no unit. To get an I/Q sample in the unit Volt the saved samples have to be multiplied by the value of the <ScalingFactor>. For polar data only the magnitude value has to be multiplied. For multi-channel signals the <ScalingFactor> must be applied to all channels. The attribute unit must be set to "V". The <ScalingFactor> must be > 0. If the <ScalingFactor> element is not defined, a value of 1 V is assumed.
<NumberOfChannels>	integer	Optional: specifies the number of channels, e.g. of a MIMO signal, contained in the I/Q data binary file. For multi-channels, the I/Q samples of the channels are expected to be interleaved within the I/Q data file (see "I/Q data binary file" on page 135). If the <NumberOfChannels> element is not defined, one channel is assumed.

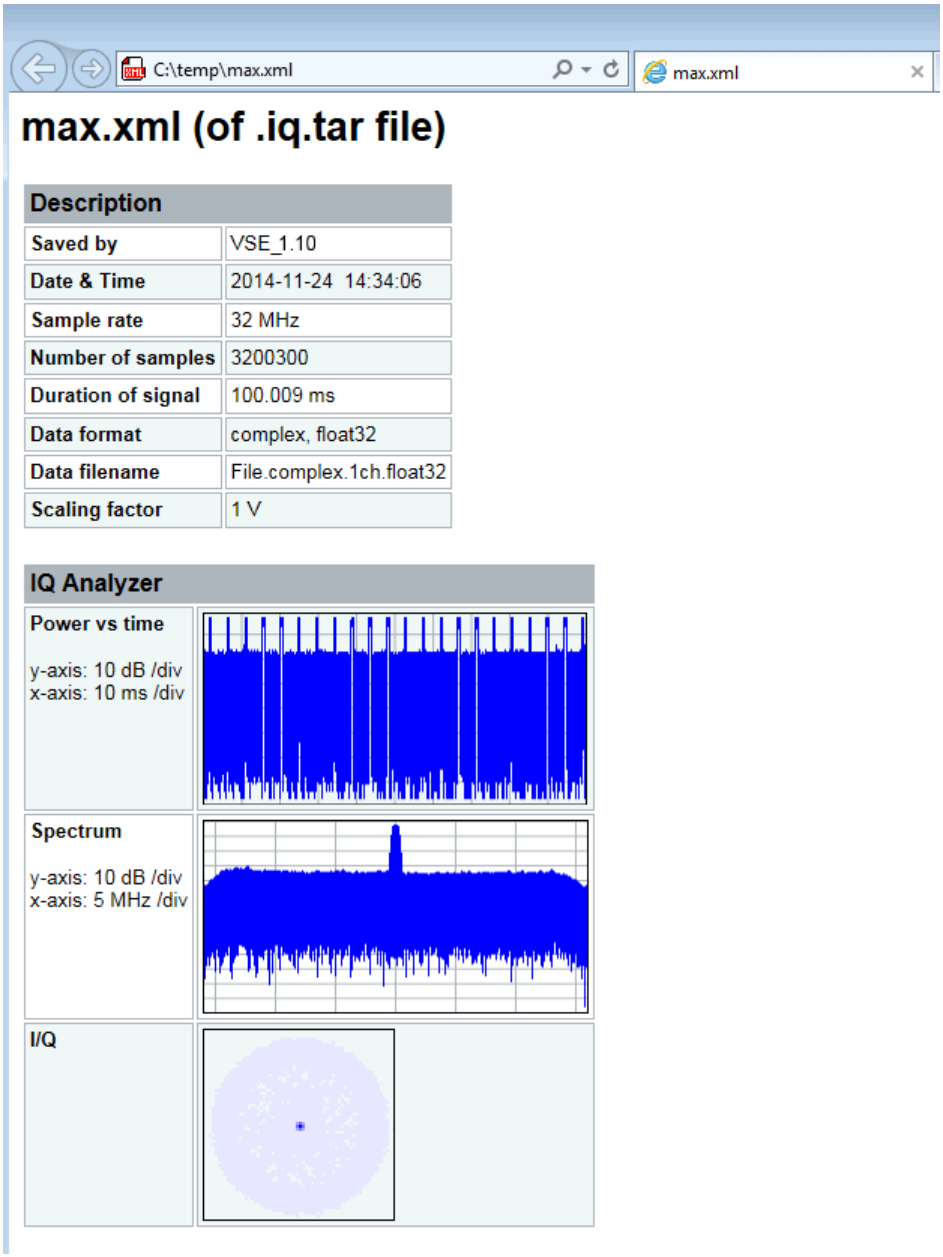
Element	Possible Values	Description
<DataFilename>		Contains the filename of the I/Q data binary file that is part of the iq-tar file. It is recommended that the filename uses the following convention: <xyz>.<Format>.<Channels>ch.<Type> ● <xyz> = a valid Windows file name ● <Format> = complex, polar or real (see Format element) ● <Channels> = Number of channels (see NumberOfChannels element) ● <Type> = float32, float64, int8, int16, int32 or int64 (see DataType element) Examples: ● xyz.complex.1ch.float32 ● xyz.polar.1ch.float64 ● xyz.real.1ch.int16 ● xyz.complex.16ch.int8
<UserData>	xml	Optional: contains user, application or device-specific XML data which is not part of the iq-tar specification. This element can be used to store additional information, e.g. the hardware configuration. User data must be valid XML content.
<PreviewData>	xml	Optional: contains further XML elements that provide a preview of the I/Q data. The preview data is determined by the routine that saves an iq-tar file (e.g. FSWX). For the definition of this element refer to the RsIqTar.xsd schema. Note that the preview can be only displayed by current web browsers that have JavaScript enabled and if the XSLT stylesheet open_IqTar_xml_file_in_web_browser.xslt is available.

Example

The following example demonstrates the XML description inside the iq-tar file. Note that this preview is not supported by all web browsers.



Open the xml file in a web browser. If the stylesheet open_IqTar_xml_file_in_web_browser.xslt is in the same directory, the web browser displays the xml file in a readable format.




```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="open_IqTar_xml_file_in_web_browser.xslt"?>
<RS_IQ_TAR_FileFormat fileFormatVersion="1" xsi:noNamespaceSchemaLocation=
"http://www.rohde-schwarz.com/file/RsIqTar.xsd" xmlns:xsi=
"http://www.w3.org/2001/XMLSchema-instance">
  <Name>VSE_1.10a 29 Beta</Name>
  <Comment></Comment>
  <DateTime>2015-02-19T15:24:58</DateTime>
  <Samples>1301</Samples>
  <Clock unit="Hz">32000000</Clock>
  <Format>complex</Format>
  <DataType>float32</DataType>
```

```
  <ScalingFactor unit="V">1</ScalingFactor>
  <NumberOfChannels>1</NumberOfChannels>
  <DataFilename>File.complex.1ch.float32</DataFilename>

<UserData>
    <RohdeSchwarz>
      <DataImportExport_MandatoryData>
        <ChannelNames>
          <ChannelName>IQ Analyzer</ChannelName>
        </ChannelNames>
        <CenterFrequency unit="Hz">0</CenterFrequency>
      </DataImportExport_MandatoryData>
      <DataImportExport_OptionalData>
        <Key name="Ch1_NumberOfPostSamples">150</Key>
        <Key name="Ch1_NumberOfPreSamples">150</Key>
      </DataImportExport_OptionalData>
    </RohdeSchwarz>
  </UserData>

</RS_IQ_TAR_FileFormat>
```

Example: ScalingFactor

Data stored as `int16` and a desired full scale voltage of 1 V

`ScalingFactor` = 1 V / maximum int16 value = 1 V / 2^{15} = 3.0517578125e-5 V

Scaling Factor	Numerical value	Numerical value x ScalingFactor
Minimum (negative) int16 value	- 2^{15} = - 32768	-1 V
Maximum (positive) int16 value	2^{15}-1= 32767	0.999969482421875 V

I/Q data binary file

The I/Q data is saved in binary format according to the format and data type specified in the XML file (see `<Format>` element and `<DataType>` element). To allow reading and writing of streamed I/Q data, all data is interleaved, i.e. complex values are interleaved pairs of I and Q values and multi-channel signals contain interleaved (complex) samples for channel 0, channel 1, channel 2 etc. If the `<NumberOfChannels>` element is not defined, one channel is presumed.

Example: Element order for real data (1 channel)

```
I[0],                       // Real sample 0
I[1],                       // Real sample 1
I[2],                       // Real sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

```
I[0], Q[0],                 // Real and imaginary part of complex sample 0
I[1], Q[1],                 // Real and imaginary part of complex sample 1
```

```
I[2], Q[2],                    // Real and imaginary part of complex sample 2
...
```

Example: Element order for complex polar data (1 channel)

```
Mag[0], Phi[0],                // Magnitude and phase part of complex sample 0
Mag[1], Phi[1],                // Magnitude and phase part of complex sample 1
Mag[2], Phi[2],                // Magnitude and phase part of complex sample 2
...
```

Example: Element order for complex cartesian data (3 channels)

Complex data: I[channel no][time index], Q[channel no][time index]

```
I[0][0], Q[0][0],              // Channel 0, Complex sample 0
I[1][0], Q[1][0],              // Channel 1, Complex sample 0
I[2][0], Q[2][0],              // Channel 2, Complex sample 0

I[0][1], Q[0][1],              // Channel 0, Complex sample 1
I[1][1], Q[1][1],              // Channel 1, Complex sample 1
I[2][1], Q[2][1],              // Channel 2, Complex sample 1

I[0][2], Q[0][2],              // Channel 0, Complex sample 2
I[1][2], Q[1][2],              // Channel 1, Complex sample 2
I[2][2], Q[2][2],              // Channel 2, Complex sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

This example demonstrates how to store complex cartesian data in float32 format using MATLAB®.

```
% Save vector of complex cartesian I/Q data, i.e. iqiqiq...
N = 100
iq = randn(1,N)+1j*randn(1,N)
fid = fopen('xyz.complex.float32','w');
for k=1:length(iq)
  fwrite(fid,single(real(iq(k))),'float32');
  fwrite(fid,single(imag(iq(k))),'float32');
end
fclose(fid)
```

Example: PreviewData in XML

```
  <PreviewData>
    <ArrayOfChannel length="1">
      <Channel>
        <PowerVsTime>
          <Min>
            <ArrayOfFloat length="256">
              <float>-134</float>
              <float>-142</float>
```

```
            ...
            <float>-140</float>
          </ArrayOfFloat>
        </Min>
        <Max>
          <ArrayOfFloat length="256">
            <float>-70</float>
            <float>-71</float>
            ...
            <float>-69</float>
          </ArrayOfFloat>
        </Max>
      </PowerVsTime>
      <Spectrum>
        <Min>
          <ArrayOfFloat length="256">
            <float>-133</float>
            <float>-111</float>
            ...
            <float>-111</float>
          </ArrayOfFloat>
        </Min>
        <Max>
          <ArrayOfFloat length="256">
            <float>-67</float>
            <float>-69</float>
            ...
            <float>-70</float>
            <float>-69</float>
          </ArrayOfFloat>
        </Max>
      </Spectrum>
      <IQ>
        <Histogram width="64" height="64">0123456789...0</Histogram>
      </IQ>
    </Channel>
  </ArrayOfChannel>
</PreviewData>
```

CSV file format

CSV files contain I/Q data as comma-separated values. Additional metadata can be saved.

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Mandatory data elements

Parameter Name	Possible Values
Name	String
Comment	String
DateTime	Year-Month-DayTHour:Min:Sec
Format	complex
DataType	float32
NumberOfChannels	Integer
Ch<n>_ChannelName	String
Ch<n>_Samples	Integer
Ch<n>_Clock[Hz]	double
Ch<n>_CenterFrequency[Hz]	Double
IQ Data Header	<Channel Name>_I; <Channel Name>_Q (IQ data value)
-----	Double ; Double (IQ data I/Q pairs)

Optional data elements

Parameter name	Possible Values
Ch<n>_AttenuElecState	ON | OFF
Ch<n>_AttenuElecValue[dB]	Integer
Ch<n>_AttenuMech[dB]	Integer
Ch<n>_CalibrationState	ON | OFF
Ch<n>_DeviceHwInfo	String
Ch<n>_DeviceId	String
Ch<n>_DeviceOptions	String
Ch<n>_DeviceVersions	String
Ch<n>_FilterSettings	FLAT | GAUSS | OFF
Ch<n>_HighPassFilterState	ON | OFF
Ch<n>_Impedance[Ohm]	50 | 75
Ch<n>_InputCoupling	AC | DC
Ch<n>_InputPath	RF
Ch<n>_MeasBandwidth[Hz]	double
Ch<n>_NumberOfPostSamples	Integer
Ch<n>_NumberOfPreSamples	Integer

Parameter name	Possible Values
Ch<n>_PreampGain[dB]	Integer
Ch<n>_PreampState	ON | OFF
Ch<n>_RefLevelOffset[dB]	Double
Ch<n>_RefLevel[dBm]	Double
Ch<n>_RefOscillatorInput	OFF | ON
Ch<n>_RefOscillatorFreq[Hz]	Double
Ch<n>_TrgSource	Extern <1 ..4> | I/Q Power | IF Power | RF Power | Power Sensor | Time
Ch<n>_TrgLevel[dB]	Double
Ch<n>_TrgHysteresis[dB]	Double
Ch<n>_TrgTpis[s]	Double
Ch<n>_TrgOffset[s]	Double
Ch<n>_TrgSlope	Rising | Falling | Rising/Falling
Ch<n>_TrgHoldoff[s]	Double
Ch<n>_TrgDropOut[s]	Double
Ch<n>_YigPreSelectorState	ON | OFF

Example

```
DataImportExport_MandatoryData;
Name;ExampleFile
Comment;Example Comment
DateTime;2015-02-19T15:26:33
Format;complex
DataType;float32
NumberOfChannels;1
Ch1_ChannelName;Example_Channel
Ch1_Samples;10
Ch1_Clock[Hz];3,2000000E+007
Ch1_CenterFrequency[Hz];100,0000000E+007
DataImportExport_EndHeaderSection;
Example_Channel_I;Example_Channel_Q
-5,9390777E-006;-3,4644620E-006
9,8984629E-007;-8,4631858E-005
-5,9885701E-005;4,1078620E-005
2,0786772E-005;7,8692778E-005
-4,9492314E-006;-1,5095156E-004
1,6332464E-005;1,8312156E-005
-5,4936470E-005;4,5532928E-005
-4,8997390E-005;9,7004937E-005
-1,1383232E-005;4,5532928E-005
-8,2157239E-005;3,2170003E-005
```

Simple CSV format

The simple `.CSV` format contains I/Q data only, without any header or meta data. That is, the file contains only (I,Q) data pairs, separated by commas. Several streams of data can be provided in one file, one after the other.

Example:

```
7.0663854e-003,1.7059683e-005,
7.0817876e-003,7.5836733e-006,
7.0711789e-003,-1.2189972e-005,
```

This format requires setting the sample rate and measurement time or record length manually.

IQW file format

IQW is a binary file format containing one channel of complex IQ data.

Format description details:

- IQDataFormat: Complex
- IQDataType: Float32
- Byte order: Intel
- Data order: IQIQIQ (I/Q paired or interleaved) or IIIQQQ (I/Q blocks, default)

This format requires setting the sample rate and measurement time or record length manually.

Mandatory Data Elements

Only the binary I/Q data.

Optional Data Elements

None.

Matlab® v. 4 / v. 7.3 file format

In Matlab® files, channel-related information is stored in Matlab® variables with names starting with '`ChX_`'. '`X`' represents the number of the channel with a lower bound of 1, e.g. the variable `Ch1_ChannelName` contains the name of the first channel. The corresponding data is contained in `ChX_Data`.

Optional user data can be saved to variables named `UserDataX`, where '`X`' starts at 0. The variable `UserData_Count` contains the number of `UserData` variables. For compatibility reasons user data needs to be saved as a 2xN char array, where the first row contains the key of the user data and the second row the actual value. Both rows must have the same column count and are therefore right-padded with white spaces.

Variables can be written to the `*.mat` files in arbitrary order.

The Matlab® v7.3. file format requires the Matlab® Compiler Runtime (MCR) to be installed on the system and registered in the `PATH` environment variable.

This format requires setting the sample rate and measurement time or record length manually.

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Mandatory data elements

Variable name	Class	Format / possible values
Name	char	
Comment	char	
DateTime	char	Year-Month-DayTHour:Min:Sec
Format	char	complex
DataType	char	float32
NumberOfChannels	Double	
Ch<n>_ChannelName	char	
Ch<n>_Samples	double	
Ch<n>_Clock_Hz	double	
Ch<n>_CFrequency_Hz	Double	
Ch<n>_Data	Double, Double	I,Q
UserData_Count	Double	(Number of optional user data variables)

Optional data elements

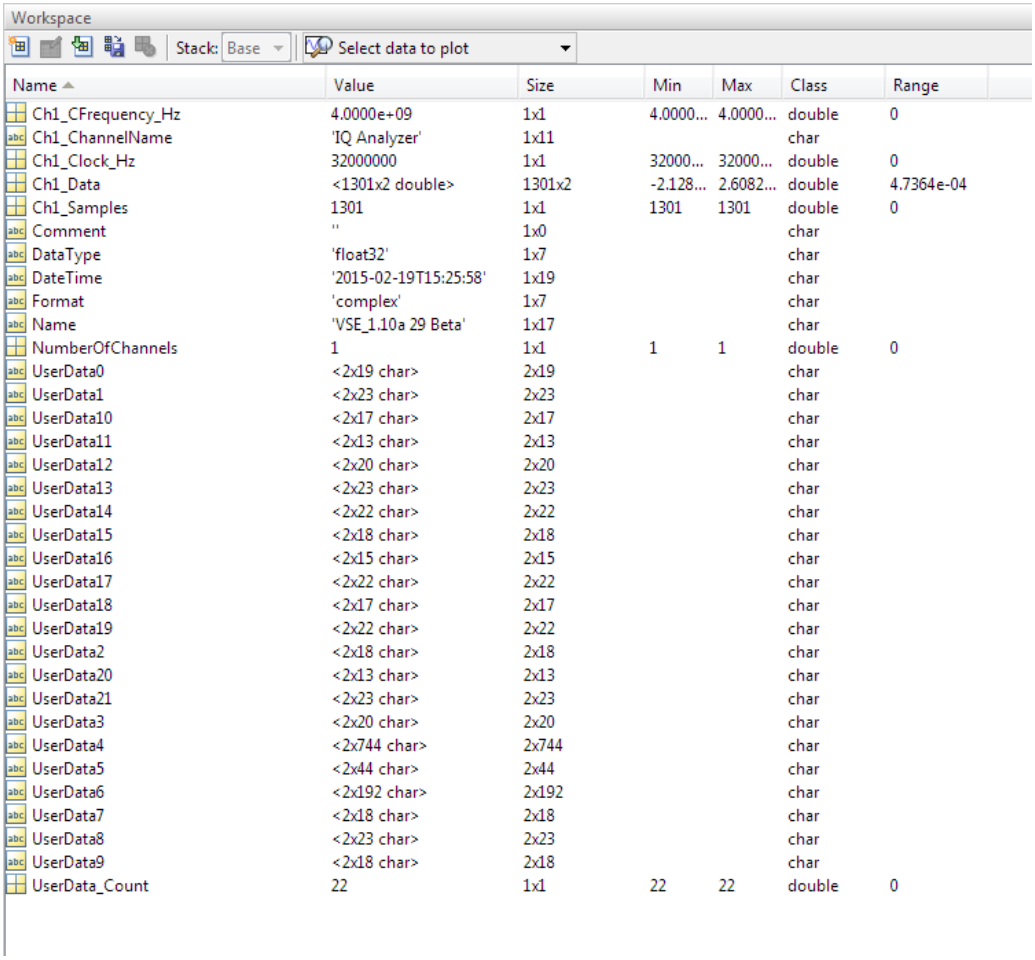
Optional user data can be saved to variables named `UserDataX`, where 'X' starts at 0. The variable `UserData_Count` contains the number of `UserData` variables. For compatibility reasons user data needs to be saved as a 2xN char array, where the first row contains the key of the user data and the second row the actual value. Both rows must have the same column count and are therefore right-padded with white spaces.

Variable name	Class	Format
UserData<n>	char	Optional Data Parameter name, Value

Table 4-13: Optional parameter names to be defined in UserData<n> variables

Parameter name	Possible Values
Ch<n>_AttenuElecState	ON | OFF
Ch<n>_AttenuElecValue_dB	Integer
Ch<n>_AttenuMech_dB	Integer
Ch<n>_CalibrationState	ON | OFF
Ch<n>_DeviceHwInfo	String
Ch<n>_DeviceId	String
Ch<n>_DeviceOptions	String
Ch<n>_DeviceVersions	String
Ch<n>_FilterSettings	FLAT | GAUSS | OFF
Ch<n>_HighPassFilterState	ON | OFF
Ch<n>_Impedance_Ohm	50 | 75
Ch<n>_InputCoupling	AC | DC
Ch<n>_InputPath	RF
Ch<n>_MeasBandwidth_Hz	double
Ch<n>_NumberOfPostSamples	Integer
Ch<n>_NumberOfPreSamples	Integer
Ch<n>_PreampGain_dB	Integer
Ch<n>_PreampState	ON | OFF
Ch<n>_RefLevelOffset_dB	Double
Ch<n>_RefLevel_dBm	Double
Ch<n>_RefOscillatorInput	OFF | ON
Ch<n>_RefOscillatorFreq_Hz	Double
Ch<n>_TrgSource	Extern <1 ..4> | I/Q Power | IF Power | RF Power | Power Sensor | Time
Ch<n>_TrgLevel_dB	Double
Ch<n>_TrgHysteresis_dB	Double
Ch<n>_TrgTpis_s	Double
Ch<n>_TrgOffset_s	Double
Ch<n>_TrgSlope	Rising | Falling | Rising/Falling
Ch<n>_TrgHoldoff_s	Double
Ch<n>_TrgDropOut_s	Double
Ch<n>_YigPreSelectorState	ON | OFF

Example



Name	Value	Size	Min	Max	Class	Range
Ch1_CFrequency_Hz	4.0000e+09	1x1	4.0000...	4.0000...	double	0
Ch1_ChannelName	'IQ Analyzer'	1x11			char	
Ch1_Clock_Hz	32000000	1x1	32000...	32000...	double	0
Ch1_Data	<1301x2 double>	1301x2	-2.128...	2.6082...	double	4.7364e-04
Ch1_Samples	1301	1x1	1301	1301	double	0
Comment	''	1x0			char	
DataType	'float32'	1x7			char	
DateTime	'2015-02-19T15:25:58'	1x19			char	
Format	'complex'	1x7			char	
Name	'VSE_1.10a 29 Beta'	1x17			char	
NumberOfChannels	1	1x1	1	1	double	0
UserData0	<2x19 char>	2x19			char	
UserData1	<2x23 char>	2x23			char	
UserData10	<2x17 char>	2x17			char	
UserData11	<2x13 char>	2x13			char	
UserData12	<2x20 char>	2x20			char	
UserData13	<2x23 char>	2x23			char	
UserData14	<2x22 char>	2x22			char	
UserData15	<2x18 char>	2x18			char	
UserData16	<2x15 char>	2x15			char	
UserData17	<2x22 char>	2x22			char	
UserData18	<2x17 char>	2x17			char	
UserData19	<2x22 char>	2x22			char	
UserData2	<2x18 char>	2x18			char	
UserData20	<2x13 char>	2x13			char	
UserData21	<2x23 char>	2x23			char	
UserData3	<2x20 char>	2x20			char	
UserData4	<2x744 char>	2x744			char	
UserData5	<2x44 char>	2x44			char	
UserData6	<2x192 char>	2x192			char	
UserData7	<2x18 char>	2x18			char	
UserData8	<2x23 char>	2x23			char	
UserData9	<2x18 char>	2x18			char	
UserData_Count	22	1x1	22	22	double	0

Simple matlab® format

As of FSWX software version 1.50, a simple `.mat` format is supported. This format contains I/Q data only, without any meta data. That is, the file contains only variables (double, double) for the corresponding channel data.

When you load a simple Matlab® file, you must define the used sample rate (and optionally analysis bandwidth) manually.

AID format

AID is a format used to transmit real or complex baseband signals. The IF signal is sent along with information that characterizes the datastream and datastream source.

All datastreams have a frame based structure using the same format, consisting of a global *Frame header* coupled with a data-type specific *Frame body* (i.e. the frame payload).

The header and the body of the frame consist of a number of 32-bit words. The *Frame header* has a predefined structure and size. The size and structure of the *Frame body*

depends on the payload type. This is an important factor in the choice of the frame size.

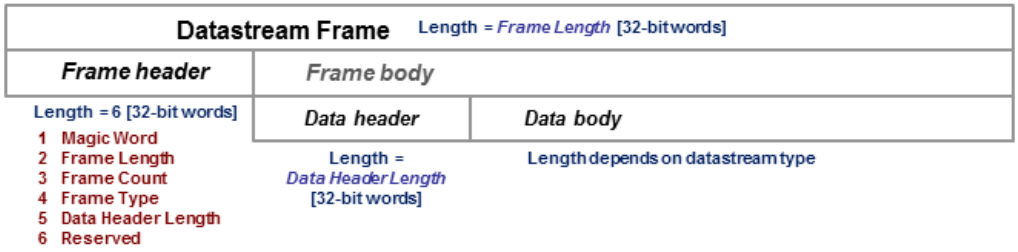


Figure 4-10: Generic Datastream Frame structure

Global Frame header

The *Frame header* contains information used for frame synchronization, frame sequencing, payload identification and frame sizing. It consist of six 32-bit words as depicted in the following figure and is defined in **`rs_gx40x_global_frame_header_if_defs.h`**

Table 4-14: Global Frame header (structure name: typFRH_FRAMEHEADER)

Word position in frame	Member name Member type	Description
1	**uintMagicWord** ptypUINT	**Magic Word** - 32-bit word, always identical (`0xFB746572`), defines the start of the *Frame header* and is used for frame synchronization. The *Magic Word* and the *Frame Length* are used to identify the beginning of each frame.
2	**uintFrameLength** ptypUINT	**Frame Length** - gives the length of the frame including both *Frame header* and *Frame body*. The length is expressed in 32-bit words. The minimum length is six in case the *Frame body* is empty and the maximum length is limited to the value: • `kFRH_FRAME_LENGTH_MAX = 0x100000` (`1048576 = 2`^{20}) in case of normal frames • `kFRH_FRAME_LENGTH_MAX_EX = 0x400000` (`64* 1048576 = 2`^{26}) in case of extended frames (an extended frame is marked by Bit#0 of the Reserved word of the frame header). Only some datastream types allow the extended frame size, see the definitions in the `rs_gx40x_global_frame_types_if_defs.h`. The next *Magic Word* which denotes the next frame in this data stream will occur `uintFrameLength` [32-bit words] after the *Magic Word* in this frame.
3	**uintFrameCount** ptypUINT	**Frame Count** - sequence counter modulo 2^{32}. Determines the position of this frame in the datastream and is used for sequencing and lost frame detection.
4	**uintFrameType** ptypUINT	**Frame Type** - identifies the data type contained in this frame and gives the specific structure of the frame payload. The complete list of frame types (i.e. datastream types) can be found in the following header file: `rs_gx40x_global_frame_types_if_defs.h`

Word position in frame	Member name Member type	Description
5	**uintDataHeaderLength** ptypUINT	**Data Header Length** - gives the length of the *data header* positioned at the beginning of the *Frame body*. The length is expressed in 32-bit words (`0` means no data header). This information can be used by the software to recognize the version of the datastream format and thus its compatibility to read and correctly interpret the datastream. It enables forward-compatibility with future datastream versions. This value will not vary for a continuous data stream.
6	**uintReserved** ptypUINT	• Bits `#31` to `#1` - Reserved (not yet used, must be `0`) • Bit `#0` - Marks the frame with extended size (up to kFRH_FRAME_LENGTH_MAX_EX 32-bit words).

The *Data Header Length* information is very important for the correct addressing of the data samples. This information gives the exact position in the frame where the *Data body* begins independent of the version of the *data header* (different versions consist of different number of parameters). From the frame beginning (indicated by the *Magic Word*), the first six 32-bit words represent the *Frame header* and the next *Data Header Length* 32-bit words represent the *data header*. After `6+uintDataHeaderLength` 32-bit words starts the *Data body*, i.e. the first data sample.

Frame body

The *Frame body* contains the payload of the frame and its structure depends on the datastream type, as defined by the *Frame Type* element in the *Frame header*.

The *Frame body* is structured into a *data header* followed by the *Data body*. The *data header* contains datastream specific information of the payload.

Bit numbering

Throughout this format description it is assumed that bit #0 is the bit of least numeric significance.

Data body

The IF Data format is valid for the following datastream types:

Table 4-15: IF Datastream types

Datastream type ID	Description	Sample data type
ekFRH_DATASTREAM__IFDATA_32RE_32IM_FIX ekFRH_DATASTREAM__IFDATA_32RE_32IM_FIX_RESCALED	Complex IF Data samples, 32-bit real-part and 32-bit imaginary-part, fixed point	typIFD_SAMPLE_32RE_32IM_FIX
ekFRH_DATASTREAM__IFDATA_16RE_16IM_FIX	Complex IF Data samples, 16-bit real-part and 16-bit imaginary-part, fixed point	typIFD_SAMPLE_16RE_16IM_FIX
ekFRH_DATASTREAM__IFDATA_16RE_16RE_FIX	Real IF Data samples, 16-bit real-part, two samples in each 32-bit word, fixed point	typIFD_SAMPLE_16RE_16RE_FIX
ekFRH_DATASTREAM__IFDATA_32RE_32IM_FLOAT_RESCALED	Complex IF Data samples, 32-bit real-part und 32-bit imaginary-part, floating point	typIFD_SAMPLE_32RE_32IM_FLOAT

For the datastream types defined in Table 4-15, the same frame body structure is used, the only difference is the carried sample data type.

IF Data Frame Structure

The structure of the IF Datastream is defined in the `rs_gx40x_global_ifdata_header_if_defs.h` header file.

The Data Frame consists of the global *frame header* of type `typFRH_FRAMEHEADER`, as described in "Global Frame header" on page 144, followed by the datastream-specific *Frame body*.

The corresponding "Frame Type" value from the *frame header* for this datastream type can be found in the global frame types header file: `rs_gx40x_global_frame_types_if_defs.h`.

The *frame body* consists of: the *data header* which describes the datastream payload and the *data body* which contains the actual datastream payload.

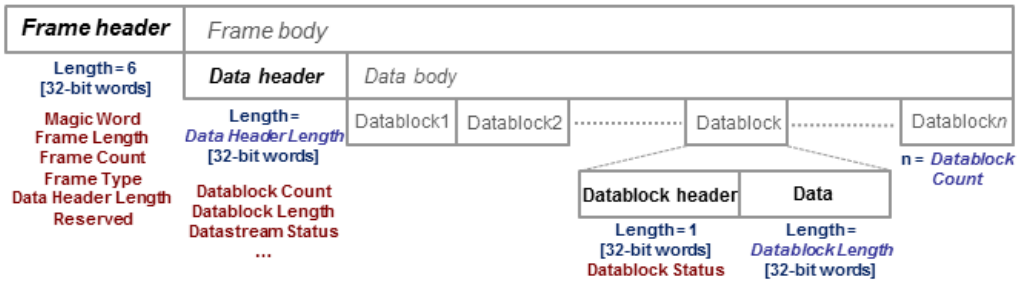


Figure 4-11: IF Data frame format

IF data header

The data header describes the datastream payload (such as number of data samples contained in this frame), and contains common properties of the data samples.

The **basic** data header contains several fields that are always sent.

The **extended** data header contains extra information fields sent after the fields of the basic structure.

The length of the data header, as specified by the `uintDataHeaderLength` parameter from the frame header. This parameter provides information about which data header type is used - i.e. the basic header or the extended header.

The IF data header structure, of type `typIFD_IFDATAHEADER`, is described in the following table (data header length = 14 [32-bit words]).

Table 4-16: IF DATA header (typIFD_IFDATAHEADER)

Word position in frame	Member name Member type	Description
7	**uintDatablockCount** ptypUINT	**Datablock Count** - represents the number of IF signal data blocks in the IF data frame.
8	**uintDatablockLength** ptypUINT	**Datablock Length** - The number 32-bit words in each IF signal data block excluding the data block header (has to be of the form 2^N with N≥2). This may not be the same as the number of IF signal data samples, as the size of a sample may be 16, 32 or 64 bits.
9 10	**bigtimeTimeStamp** ptypBIGTIME	64-bit **Timestamp** [µs] - Absolute time of the first IF signal data sample, in the first data block of IF signal data in this frame.
11	**uintStatusword** ptypUINT	**Status Word** - extra information that help the receiver react by parameter changes. ● Bit #31 - Reserved ● Bit #30 - **dBFS flag** – 1 indicates that all samples in this frame are considered to be dBFS (dB full scale). – 0 indicates that the values *Antenna Voltage Reference* and *Reciprocal gain correction* (see the *Status Word* description of the datablock header) can be used to calculate the corresponding level for each sample. ● Bits #29 to #8 - Reserved (not yet used, must be 0) ● Bits #7 to #0 - User flags for special signaling between IF Data processing components.
12	**uintSignalSourceID** ptypUINT	**Signal Source Identifier** or antenna identifier (value 0x0 if not used)

Word position in frame	Member name Member type	Description
13	**uintSignalSourceState** ptypUINT	Current **Signal Source State** (value `0x0` if not used) ● gives the *Configuration Set Identifier* of the Task Data Set (in GX400) currently being applied by the IF signal source OR ● the current *Scan Step Number* in the case of scan operation In the case of memory scanning, the scan step number starts at `0` for the scan channel (memory location) configured with the lowest frequency, and increments (`+1`) for every channel configured for scanning in the memory scan list. In the case of frequency scanning, the scan step number starts at `0` for the scan step at the lowest frequency, and increments (`+1`) for every step taken within the configured frequency scan range.
14 15	**uintTunerFrequency_Low** **uintTunerFrequency_High** ptypUINT	64-bit **Tuner Center Frequency** [Hz] - least significant 32 bits (uintTunerFrequency_Low) followed by most significant 32 bits (uintTunerFrequency_High)
16	**uintBandwidth** ptypUINT	IF signal 3dB **Bandwidth** [Hz]
17	**uintSamplerate** ptypUINT	**Sample Rate** of the AD Converter [samples / second] - due to digital filtering within the source, the resulting sample rate of the samples within this frame is: Sample Rate × Interpolation / Decimation
18	**uintInterpolation** ptypUINT	**Interpolation Factor** referred to the ADC signal sample rate. The value `0x1` indicates no interpolation

Word position in frame	Member name Member type	Description
19	**uintDecimation** ptypUINT	**Decimation Factor** referred to the ADC signal sample rate. The value `0x1` indicates no decimation
20	**intAntennaVoltageRef** ptypINT	**Antenna Voltage Reference (AntVoltRef)** is the device specific correction value for the tuner front-end Rx attenuation (expresses anything from antenna input connector to ADC) and is expressed in `[0.1 dBµV]`. This is the level which, while the AGC amplification is at maximum attenuation, is required at the antenna input to produce the full scale value at the ADC. Using this value together with the Recip-Gain (Reciprocal Gain) value, one can calculate the true signal level at the antenna input connector (see "Data samples" on page 151). The RecipGain value is given in the Status Word of the IF Datablock header Table 4-15

The extended IF data header structure, of type `typIFD_IFDATAHEADER_EX`, is described in the following table (total data header length = 19 [32-bit words]).

Table 4-17: Extended IF data header (typIFD_IFDATAHEADER_EX) - extra fields only

Word position in frame	Member name Member type	Description
21 22	**bigtimeStartTimeStamp** ptypBIGTIME_NS	64-bit **Timestamp** [ns] - Absolute time of the first sample of the datastream since starting the datastream ("Sample Counter" == 0). This value remains constant until the datastream is stopped and started again or until the tuner performs an internal synchronization.
23 24	**uintSampleCounter_Low** **uintSampleCounter_High** ptypUINT	**Sample Count** - 64-bit counter from the first sample of the first datablock in this frame. Note that this value can be reset when the datastream is stopped and started again or when the tuner performs an internal synchronization. The Sample Count of the next IF frame can be deduced from Datablock Count, Datablock Length and the number of 32-bit words per sample. In this way the number of sample Dropouts can be estimated (that can be replaced with Null values). The exact time is given by *t = Start Time + Sample Count * Decimation / (Sample rate * Interpolation)*.
25	**intKFactor** ptypINT	**kFactor** - Correction factor of the current antenna, given in `0.1dB/m`. Used to determine the field strength (in [dBµV/m]) at the antenna from the voltage level at the antenna input of the receiver. Contains antenna gain, cable attenuation, antenna switch matrix attenuation and anything else from air to antenna input. (the value `0x80000000` is used if no kFactor is defined).

The values contained in the data header fields represent the status at the beginning of the frame. A modification happening during the transmission of a frame will only be noted in the data header of the next frame.

IF Data Body

The IF data body contains zero or more IF Data samples arranged as an array of `typIFD_DATABLOCK` data blocks (the actual IF signal datastream payload). The number of datablocks is specified by the `Datablock Count` parameter from the data header.

Each datablock (`typIFD_DATABLOCK`) has its own datablock header: `datablockheaderDatablockHeader` (of type `typIFD_DATABLOCKHEADER`) and a datablock body that contains the actual data sample.

Table 4-18: IF Datablock header (typIFD_DATABLOCKHEADER)

Member name **Member type**	**Description**
uintStatusword ptypUINT	Status of the Datablock • Bits `#31` to `#16` - **RecipGain** - Automatic Gain Control (AGC) **Reciprocal Gain Correction** value that was applied when generating the following IF Data samples. The RecipGain is represented as 16-bit unsigned decimal value (the 16-bit unsigned decimal has to be divided by 2^{16} = 65535 to obtain the unsigned fractional between 0 and 1). For example a correction value of `-17.5dB` gives a value for RecipGain of `0.1333` which will be represented as `0x2220`. Using this value together with the value for the antenna voltage reference, one can calculate the true signal level at the antenna input connector (see "Data samples" on page 151). • Bits `#15` to `#8` - Reserved (must be `0`). • Bits `#7` to `#2` - User flags for special signaling between IF Data processing components. Set to `0` if not used. • Bit `#1` - **Blanking flag** - this flag is set (`1`) to indicate that the data in this block may have been falsified by some external event. • Bit `#0` - **Invalidity flag** - this flag is set (`1`) to indicate that the data within this block may be corrupt (e.g. the input signal exceeded the range of the AD converter, or the analog signal input from which the data was converted was overloaded), OR any one of the fields in the IF datastream header does not represent the data in this block correctly.

The datablock body is defined as an array of size `uintDatablockLength` with `uintData` elements interpreted using the corresponding sample type format ("typIFD_SAMPLE...." as described in the following table). The actual IF data samples have to be extracted from the array. Their structure and size is given by the IF datastream format (Table 4-15). The possible IF data sample formats are described in the table below:

Table 4-19: IF data sample format

Sample type	**Sample format**	**Most significant bits**	**Least significant bits**	**Data type**
typIFD_SAMPLE_32RE_32IM_FIX	64-bit I/Q format	First 32-bit Real component		ptypINT or ptypFLOAT_SP
typIFD_SAMPLE_32RE_32IM_FLOAT		Second 32-bit Imaginary component		ptypINT or ptypFLOAT_SP

Sample type	Sample format	Most significant bits	Least significant bits	Data type
typIFD_SAMPLE _16RE_16IM_FIX	32-bit I/Q format	16-bit Imaginary component	16-bit Real component	ptypINT
typIFD_SAMPLE _16RE_16RE_FIX	16-bit Real format	16-bit sample number `I+1`	16-bit sample number `I`	ptypINT

The term 'fix' ('fixed' point) indicates signed (2s-complement) fixed point fractional numbers.

Data samples

The absolute signal level in [dBµV] may be calculated as follows:

Level [dBµV] = 10*log(I_{rel}^2+Q_{rel}^2) [dB] + 20*log (RecipGain / 2^{16}) [dB] + 0.1*AntVoltRef [dBµV]

where I and Q are the real and imaginary parts of each signal sample.

The absolute signal level in [µV] may be calculated as follows:

I [µV] = I_{rel} * (RecipGain / 2^{16}) * AntVoltLin

Q [µV] = Q_{rel} * (RecipGain / 2^{16}) * AntVoltLin

where AntVoltLin [µV] = $10^{(0.1 * AntVoltRef) / 20}$

Depending on the sample format, as presented in Table 4-19, I and Q values can be represented as signed integers on 32-bits (I_{int32}) or 16-bits (I_{int16}) or as 32-bit float values (I_{float}). The relative values of I and Q can be calculated with the following formulas (same applies for Q_{rel}):

- I_{rel} = I_{int32}/(2^{31}-1) where I_{int32} is a signed integer, the most significant bit gives the sign (0 is positive, 1 is negative)
- I_{rel} = I_{int16}/(2^{15}-1) where I_{int16} is a signed integer, the most significant bit gives the sign (0 is positive, 1 is negative)
- I_{rel} = I_{float}

In the first two cases I_{rel} and Q_{rel} represent relative signal level values between -1 and 1. The absolute signal levels are retrieved through the parameter AntVoltRef as presented above. In the third case, I_{rel} and Q_{rel} can represent directly the absolute signal levels - in this case the RecipGain and AntVoltRef are not used (and are set to RecipGain=1, AntVoltRef=0).

Example

Word position in frame	Frame component name	Hex value	Description
1	**uintMagicWord**	FB746572	Frame synchronisation
2	**uintFrameLength**	0000001E	Entire frame length = 30 (in 32-bit units)

Word position in frame	Frame component name	Hex value	Description
3	**uintFrameCount**	000000FE	Running frame number = 254
4	**uintFrameType**	00000004	The type of data contained in this frame
5	**uintDataHeaderLength**	0000000E	data header length = 14 (in 32-bit units)
6	**uintReserved**	00000000	Reserved field
7	**uintDatablockCount**	00000002	Number of data blocks in this frame = 2
8	**uintDatablockLength**	00000004	The data block length (in 32-bit units) excluding the data block header = 4. Every data block in this frame will have the same length.
9 10	**bigtimeTimeStamp**	00035CED 1D63F4D0	Absolute time [µs] of the first IF signal data sample in this frame
11	**uintStatusword**	00000000	No status change indications.
12	**uintSignalSourceID**	00000003	Antenna ID = 3
13	**uintSignalSourceState**	00000A73	Tuner scan status = position 2675
14	**uintTunerFrequency_Low**	42Ef9EC0	Tuner center frequency = 1,123 GHz
15	**uintTunerFrequency_High**	00000000	
16	**uintBandwidth**	01312d00	The IF Data bandwidth = 20 MHz
17	**uintSamplerate**	0493E000	ADC sample rate = 76,8 Msample/s
18	**uintInterpolation**	00000001	Interpolation factor = none
19	**uintDecimation**	00000003	Decimation factor referred to the ADC sample rate = 3
20	**intAntennaVoltageRef**	0000001E	Antenna reference voltage = 3dBµV
21	**uintStatusword**	22200000	Beginning of the first Datablock. Statusword contains AGC correction factor = 0.1333 and no flags indications.
22	**uintData**	23873454	Real part of first sample
23	**uintData**	34234523	Imaginary part of first sample
24	**uintData**	56567543	Real part of second sample
25	**uintData**	34563456	Imaginary part of second sample
26	**uintStatusword**	41000004	Beginning of the second Datablock. Statusword contains AGC correction factor = 0.2539 and one user flag indication.
27	**uintData**	45345222	Real part of third sample
28	**uintData**	546672ab	Imaginary part of third sample
29	**uintData**	5BB25346	Real part of fourth sample
30	**uintData**	BBF7673e	Imaginary part of fourth sample

WV format

WV is a format used by Rohde & Schwarz signal generators to store waveforms. A waveform file contains a header and raw I/Q samples.

Mandatory elements

Each waveform file must begin with the TYPE tag. The sequence of the remaining tags is arbitrary.

Element	Description
TYPE	Designates the file type and source of creation (instrument type). Also includes an ASCII-coded checksum of the data part of the WAVEFORM tag, used to detect transmission errors.
CLOCK	The clock frequency (sample rate), in Hz
EMPTYTAG-Length	Length is an ASCII integer value that specifies the number of bytes in the EMPTYTAG, i.e. defines the number of bytes from the colon : to the end bracket }
WAVEFORM-Length	The actual waveform data (I/Q stream) Length specifies the number of bytes in a WAVEFORM tag and is calculated as follows: Length = Number of I/Q pairs * 4 (2 bytes per I and 2 bytes per Q value) + 1 byte (the length of the #) The binary data is represented by 16-bit signed integer in 2's complement notation. It contains the I and Q component alternately, starting with the I component. Each component consists of 2 bytes in Little endian format representation, i.e least significant byte (LSB) first. The values of the 2 bytes in an I component and a Q component are in the range 0x0 to 0xFFFF (-32767 to +32767).

Optional elements

The following elements are optional in a `.wv` file.

Element	Description
DATE	Date and time at which the file was created Syntax: yyyy-mm-dd;hh:mm:ss
LEVEL OFFS	Offset of RMS and peak level relative to the 16-bit full scale modulation (-32767 to + 32767) = 0 dB.
SAMPLES	Number of I/Q samples in the waveform in ASCII format

Reference: format description for I/Q data files

This section describes how I/Q data is transferred to the memory during remote control.

(See the `TRACe:IQ:DATA:FORMat` command).

For details on the format of the individual values, see Section 4.10.4.7, "Reference: ASCII file export format", on page 374.

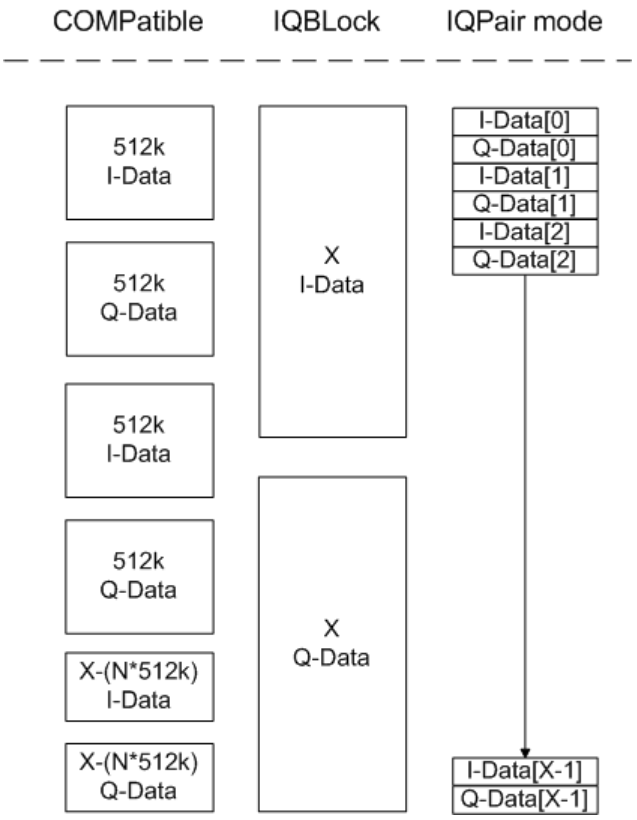


Figure 4-12: I/Q data formats

Note: 512k corresponds to 524288 samples

For maximum performance, the formats "Compatible" or "IQPair" should be used. Furthermore, for large amounts of data, the data should be in binary format to improve performance.

In binary format, the number of I- and Q-data can be calculated as follows:

$$\#\,of\ I-Data \;=\; \#\,of\ Q-Data \;=\; \frac{\#\,of\ DataBytes}{8}$$

For the format "QBLock", the offset of Q-data in the output buffer can be calculated as follows:

$$Q-Data-Offset \;=\; \frac{(\#\,of\ DataBytes)}{2} + LengthIndicatorDigits$$

with "LengthIndicatorDigits" being the number of digits of the length indicator including the #. In the example above (#41024…), this results in a value of 6 for "LengthIndicatorDigits" and the offset for the Q-data results in 512 + 6 = 518.

4.1.4.3 Multi-input and combined input

Some FSWX models have more than one RF input connector ("RF A | B"). We refer to them as *multi-input* instruments. For multi-input instruments, you can capture 2

different signals at the same time. Some applications can combine multiple signals in one result ("Combined Input").

The "Spectrum" application does not support "Combined Input" measurements.

Using the base-unit "I/Q Capture" application, for example, you can capture I/Q signals at 2 different connectors at the same time. Note that measurements start simultaneously at all inputs.

Some typical use cases for multi-input measurements include:

- Comparing the results from a reference signal and a signal from a DUT.
- Measuring the phase difference between 2 ports of a DUT.
- Comparing the signals before and after a 2-port DUT.

Multi-input configuration

For instruments and applications that support input from multiple connectors, you configure each input connector individually. You can only configure a single input connector at the same time.

For some settings, you can switch between a table view and a tabbed view.

To switch between tabbed and table view, select the icon in the dialog title bar.

In tabbed view, the individual inputs are displayed in separate vertical tabs. You get a compact overview of all settings for a particular input.



Figure 4-13: Tabbed view configuration

In table view, the inputs are displayed in columns, so you can compare the settings for different inputs.

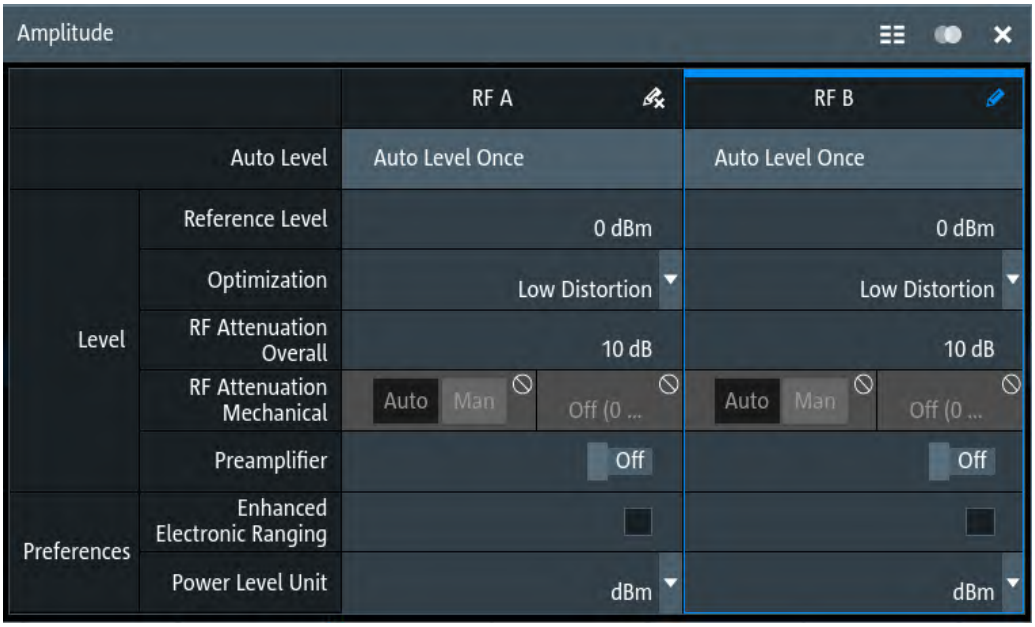


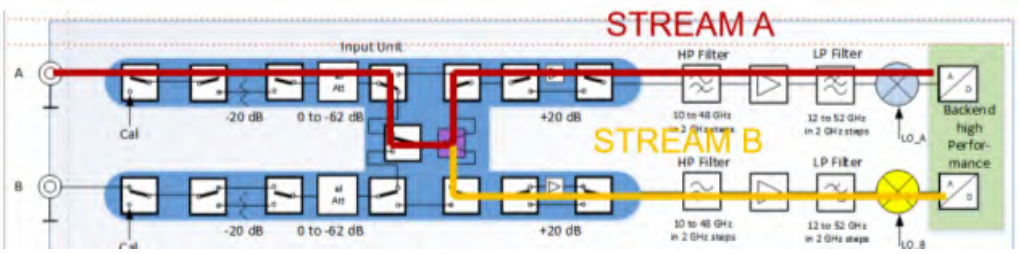
Figure 4-14: Table view configuration

Combined input

Some applications support measurements for multiple input sources, where the application combines the results for the individual sources. For example, you can combine a reference signal from a file with an input signal from the RF input connector. Or you can combine two signals from different RF input connectors in one application.

4.1.5 Basics on signal splitting and cross-correlation

As opposed to providing 2 different signals at separate input connectors, an optional internal splitter transmits a signal from a single connector to 2 different signal paths. Thus, the FSWX can process the same signal using different parameters. Since the splitter is internal, the FSWX only needs to select a different signal path, which is also calibrated. As opposed to using an external splitter, you do not require additional hardware that needs to be calibrated, and do not need to change the (physical) measurement setup.



Splitter restrictions

The following restrictions and limitations apply to the use of the internal splitter:

- The internal splitter is only available for the "RF A" input connector. In this case, the "RF B" connector is not available.
- Features that use the splitter are mutually exclusive. If you enable a new feature using the splitter, the previously active feature is automatically disabled. A message in the status bar indicates the resolved conflict.

Cross-correlation

Signal splitting is also required for cross-correlation calculation. In this case, the signal from a single connector is split and transmitted to two different signal paths using the same parameters. The data from both signal paths is then combined using cross-correlation. As a result, noise and distortion from analyzer components are eliminated from the signal.

Cross-correlation factor

The number of cross-correlation operations that the application performs during a single measurement depends on the "X-Corr Factor". The higher the number, the more noise is eliminated, and the more accurate the results of the cross-correlation. Increasing the number by a factor of 10 reduces the uncorrelated noise by approximately 5 dB. The factor is defined globally and indicated in the application info panel "X-Corr" settings, if applicable.

Cross-correlation functions

The FSWX provides the following cross-correlation functionality (not supported by all applications):

- "RMS X-Corr" trace detector: improves spectral data
- Data acquisition optimization mode: "Improve EVM (via X-Corr)"; improves I/Q input data

- Sweep time and X-Corr Factor....157
- RMS X-Corr detector....161
- EVM improvement using cross-correlation.... 162

4.1.5.1 Sweep time and X-Corr Factor

For swept RF data, the number of cross-correlation operations that the application performs during a single measurement depends on the "X-Corr Factor".

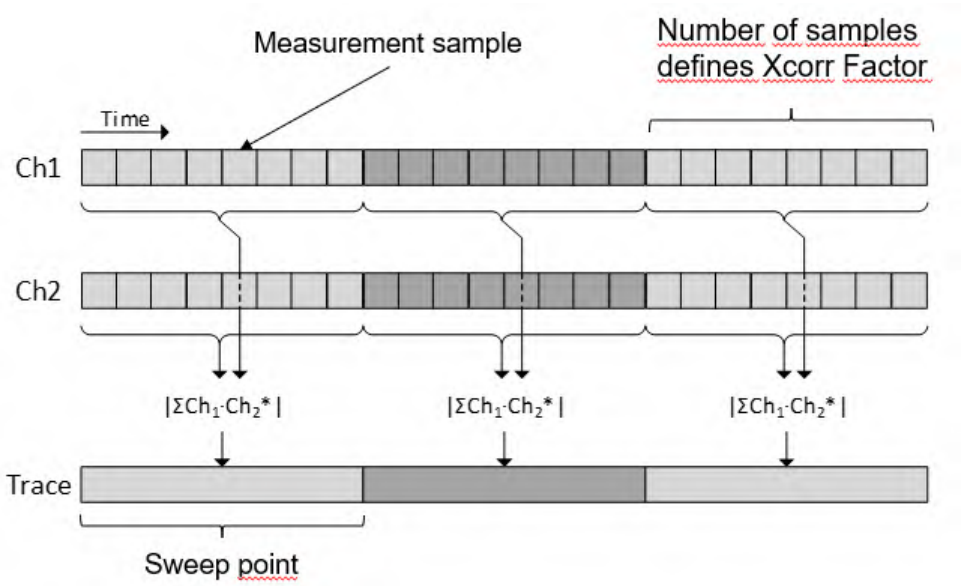


Figure 4-15: Cross-correlation for swept data

Cross-correlation for data acquired using FFT

FFT data can be cross-correlated both in the time and in the frequency dimensions. In the time dimension, subsequent FFTs are cross-correlated. In the frequency dimension, multiple FFT bins are cross-correlated, thus reducing the frequency resolution to match the sweep point width.

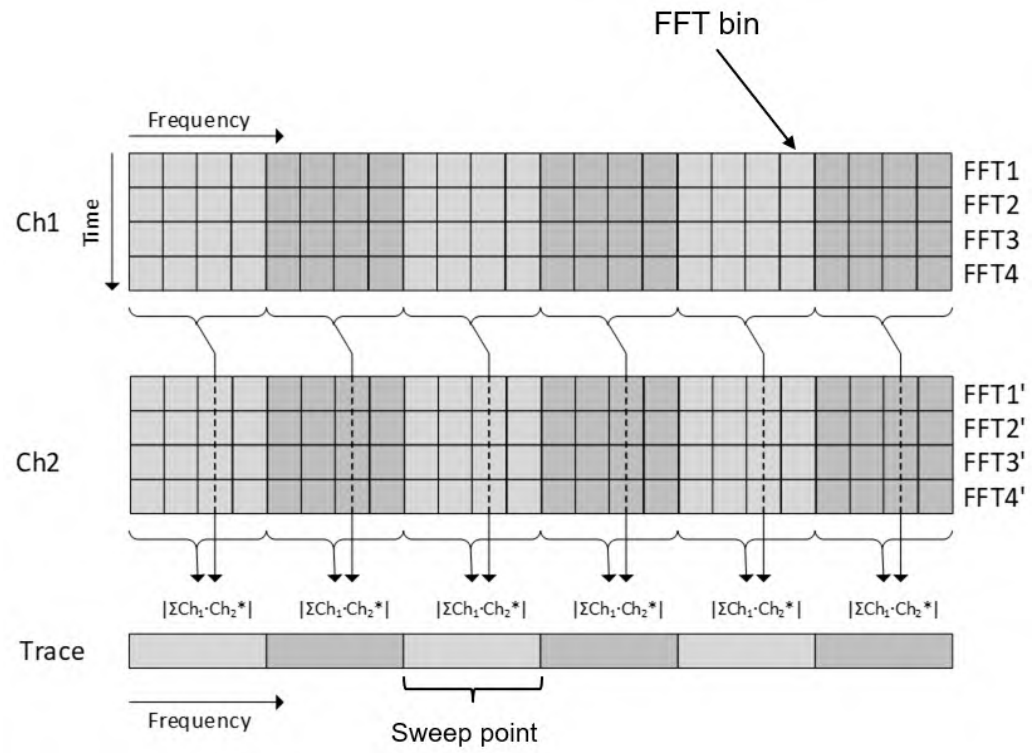


Figure 4-16: Cross-correlation for FFT data

The result is a single trace of sweep points for the I and the Q data.

The sweep time increases due to cross-correlation. If the sweep time is fixed, the "X-Corr Factor" must be adapted, and vice versa. You can define the sweep time and the "X-Corr Factor" manually in the "Sweep Configuration". The "Spectrum" application determines the parameters as follows, depending on the sweep type.

Table 4-20: Sweep time and X-Corr Factors depending on the sweep type

Sweep mode	Sweep time	"X-Corr Factor"
Sweep	SWT = ("X-Corr Factor"* Span) / RBW^2	fixed (manual)
	fixed (manual)	"X-Corr Factor" = (SWT / Span) * RBW^2
FFT	SWT = "X-Corr Factor" / RBW	fixed (manual)
	fixed (manual)	"X-Corr Factor" = SWT * RBW)
Zero span	fixed (manual)	"X-Corr Factor" = Sweep point interval * RBW Sweep point interval = SWT / sweep points

Example: Improving the trace for a signal with a low SNR

Consider a continuous wave with a level of -90 dBm as the input signal. First we use an "RMS X-Corr" detector with an "X-Corr Factor" of 20 for trace 2. For comparison, a common "RMS" trace detector is used for trace 1.

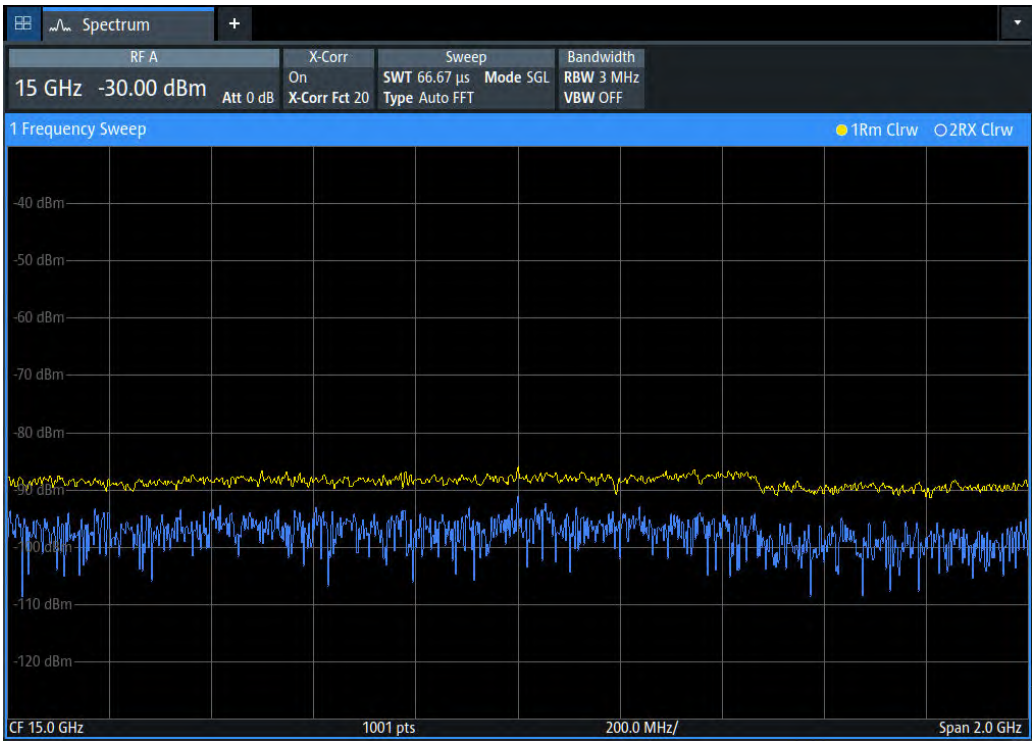


Figure 4-17: RMS X-Corr detector with an X-Corr Factor of 20

The cross-correlated trace shows less power than the common RMS trace, but the CW signal does not rise above the noise level yet.

Then we increase the "X-Corr Factor" to 1000.

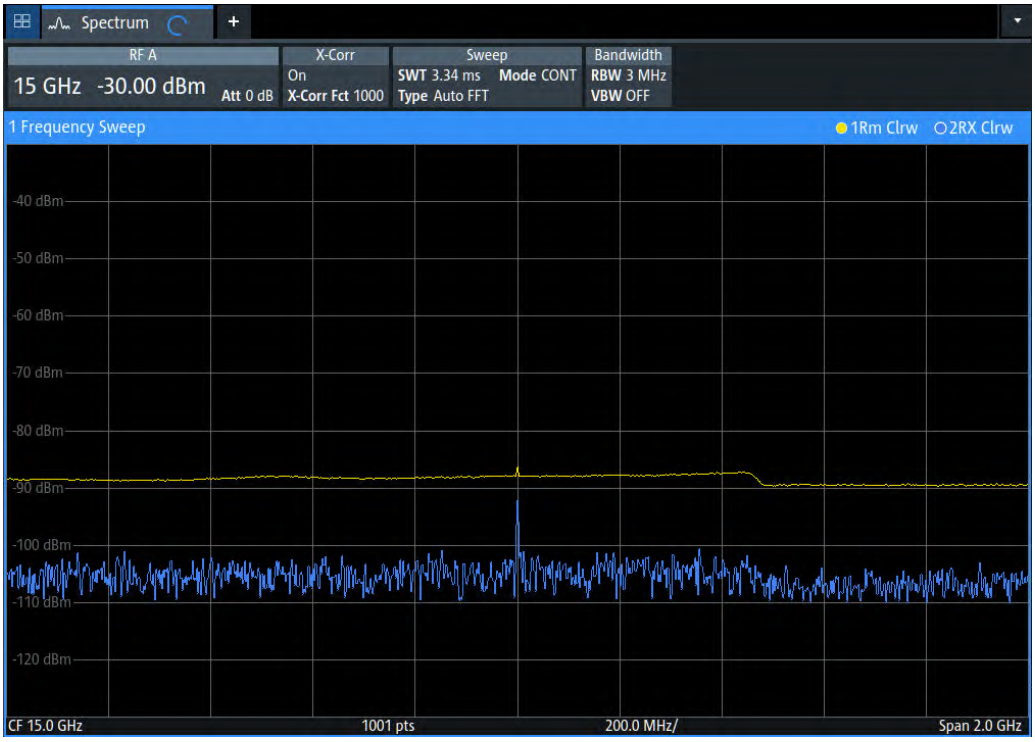


Figure 4-18: RMS X-Corr detector with an X-Corr Factor of 1000

Now the wanted signal rises above the noise floor significantly in the cross-correlated trace. Notice the sweep time increases from 66.67 µs to 3.34 ms due to the higher "X-Corr Factor".

4.1.5.2 RMS X-Corr detector

The "Spectrum" application in the FSWX base unit provides a new trace detector based on cross-correlation.

If the "RMS X-Corr" detector is active, the FSWX splits the signal from the input connector and transmits it to two different signal paths using the same parameters. The measurement samples from both signal paths are then cross-correlated. As a result, the "RMS X-Corr" detector provides a single stream of sweep or trace points. I/Q data is not supported.

Since the "RMS X-Corr" detector requires the internal splitter, it can only be used by application instances based on input from the RF A connector. If you change the input port for the application instance, the trace detector is set to the default detector.

Any other trace detectors can be used at the same time for other traces in the same measurement.

Notes and restrictions

If the "RMS X-Corr" detector is used by at least one trace, the following notes and restrictions apply:

- VBW parameters are not available.

- The detector is only available for the input connector "RF A".
- In "Auto" sweep time mode, the sweep time increases by the "X-Corr Factor".
- In manual sweep time mode, the "X-Corr Factor" changes depending on the defined sweep time.

4.1.5.3 EVM improvement using cross-correlation

Some I/Q-based applications provide a function to improve the EVM calculation using cross-correlation. Optional applications require an additional license that includes cross-correlation to use the "EVM improvement (via X-Corr)" function.

To calculate the overall EVM of a signal, an application usually demodulates the raw I/Q data, determines the error vector magnitude for the individual symbols, and summarizes all symbol EVMs.

If you cross-correlate the raw I/Q data, the data is only correlated in the time domain. Cross-correlation removes more inherent noise the more operations on statistically independent correlations are performed.

Thus, rather than to cross-correlate the raw I/Q data, some applications provide functions to demodulate the signal and calculate the error vectors on the two signal paths first. Then the calculated error vectors from both paths can be correlated in the time and the frequency domain. Note that the correlated error vectors lose their dimensions. The error vectors are then normalized with the measured signal power to obtain the overall error vector magnitude (EVM). The EVM determined by cross-correlating the demodulated signal can improve by up to 8 dB, depending on the sweep times and thus the cross-correlation factor.

Instead of cross-correlating the error vectors for individual symbols, the EVM for demodulated carriers or frames can also be correlated.

EVM cross-correlation results

The applications only indicate the improved *overall* EVM as a result in the result summary (**"EVM All"**). The improved result is compliant with most standards. Additional information on the EVM cross-correlation function is provided.

EVM X-Corr Margin

The difference of the improved EVM to the theoretically possible instrument noise floor is referred to as the "EVM X-Corr Margin". The larger the difference, the more inherent noise was removed, and the better the EVM quality. The lower the margin, the more variance the values in the trace still have. The margin also depends on the SNR of the analyzer and the DUT. If the margin is too low, increase the number of cross-correlations, for example by extending the measurement time.

4.1.6 Methods of correcting the trace

The FSWX provides various methods to correct and improve the measured trace data, for example by removing known noise and distortion values or inherent values in the analyzer.

- Fixed transducer factors for discrete trace points 163
- Reference: transducer factor file format 164
- Input-specific frequency response correction 165

4.1.6.1 Fixed transducer factors for discrete trace points

Using a transducer, you can manipulate the trace at discrete trace points to correct the input signal. Transducers are often used to correct the frequency response for antennas, for example. You configure a transducer by defining transducer factors for specific trace points. A set of transducer factors defines an interpolated transducer line. You can store the transducer on the instrument.

In the Spectrum application, the correction factor from all active transducers is calculated for each displayed trace point once in advance. During the sweep, the total correction is added to the result of the level measurement. If the sweep range changes, the application recalculates the correction values. If several measured values are combined in one point, the application only considers one value. If the active transducer is not defined for the entire sweep range, the missing values are replaced by zeroes.

When using a transducer, the trace is shifted by a calculated factor. However, an upward shift reduces the dynamic range for the displayed values. The application can adapt the reference level automatically to restore the original dynamic range. The application shifts the reference level by the maximum transducer factor. By default, if transducers are active, the application adapts the reference level automatically to obtain the best dynamic performance.

The application panel indicates an active transducer factor as "TDF".

When using probes for RF input, the FSWX automatically creates a transducer according to the detected characteristics of the probe as soon as you connect it.

If you import I/Q data that was stored with a correction factor applied, for example from transducers, the imported data includes that correction. However, any currently configured correction factors at the time of import are not applied.

Y-axis unit

You can define the individual transducer factors as absolute values or relative (dB) values. However, all factors for one transducer use the same unit. As soon as you activate a transducer, the FSWX automatically applies the unit of the transducer to all the level settings and outputs. You cannot change the unit in the amplitude settings since the FSWX and the active transducer are regarded as one measuring instrument. Only for relative transducer factors (unit dB), the unit originally set on the instrument is maintained and can be changed.

When you switch off all transducers, the FSWX returns to the unit that was used before you activated a transducer.

Configuration

The FSWX supports transducers with a maximum of 1001 data points. You can activate 8 of the transducers stored in the instrument simultaneously. The number of transducers stored in the instrument is only limited by the capacity of the storage device used.

A transducer consists of the following data:

- A maximum of 1001 data points with a position and value
- A unit for the values
- A name to distinguish the transducers

Validity

The transducer factors must comply with the following rules to ensure correct operation:

- Define the frequencies for the data points in ascending order. Otherwise the FSWX does not accept the entry and displays an error message.
- The frequencies of the data points can exceed the valid frequency range of the FSWX. Only the selected frequency range is considered for measurements. The minimum frequency of a data point is 0 Hz, the maximum frequency 200 GHz.
- The value range for the transducer factor is ±200 dB.
- Define gain as a negative value, and attenuation as a positive value.

Storing transducer factors

You can export transducer factors to a file in ASCII (CSV) format for further evaluation in other applications. You can also import transducer factors stored in the specified ASCII (CSV) format to the FSWX for other measurements.

You can also store transducer factors with the configuration settings so you can recall them for other measurements later. Note, however, that you cannot restore any changes you make to the transducer factors *after* storing the configuration file. They are overwritten by the stored values when you recall the configuration file. Always remember to store the settings again after changing the transducer factors.

Recalling transducer factors stored with measurement settings

After recalling measurement settings, the transducer factors applied to the measurement can be different to the values displayed in the "Transducer" dialog box.

4.1.6.2 Reference: transducer factor file format

This reference describes in detail the format of the export/import files for transducer factors. Note that the **bold** data is **mandatory**, all other data is optional.

Different language versions of evaluation programs can require a different handling of the decimal point. Thus, you can define the decimal separator to be used.

Table 4-21: ASCII file format for transducer factor files

File content	Description
Header data	
`sep=;`	Separator for individual values (required by Microsoft Excel, for example)
`Type;RS_TransducerFactor;`	Type of data
`FileFormatVersion;1.00;`	File format version
`Date;01.Oct 2006;`	Date of data set storage
`OptionID;SpectrumAnalyzer`	Application the transducer factor was created for
`Name;TestTDF1`	Transducer factor name
`Comment;Transducer for device A`	Description of transducer factor
`XAxisScaling;LINEAR`	Scaling of x-axis linear ("LIN") or logarithmic ("LOG")
`YAxisUnit;LEVEL_DB`	Unit of y values
`YAxisScaleMode;ABSOLUTE`	Scaling of y-axis (absolute or relative)
`NoOfPoints;5`	Number of points the line is defined by
Data section for individual data points	
100000000;-50.000000	x- and y-values of each data point defining the line
500000000;-30.000000	
1000000000;0.000000	
1500000000;-30.000000	
2500000000;-50.000000	

4.1.6.3 Input-specific frequency response correction

You can configure frequency response correction individually for each input source. The settings in the "User-defined Frequency Response Correction" dialog box apply to the currently selected input source. Be sure to select the appropriate input source before you define the correction data. In remote operation, be sure to use the correct command for the required input source. Otherwise, the correction can seem to fail because it was defined for a different input source than the one being used.

Touchstone (.snp) files

Touchstone (`.snp`) files contain data to characterize a measurement setup in respect to the gain and phase error over frequency. Network analyzers generate such files, for example. The FSWX can use such files to compensate for any gain or phase errors between the DUT and the connection from the DUT to the instrument.

Touchstone files can be defined for a varying number of input and output ports. The total number of ports configured in the file is indicated by the file extension; the "n" in `.snp` is merely a placeholder. Thus, a file for a cable with one input and one output is referred to as an S2P file. A file for a switch with 1 input and 3 outputs is referred to as an S4P file etc.

Transducer vs filter function

The FSWX handles Touchstone files similarly to transducer files. However, while a transducer adapts the frequency values by a fixed factor, Touchstone files act as a filter on I/Q input data. For common frequency sweeps, the effects of transducers and Touchstone files are the same.

.fres files

Additional frequency response correction files in `.fres` format allow you to correct effects from components for which no Touchstone files are available.

Some applications can create correction files from user-defined equalizer files.

Files in `.fres` format correspond to an S1P file. They contain exactly three values for each frequency:

- The frequency
- The magnitude correction value
- The phase correction value

Instead of the magnitude and phase correction values, the I and Q values can be provided.

The FSWX applies those values to the input data. If the file contains any other data, the FSWX cannot load it.

For `.fres` files, you can activate magnitude and phase correction separately.

Group delay compensation

You can use the phase correction values to compensate for a group delay. However, to calculate the correction correctly, the spacing between two values must not be too large. Thus, the FSWX requires a minimum number of values in the correction file. Define at least enough values so the following equation is true:

```
Group_delay * Frequency_Spacing * 360 < 180
```

Combining multiple correction files

The measurement setup can consist of several cables, DUTs and other components. Thus, full compensation can require multiple Touchstone and frequency response files. In this case, the order in which the FSWX applies the files is important. The FSWX combines all active Touchstone files to a single S2P file, and creates the required filter or correction factors for the measurement.

Correction filters for I/Q data

The application can only apply filters to I/Q data if they are defined for the complete analysis bandwidth. Therefore, if the combined frequency response filter does not cover the complete analysis span, it is invalid and cannot be used for the measurement.

For common frequency sweeps, values not covered by the combined frequency response are not corrected, but the settings remain valid. A message is displayed in the status bar. See also "Recognizing frequency response correction in measurement results" on page 167.

External preamplifier Touchstone files

If an external preamplifier is connected to the FSWX, the preamplifier provides an additional Touchstone file. The combined frequency response filter also considers those values. For your convenience, you can switch on or off the external preamplifier directly in the "User-Defined Frequency Response Correction" dialog box, as an alternative to the common input settings.

Correcting data in one or more applications

While the instrument always uses transducer files for all measurements, you can configure `.snp` and `.fres` files either for the current application only, or for all measurement applications.

Thus, you can configure different files for individual measurement setups with a particular input source and application setup. For example, you can set up three different "I/Q Spectrum Analyzer" application instances in parallel and use different Touchstone files for each application instance.

Recognizing frequency response correction in measurement results

If frequency response correction is active for an application instance, the application panel indicates "FRCORR". The status of the correction settings is indicated by the color of this message:

Color	Meaning
Green	Active correction settings are valid and in use
Yellow	For Spectrum mode only: Correction settings are active, but the filter does not cover all frequencies in the measurement span, or the combined filter does not cover any frequencies.
Red	Correction settings are active, but not in use, e.g. due to invalid settings

Since multiple correction settings can be active at the same time, the application panel merely indicates that frequency response correction is being applied, but not which files are being used. To find out which correction files that the active application is using, check the "User-Defined Frequency Response Correction" dialog box.

An LED-like symbol indicates whether each file is active and user correction or the external preamplifier in general is switched on (symbol "lights up") or not (symbol is dark). A purple symbol represents a Touchstone file. A green symbol represents a frequency response (`.fres`) file.

Storing frequency response correction settings

You can store frequency response correction settings to a file (saveset) and load them for future measurements.

Storing SaveSets with a loaded Touchstone file

If you store the settings for a measurement using a Touchstone file in a saveset, only the link to the Touchstone filename is actually stored. That means that if you change the settings in the file and recall the saveset for the measurement later, the results differ from the original measurement.

Imported I/Q data

When you import I/Q data from a file, currently defined correction factors are not applied to the I/Q data files. Data from these files is imported as it was stored. However, if any correction factors were applied to the stored data, for example from Touchstone files, the imported data contains those corrections.

Restrictions

Currently, the FSWX has the following restrictions for Touchstone file support:

- Trace data containing corrections from Touchstone files cannot be returned in I/Q block format.

4.2 Receiving data input and providing data output

The FSWX can analyze signals from different input sources and provide various types of output signals.

- Data input configuration 169
- How to capture data 189
- Power sensors 192
- Probes 201
- External frontends 206
- Signal output 231
- Receiving and providing trigger signals 233

4.2.1 Data input configuration

- Input source configuration (Input Assistant)....169
- RF input settings....171
- I/Q file input settings....173
- Data acquisition settings....176
- Frequency settings....178
- Amplitude settings....179
- Signal path settings....184
- Correction factors....187

4.2.1.1 Input source configuration (Input Assistant)

Access: [Input / Output] > "Input Source Configuration"

The input source determines which data the application analyzes.

The "Input Assistant" helps you configure the input source for the measurement. The input source determines which data the application analyzes.

The "Input Assistant" dialog box is identical for all applications, for the input sources the application supports.

The default input source for the FSWX is radio frequency (RF). If no additional options are installed, this is the only available input source in the "Spectrum" application. In the "I/Q Capture" application, input can also be provided in I/Q files.

Separate tabs per input source

The settings for each input source are provided in separate tabs of the "Input Assistant" dialog box. You activate an input source globally on the corresponding tab.

Only one input source can be active at the same time, where "Combined Input" is considered a separate input source (see Section 4.1.4.3, "Multi-input and combined input", on page 154). You do not deactivate an input source explicitly, but rather by activating another source. The currently active input source is indicated as "On" on the corresponding tab in the "Input Assistant" dialog box.

Multiple input connectors

The "Input Assistant" dialog box contains the most important and frequently used hardware parameters for each input connector. The values for each input connector are indicated in one column of a table.

You can only configure the values for one input connector at a time. A blue frame and a pencil indicate which input connector is currently being configured.

The default input source is the signal at the "RF A" connector of the FSWX.

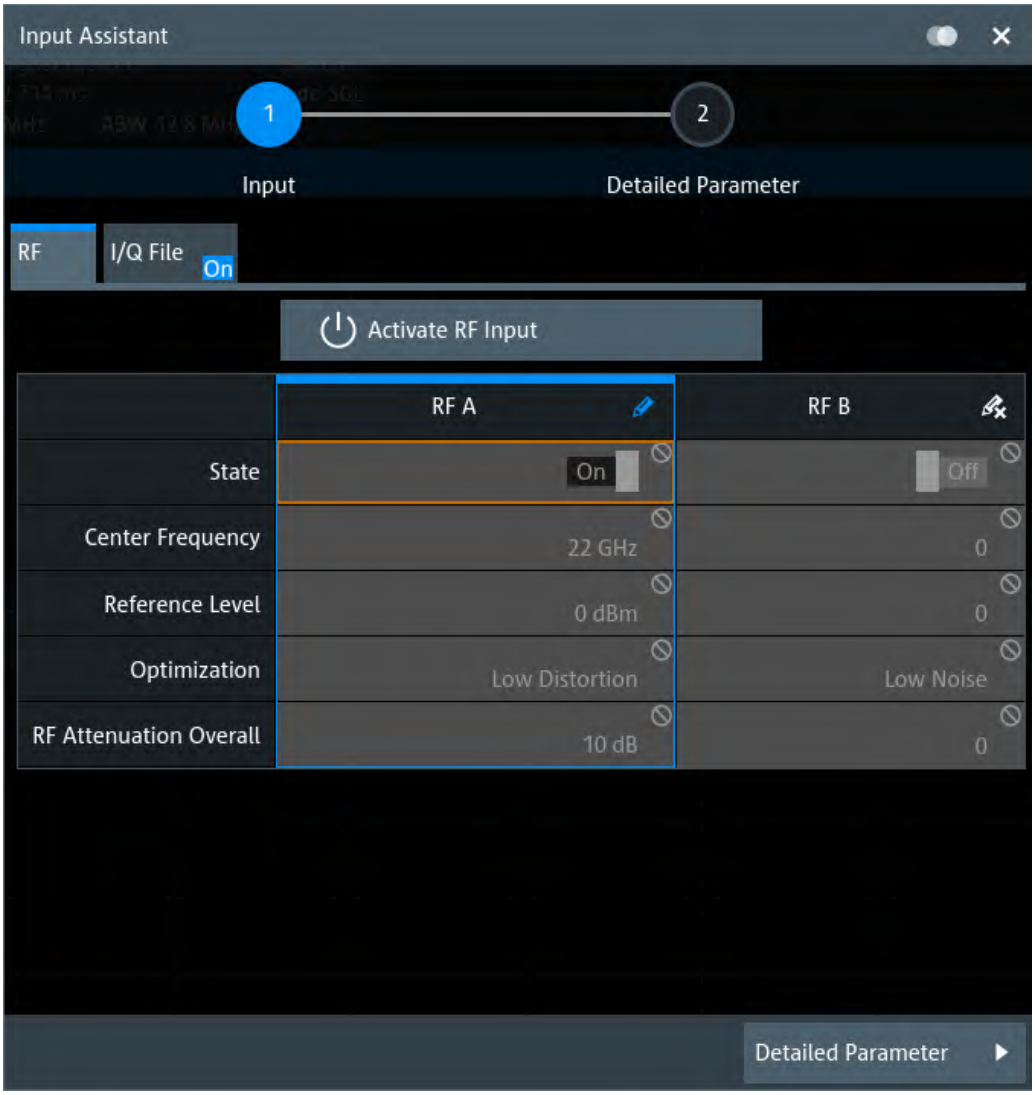
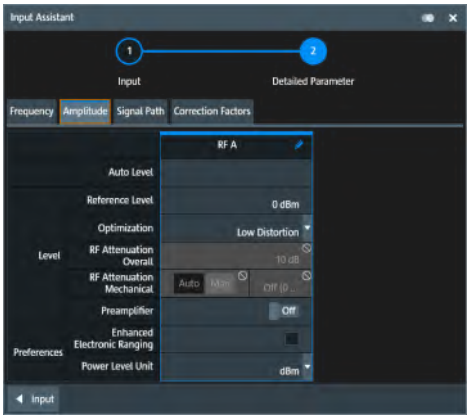
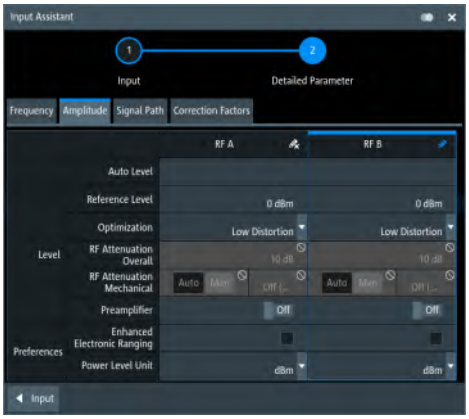


Figure 4-19: Input assistant for multi-input instrument

In addition to the global activation for the input source, you activate the individual input connectors separately.

Detailed Parameter views
The "Detailed Parameter" views provide the same parameters as the basic view, but also additional parameters, in separate tabs. From there, you can return to the basic "Input Assistant" dialog box.

"Detailed Parameter" view for single input	"Detailed Parameter" view for multi-input
	

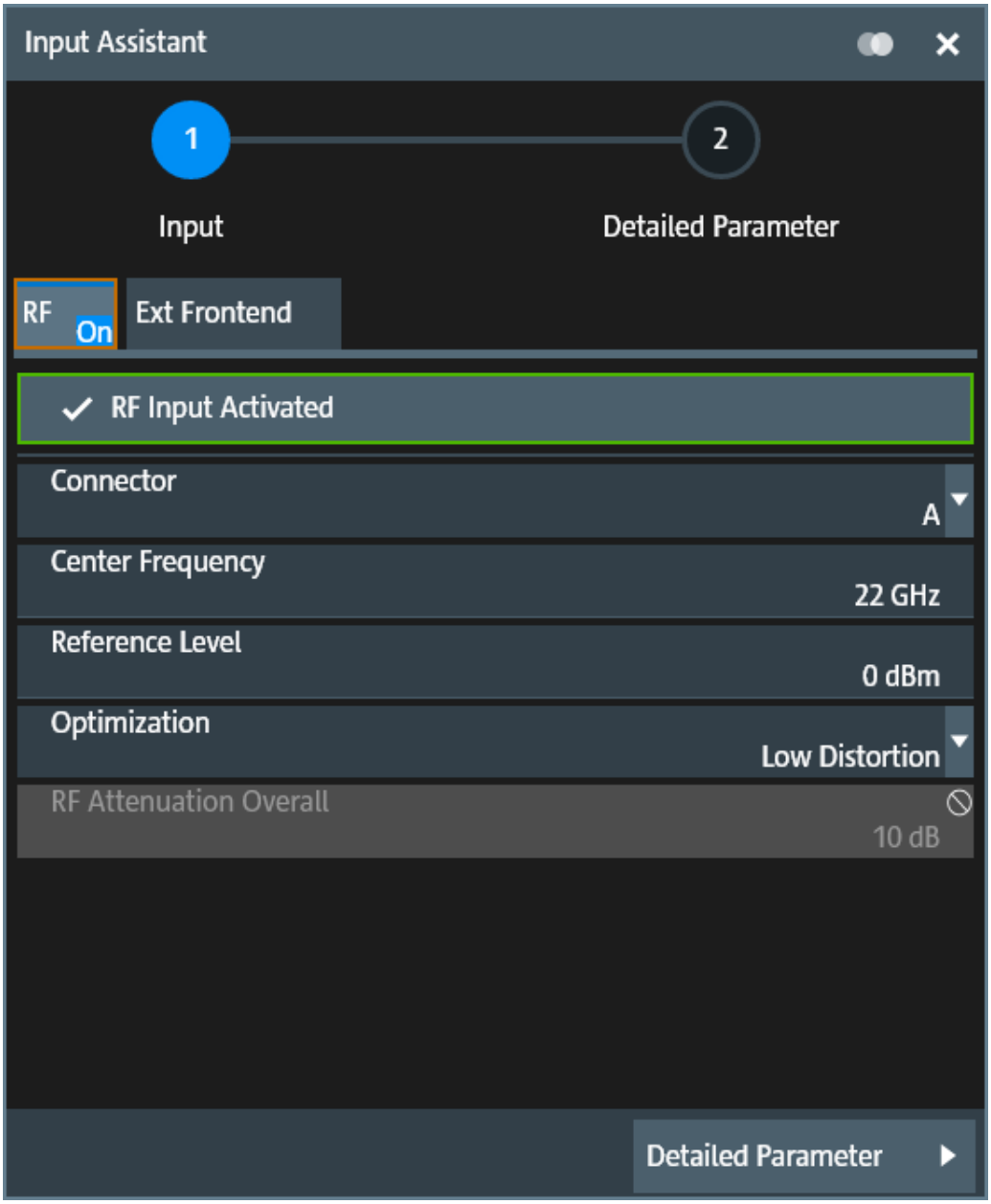
See also:

- Section 5.2.2.1, "Frequency and span settings", on page 958
- Section 4.2.1.6, "Amplitude settings", on page 179

4.2.1.2 RF input settings

Access: Input / Output > "Input Assistant" > "RF"

The default "Input Assistant" dialog box contains the most important and frequently used parameters for the individual input sources. The same parameters are also available in the "Detailed Parameter" views.



RF input protection

Protect the RF input connectors of the FSWX against signal levels that exceed the ranges defined in the specifications document. For more information, see "RF input protection" on page 115.

See also:

- "Center Frequency" on page 178
- "Reference Level" on page 181
- "Optimization" on page 182
- "RF Attenuation Overall" on page 182

Activate RF Input / RF Input Activated
Enables RF input or indicates the active state of the RF input.

If enabled, the FSWX analyzes the input from the selected RF Input Connector/ State.

Remote command:
`INP:SEL RF`, see `INPut:SELect` on page 558

Connector/ State
For instruments with multiple RF input connectors and an application that only supports a single input, select which connector to use ("RF A | B").

For instruments with multiple RF input connectors and an application that supports multi-input, enable one or more connectors that provide input ("RF A | B").

An LED next to the connector lights up when the input connector is activated for a measurement.

If an external frontend is active, you cannot use another RF input connector simultaneously for the same application instance.

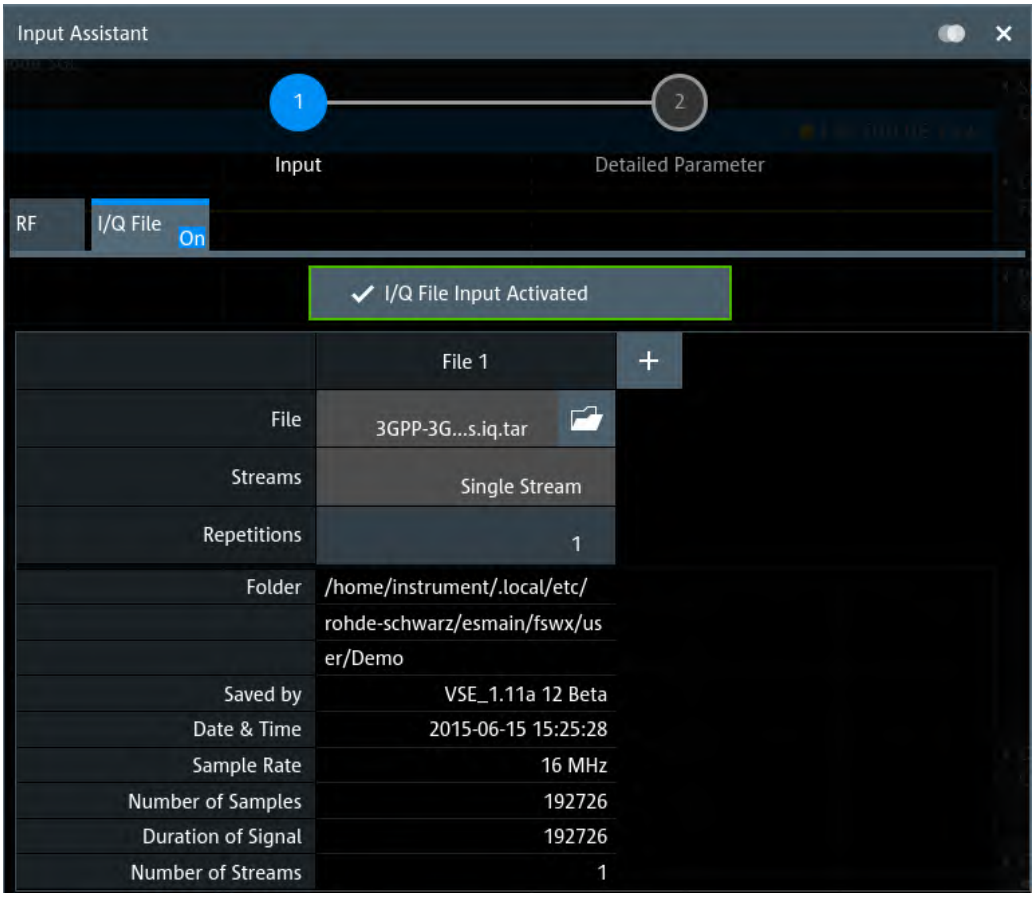
Remote command:
`INPut<ip>:RF:STATe` on page 557

Input Assignment
For applications that use reference signals to compare with the measured signals, this setting defines whether the input signal is the reference signal or a measured signal.

4.2.1.3 I/Q file input settings

Access: Input / Output > "Input Assistant" > "I/Q File"

You can load I/Q data as input from a file. The file is then used as the input source for the application.



Activate I/Q File Input / I/Q File Input Activated 174
+ Add I/Q file 175
Remove I/Q file 175
File 175
Streams 175
Repetitions 175
Folder 175
Saved by 175
Date & time 175
Sample Rate 175
Number of Samples 175
Duration of Signal 176
Number of Streams 176

Activate I/Q File Input / I/Q File Input Activated
Enables I/Q file input or indicates the active state of the I/Q file input.

If enabled, the FSWX analyzes the input from the selected I/Q files.

Remote command:
`INP:SEL FIQ`, see `INPut:SELect` on page 558

+ Add I/Q file
Inserts another column with settings for another input file. The new file is considered a new input source. It is assigned the lowest available input source index.

Remote command:
`INPut:FILE:ADD?` on page 561

Remove I/Q file
Removes the column for the input file. Input from that file is no longer analyzed.

Remote command:
`INPut:FILE<fi>:DELete` on page 561

File
Indicates the path and name of the selected data file.

Remote command:
`INPut:FILE<fi>:PATH` on page 561

Streams
Determines which of the streams stored in the file is to be restored to which input source of the selected application instance. This is relevant only for files that contain data from multiple channels (for example from MIMO measurements). You can select all streams or a single stream.

For files that contain only one stream, "Single Stream" is indicated.

Remote command:
`INPut:FILE<fi>:STReam:LIST?` on page 563
`INPut:FILE<fi>:STReam[:SELect]` on page 562
`INPut:FILE<fi>:STReam:AUTO` on page 563

Repetitions
Determines how often the data stream is repeatedly copied in the I/Q data memory to create a longer record. If the available memory is not sufficient for the specified number of repetitions, the largest possible number of complete data streams is used.

Remote command:
`INPut:FILE<fi>:REPetition:COUNt` on page 562

Folder
Indicates the storage location of the selected file.

Saved by
Indicates the creator of the selected file.

Date & time
Indicates the storage date and time of the selected file.

Sample Rate
Indicates the sample rate of the data in the selected file.

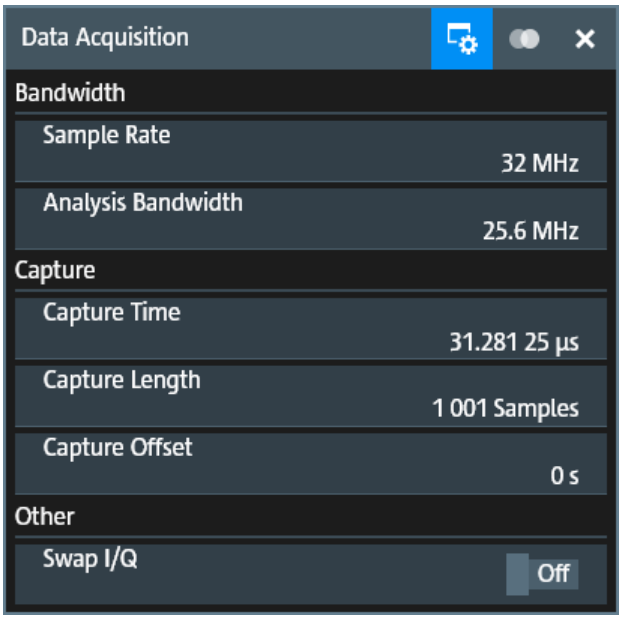
Number of Samples
Indicates the number of samples in the selected file.

Duration of Signal
Indicates the duration of the signal in the selected file.

Number of Streams
Indicates the number of streams in the selected file.

4.2.1.4 Data acquisition settings

I/Q-based measurements have common data acquisition settings.



Sample Rate 176
Analysis Bandwidth (expert parameter) 177
Capture Time 177
Capture Length (expert parameter) 177
Capture Offset (expert parameter) 177
Swap I/Q (expert parameter) 177

Sample Rate
Defines the I/Q data sample rate of the FSWX. This value depends on the defined analysis bandwidth.

Up to the maximum bandwidth, the following rule applies:

sample rate = analysis bandwidth / 0.8

This rate can differ from the sample rate of the connected device (*input sample rate*).

For details, see "Sample rate and maximum usable I/Q bandwidth for RF input" on page 123.

Remote command:
`[SENSe<ip>:]IQ:SRATe` on page 623

Analysis Bandwidth (expert parameter)
Defines the flat, usable bandwidth of the final I/Q data. This value depends on the defined sample rate.

Up to the maximum bandwidth, the following rule applies:

*analysis bandwidth = 0.8 * sample rate*

See "Sample Rate" on page 176.

Remote command:
`[SENSe<ip>:]IQ:BWIDth` on page 622

Capture Time
Defines the I/Q data acquisition time. By default, the capture time is calculated as the number of I/Q samples ("Capture Length") divided by the sample rate. If you change the capture time, the "Capture Length" is automatically changed, as well.

For details, see "Sample rate and maximum usable I/Q bandwidth for RF input" on page 123.

Remote command:
`[SENSe<ip>:]IQ:CTIMe` on page 623

Capture Length (expert parameter)
Defines the number of I/Q samples to record. The capture length is calculated as the capture time multiplied by the sample rate. If you change the capture length, the "Capture Time" is automatically changed, as well.

See "Capture Time" on page 177.

Remote command:
`[SENSe<ip>:]IQ:CLENgth` on page 623

Capture Offset (expert parameter)
Defines an offset between the start of data capturing and the start of the analysis range in the application, similar to a trigger offset.

Remote command:
`[SENSe<ip>:]IQ:CAPTure:OFFSet` on page 622

Swap I/Q (expert parameter)
Enables or disables the inverted I/Q modulation. If the I and Q parts of the signal from the DUT are interchanged, the FSWX can do the same to compensate for it.

If enabled, I and Q signals are interchanged.

Inverted sideband, Q+j*I

If disabled, I and Q signals are not interchanged.

Normal sideband, I+j*Q

For "Combined Input" measurements, you can define the inversion individually for the different input signals.

Remote command:
`[SENSe<ip>:]SWAPiq` on page 623

4.2.1.5 Frequency settings

Access: [Input / Output] > "Detailed Parameters" > "Frequency"



Center Frequency 178
Frequency Offset 179

Center Frequency
Defines the center frequency of the signal in Hertz.

The allowed range of values for the center frequency is:

$f_{min} \leq f_{center} \leq f_{max}$

f_{min} and f_{max} depend on the instrument model and are defined in the specifications document.

Remote command:
[SENSe<ip>:]FREQuency:CENTer on page 612

Frequency Offset
Shifts the displayed frequency range along the x-axis by the defined offset.

This parameter has no effect on the instrument's hardware, on the captured data, or on data processing. It is simply a manipulation of the final results in which absolute frequency values are displayed. Thus, the x-axis of a spectrum display is shifted by a constant offset if it shows absolute frequencies. However, if it shows frequencies relative to the signal's center frequency, it is not shifted.

You can use a frequency offset to correct the display of a signal that is downconverted externally, for example by an external mixer.

The allowed values range from -1 THz to +1 THz. The default setting is 0 Hz.

Remote command:
[SENSe<ip>:]FREQuency:OFFSet on page 612

4.2.1.6 Amplitude settings

Access: [Input / Output] > "Detailed Parameters" > "Amplitude"

A basic measurement on the FSWX determines the signal levels for a specified frequency range or during a specified measurement time. As a result, the levels or amplitudes are displayed on the vertical (y-)axis. The specified frequency range or the measurement time is displayed on the horizontal (x-)axis.

Amplitude settings determine how the FSWX processes or displays the expected input power levels.

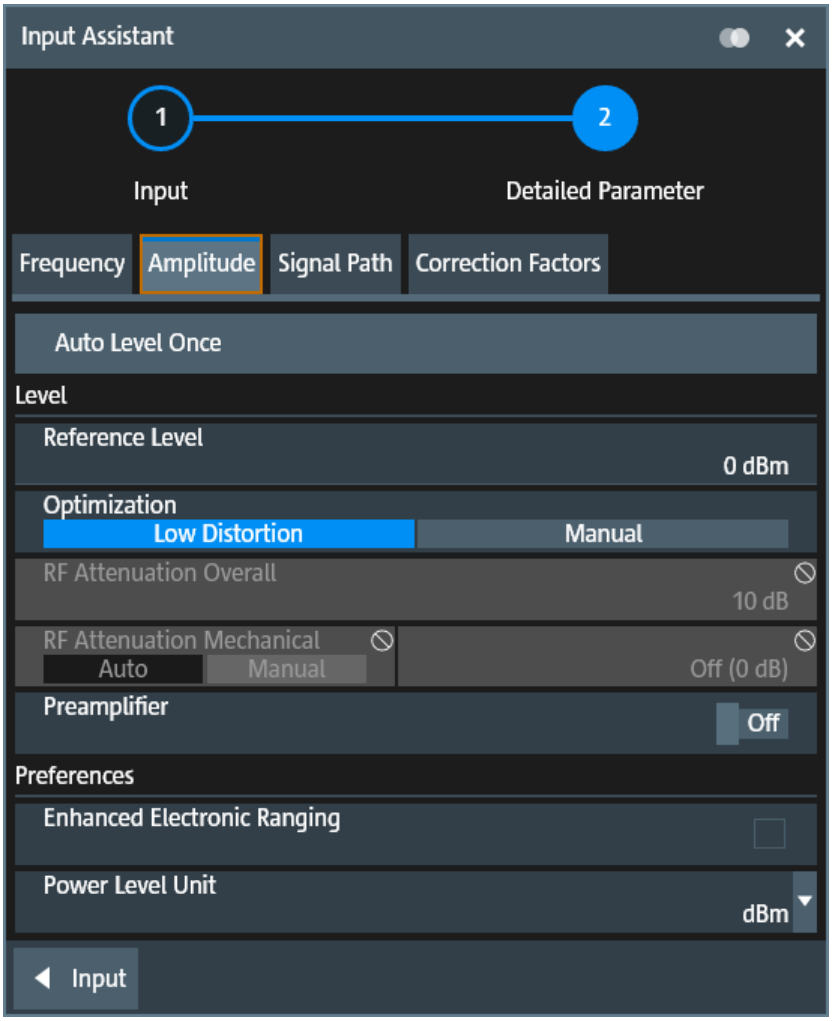
Configuring amplitude settings allows you to:

- Adapt the instrument hardware to the expected maximum signal level by setting the Reference Level to this maximum.
- Consider an external attenuator or preamplifier (using the "Reference Level Offset").
- Optimize the SNR of the measurement for low signal levels by configuring the Reference Level as high as possible without introducing compression, clipping or overload. Use early amplification by the preamplifier and a low attenuation.
- Optimize the SNR for high signal levels and ensure that the instrument hardware is not damaged, using high attenuation and AC coupling (for DC input voltage).
- Adapt the reference impedance for power results when measuring in a 75-Ohm system by connecting an external matching pad to the RF input.

For background information, see Section 4.3.2, "Impact of the vertical axis settings", on page 238.

Using external frontends

For an active external frontend, the amplitude settings refer to the RF input at the external frontend, not the levels at the RF input of the FSWX. You can configure the attenuation at the external frontend and the analyzer separately. Electronic attenuation, preamplifier and noise cancellation are not available. Input coupling is always AC. Impedance is always 50 Ω.



Setting the Reference Level Automatically (Auto Level Once) 181
Reference Level 181
Shifting the display (Reference Level Offset) 181
Optimization 182
RF Attenuation Overall 182
RF Attenuation Mechanical 182
External Frontend Attenuation 183
IF Attenuation (expert parameter) 183
Enhanced Electronic Ranging 183

Preamplifier 183
Power Level Unit 184
Noise Cancellation 184

Setting the Reference Level Automatically (Auto Level Once)
To determine the required reference level, the FSWX performs a level measurement on the selected input connector.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

Remote command:
`[SENSe<ip>:]ADJust:LEVel` on page 644

Reference Level
Defines the expected maximum signal level. Signal levels above this value are possibly not measured correctly. Signals above the reference level are indicated by an "IFOVLD" or "OVLD" status display.

For some power diagrams, the reference level defines the maximum value on the y-axis.

The FSWX adapts the hardware settings according to this value. We recommend setting the reference level close above the expected maximum signal level. Thus, you ensure an optimal measurement without compression and with a good signal-to-noise ratio.

For more information, see Section 4.3.2.1, "Expected input levels: Reference level", on page 238.

For an active external frontend, the reference level refers to the RF input at the external frontend, not the levels at the RF input of the FSWX. The FSWX adjusts its hardware settings to the defined reference level optimally for input signals with a crest factor of 10 dB. The required reference level for an optimal measurement can differ depending on the crest factor of the input signal.

See "External frontend Connection State / Status" on page 214.

Remote command:
`INPut<ip>:RLEVel` on page 614

Shifting the display (Reference Level Offset)
Defines an arithmetic level offset. This offset is added to the measured level. In some result displays, the scaling of the y-axis changes accordingly.

Define an offset if the signal is attenuated or amplified before it is fed into the FSWX so the application shows correct power results. All displayed power level results are shifted by this value.

The setting range is ±200 dB in 0.01 dB steps.

Note, however, that the *internal* reference level (used to adjust the hardware settings to the expected signal) ignores any "Reference Level Offset". Thus, it is important to keep in mind the actual power level the FSWX must handle. Do not rely on the displayed reference level (internal reference level = displayed reference level - offset).

For more information, see Section 4.3.2.1, "Expected input levels: Reference level", on page 238.

Remote command:
INPut<ip>:RLEVel:OFFSet on page 615

Optimization
Selects the priority for signal processing when determining the required RF attenuation.

- "Low Distortion" ("Dist"): Default: Optimized for low distortion by avoiding intermodulation
- "Low Noise": (I/Q input only) Optimized for high sensitivity and low noise levels
- "Manual": Define the attenuation manually

Remote command:
RF input: INPut<ip>:ATTenuation:AUTO on page 616
I/Q input: INPut<ip>:ATTenuation:AUTO:MODE on page 552

RF Attenuation Overall
Defines or indicates the overall attenuation applied to the RF input of the FSWX.

By default and without the additional option, the FSWX uses the electronic attenuator for attenuation levels up to 19 dB. For higher levels, the FSWX enables the mechanical attenuator for 20 dB attenuation, and covers the remaining level by electronic attenuation. Thus, the FSWX provides an overall RF attenuation up to 39 dB.

If you set RF Attenuation Mechanical to "Manual", you can change the overall RF attenuation down to 0 dB. Using the arrow keys, the value changes in 5-dB steps. Using the rotary knob, the step size is 1 dB. If you enter other values using the keypad, they are rounded to the next integer value. The valid range is defined in the specifications document. Ensure that the signal power level does not exceed the maximum level allowed at the RF input. An overload can lead to hardware damage. If the FSWX cannot set the defined reference level for the defined RF attenuation, it adjusts the reference level accordingly and displays the warning "Limit reached".

Note: Using an external frontend. If an external frontend is active, you can configure the attenuation for the external frontend and the analyzer separately.
For more information, see "External frontend attenuation vs. analyzer attenuation" on page 209.

Remote command:
INPut<ip>:ATTenuation on page 616
Defining attenuation for the analyzer when using an external frontend:
INPut<ip>:SANalyzer:ATTenuation on page 619

RF Attenuation Mechanical
Determines how the mechanical RF attenuation is defined.

In "Auto" mode, the FSWX uses the electronic attenuator for attenuation levels up to 19 dB. For higher levels, the FSWX enables the mechanical attenuator for 20 dB attenuation, and covers the remaining level by electronic attenuation.

For more information, see "Electronic vs mechanical attenuation" on page 240.

In "Manual" mode, you can switch off mechanical attenuation entirely, or set it to 20 dB.

Remote command:
INPut<ip>:ATT:MECH on page 618
INPut<ip>:ATT:MECH:AUTO on page 618

External Frontend Attenuation
If an external frontend is active, you can configure the attenuation for the external frontend and the analyzer separately.

For more information, see "External frontend attenuation vs. analyzer attenuation" on page 209.

When using an external frontend, only mechanical attenuation is available.

The FSWX can set the RF attenuation automatically as a function of the selected reference level ("Auto" mode). Automatic attenuation ensures that no overload occurs at the RF Input connector for the current reference level. It is the default setting.

In "Manual" mode, you can set the RF attenuation in 1-dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is defined in the specifications document. If the FSWX cannot set the defined reference level for the defined RF attenuation, it adjusts the reference level accordingly and displays the warning "Limit reached".

When you decrease the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input. An overload can lead to hardware damage.

Remote command:
INPut<ip>:ATTenuation on page 616
INPut<ip>:ATTenuation:AUTO on page 616

IF Attenuation (expert parameter)
Determines how the IF attenuation between the preamplifier and the A/D converter is defined. This setting is only available for I/Q data capture.

In "Auto" mode, the FSWX determines the optimum attenuation according to the signal path.

In "Manual" mode, you can define the IF attenuation manually.

Remote command:
INPut<ip>:ATTenuation:IF on page 617
INPut<ip>:ATTenuation:IF:AUTO on page 617

Enhanced Electronic Ranging
Prerequisite: Enhanced electronic ranging option

Optimizes the RF attenuation to reduce the amount of mechanical switching required and increase the dynamic range with the same signal path.

Remote command:
INPut<ip>:EATT:RANGing on page 619

Preamplifier
If the (optional) internal preamplifier hardware is installed on the FSWX, you can enable a preamplifier for the RF input signal.

You can use a preamplifier to analyze signals from DUTs with low output power.

If enabled, the preamplifier amplifies the input signal by 20 dB.

If an optional splitter is active, the preamplifier amplifies the input signal in each signal path by 10 dB.

For an active external frontend, a preamplifier is not available.

See "Activate External Frontend / External Frontend Activated" on page 213.

Remote command:
`INPut<ip>:GAIN:STATe` on page 621

Power Level Unit
The FSWX measures the signal voltage at the RF input.

In the default state, the FSWX displays the level at a power level of 1 mW (= dBm). From the known input impedance (50 Ω or 75 Ω), the FSWX can convert the value to the other units.

See "Impedance" on page 189.

Remote command:
`CALCulate<n>:UNIT:POWer` on page 614

Noise Cancellation
The FSWX can correct the results by removing the inherent noise of the analyzer, which increases the dynamic range.

In this case, the FSWX performs a reference measurement of the inherent noise of the analyzer. The FSWX then subtracts the measured noise power from the power in the application instance that is being analyzed (first active trace only).

The inherent noise of the instrument depends on the selected center frequency, resolution bandwidth and level setting. Therefore, the FSWX disables the correction function whenever you change one of these parameters and displays a message. To enable the correction function after changing one of these settings, enable it again. The FSWX performs a new reference measurement.

Noise cancellation is also available in zero span.

For an active external frontend, noise cancellation is not available. See "Activate External Frontend / External Frontend Activated" on page 213.

Currently, noise cancellation is only available for the following trace detectors (see "Detector" on page 1217):
- "RMS"
- "Average"
- "Sample"
- "Positive Peak"

Remote command:
`[SENSe:]POWer:NCORrection` on page 614

4.2.1.7 Signal path settings

Access: Input / Output > "Signal Path Configuration"

The signal path settings configure the hardware from the input connector via filters to the A/D converter.



For instruments and applications that support input from multiple connectors, you configure each input connector individually. You can only configure a single input connector at the same time.

For some settings, you can switch between a table view and a tabbed view.

For details, see Section 4.1.4.3, "Multi-input and combined input", on page 154.

Input Coupling....186
Low Phase Noise (Spectrum application only)....186
Direct Path....186
YIG Preselector....187
Input Connector....187

Input Coupling
The RF input of the FSWX can be coupled by alternating current (AC) or direct current (DC).

For an active external frontend, input coupling is always DC.

AC coupling blocks any DC voltage from the input signal. AC coupling is enabled by default to prevent damage to the instrument. Low frequencies in the input signal can be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the specifications document.

Remote command:
`INPut<ip>:COUPling` on page 554

Low Phase Noise (Spectrum application only)
Enables or disables a signal path that is optimized for a lower IF to improve phase noise for RF frequencies larger than 9 GHz. As a result, image rejection can be reduced.

In some cases, this signal path is chosen by default, for example for analysis bandwidths larger than 1 GHz.

This setting is only available in the "Spectrum" application and only for single RF input.

Remote command:
`INPut<ip>:LPNoise[:STATe]` on page 555

Direct Path
Enables or disables the use of the direct path for small frequencies.

In spectrum analyzers, passive analog mixers are used for the first conversion of the input signal. In such mixers, the LO signal is coupled into the IF path due to its limited isolation. The coupled LO signal becomes visible at the RF frequency 0 Hz. This effect is referred to as *LO feedthrough*.

To avoid the LO feedthrough, the FSWX provides an alternative signal path to the A/D converter, referred to as the *direct path*. By default, the FSWX selects the direct path automatically for RF frequencies close to zero. However, you can disable the use of the direct path. If disabled, the FSWX always uses the analog mixer path.

For an active external frontend, the FSWX always selects the direct path automatically for RF frequencies close to zero.

"Auto" (Default:) The FSWX selects the direct path automatically for RF frequencies close to zero.

"Off" The FSWX always uses the analog mixer path.

Remote command:
`INPut<ip>:DPATh` on page 554

YIG Preselector
Prerequisites:
- YIG Preselection option

Enables or disables the YIG-preselector.

Restrictions:
- Only available for RF input connector A.
- Active only on frequencies greater than 8 GHz. Switching the YIG-preselector on or off has no effect if the frequency is below that value.
- Not available for sweep type "Sweep".

An internal YIG-preselector at the input of the FSWX ensures that image frequencies are rejected. However, image rejection is only possible for a restricted bandwidth. To use the maximum bandwidth for signal analysis, you can disable the YIG-preselector at the input of the FSWX. However, disabling the YIG-preselector can lead to image frequency display.

The YIG-preselector is off by default.

Remote command:
`INPut<ip>:FILTer:YIG[:STATe]` on page 554

Input Connector
Determines which type of connector the input data for the measurement is taken from.

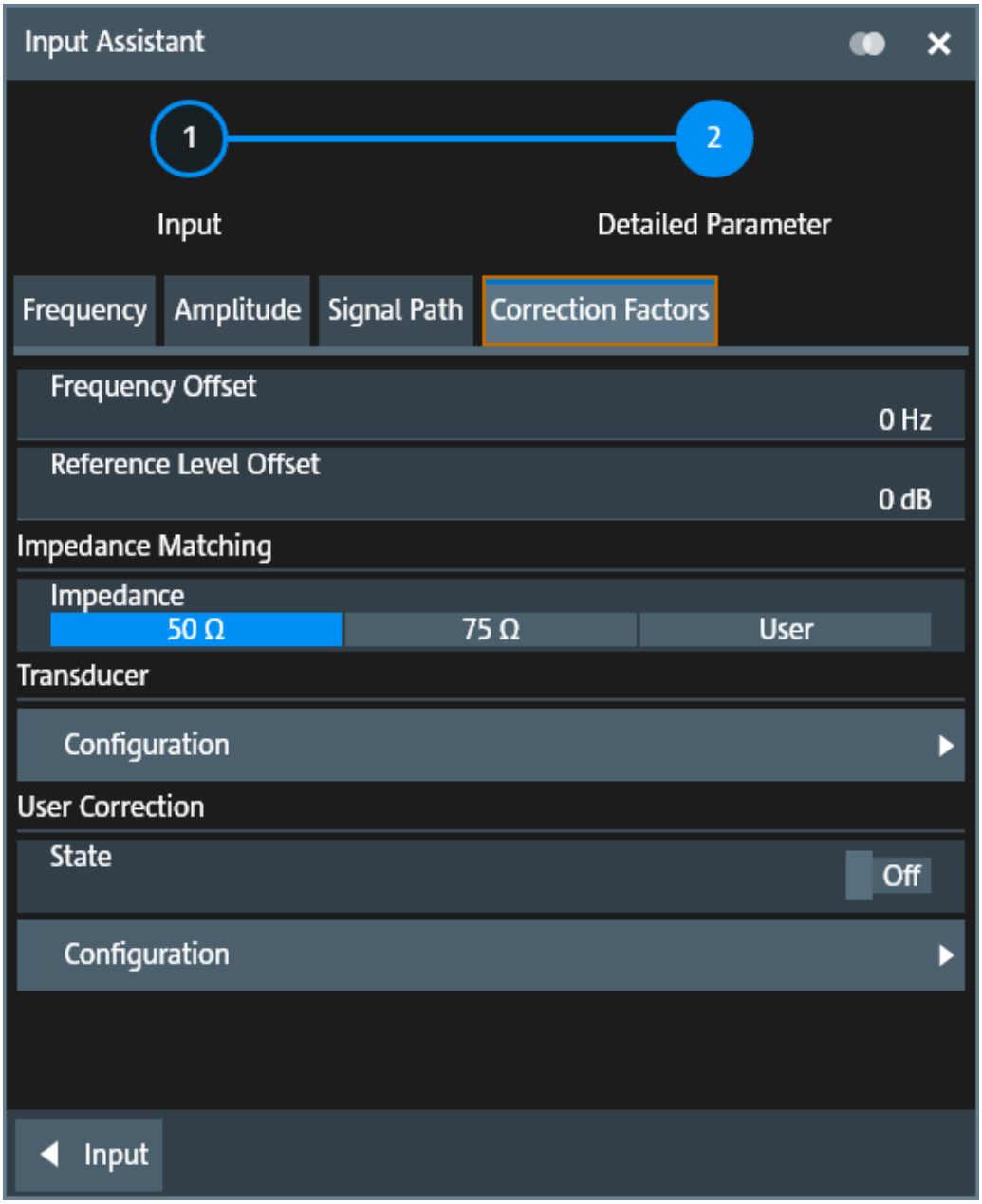
"RF"	(Default:) The "RF Input" connector
"RF Probe"	The "RF Input A" connector with an adapter for a modular probe This setting is only available if the "RF Input A" connector is active and a probe is connected. See also "Activate RF Input / RF Input Activated" on page 173. It is not available for an active external frontend.

Remote command:
`INPut<ip>:CONNector` on page 553

4.2.1.8 Correction factors

Access: Input / Output > "Correction Factors"

Correction factors compensate for the effects of the signal path on the input signal.



See also:

- "Frequency Offset" on page 179
- "Shifting the display (Reference Level Offset)" on page 181
- Section 4.11.4, "User-defined frequency response correction", on page 411
- Section 4.11.3, "Transducers", on page 402

Impedance 189

Impedance
The FSWX has an internal impedance of 50 Ω. However, some applications use other impedance values. To match the impedance of an external application to the impedance of the FSWX, you can insert an *impedance matching pad* at the input. If the type and impedance value of the used matching pad is known to the FSWX, it can convert the measured units accordingly so that the results are calculated correctly.

(See "Reference Level" on page 181).

For an active external frontend, impedance is always 50 Ω.

The impedance conversion does not affect the level of the output signals (such as IF, video, demod, digital I/Q output).

"50 Ω"	(Default:) no conversion takes place.
"75 Ω"	The 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the selected "Pad Type": "Series-R" (default) or "MLP" (minimum loss pad)
"User"	The 50 Ω input impedance is transformed to a user-defined impedance value according to the selected "Pad Type": "Series-R" (default) or "MLP" (minimum loss pad)

Remote command:
`INPut<ip>:IMPedance` on page 555
`INPut<ip>:IMPedance:PTYPe` on page 556

4.2.2 How to capture data

4.2.2.1 How to capture RF data

The following step-by-step instructions demonstrate how to capture RF input data on the FSWX, e.g. in the "Spectrum" application.

How to capture RF input data

1. Select [Input / Output] > "Input Source Configuration" to configure RF input as the signal source.

   The "Input Assistant" is displayed.
2. On the "RF" tab, select "Activate RF Input".
3. For multi-input instruments, select or enable the connector that provides the input.
4. Define the input signal's center frequency.
5. Define the reference level, optimization mode and overall RF attenuation according to the input signal's amplitude.
6. If necessary, select "Detailed Parameters" to configure further hardware-related parameters for the input signal, such as filters or correction factors.

7. Optionally, select "Trigger/Gate" and define a trigger for data acquisition, for example a power trigger to start capturing data only when a specific power is exceeded.
8. Select "Display Config" and select the result displays that are of interest to you. Arrange them on the display to suit your preferences.
9. Exit the "Display Configuration" mode.
10. Select [Run Single] to start a new sweep with the defined settings.

4.2.2.2 How to capture I/Q data

The following step-by-step instructions demonstrate how to capture I/Q data in an I/Q-based application, such as the "I/Q Capture" application.

How to capture I/Q data as RF input

1. Select [Input / Output] > "Input Source Configuration" to configure the RF input as the signal source.

   The "Input Assistant" is displayed.
2. On the "RF" tab, select "Activate RF Input".
3. For multi-input instruments, enable the connectors that provide input.
4. Define the input signal's center frequency.
5. Define the reference level, optimization mode and overall RF attenuation according to the input signal's amplitude.
6. If necessary, select "Detailed Parameters" to configure further hardware-related parameters for the input signal, such as correction factors.
7. Optionally, select "Trigger/Gate" and define a trigger for data acquisition, for example an I/Q Power trigger to start capturing data only when a specific power is exceeded.
8. Select "Data Acquisition" to define the parameters for data acquisition:
   - "Sample Rate", the rate at which samples are captured or "Analysis Bandwidth", the span of the input signal to be captured for analysis (both values are correlated)
   - "Capture Time": how long the data is to be captured
   - "Capture Length": the number of samples to be captured (also defined by sample rate and capture time)
9. Select "Display Config" and select the result displays that are of interest to you. Arrange them on the display to suit your preferences.
10. Exit the "Display Configuration" mode.
11. For multi-input analysis, select [Trace] > "Trace Configuration" to configure the input sources for the individual traces in the displays.

    Now you can compare the results for different input sources in one display.

12. Select [Run Single] to start a new data capture with the defined settings.

How to analyze I/Q data from files

1. Select [Input / Output] > "Input Source Configuration" to configure a file as the signal source.

   The "Input Assistant" is displayed.

2. On the "I/Q file" tab, select the input file with the stored data.

   The "Activate I/Q File Input" function becomes available.
   Metadata provided in the input file is displayed for reference, e.g. the creator and time of storage. Information on the signal data is also indicated, if available, such as the number of samples and streams, the duration of the signal and the sample rate with which the data was stored.

3. If the file contains multiple streams of data, select which one to analyze. If you select "All", one stream after the other is input. If you want to compare streams in the same file with each other, add multiple files in the "Input Assistant". Then select the same file, but different streams as the input source.

4. Define how often the data in the file is repeated as input ("Repetitions").

5. To add another file with I/Q data input, or another stream in the same file, select the "+" icon next to the "File<x>" title.

   A new column is inserted in the dialog box. Repeat the steps above to configure the file input.

6. Select "Activate I/Q File Input".

7. Close the "Input Assistant".

8. If necessary, select "Correction Factors" to configure correction factors for the stored data.

9. Select "Data Acquisition" to define how much of the stored data is used as input, either in time or samples ("Capture Time" / "Capture Length"). By default, all available samples are used.

10. Select "Display Config" and select the result displays that are of interest to you. Arrange them on the display to suit your preferences.

11. Exit the "Display Configuration" mode.

12. For multiple files, select [Trace] > "Trace Configuration" to configure the input sources for the individual traces in the displays.

    Now you can compare the results for different files in one display.

13. Select [Run Single] to start a new data input with the defined settings.

4.2.3 Power sensors

4.2.3.1 Input from power sensors

For precise power measurement, you can connect up to 4 power sensors to the instrument via the power sensor interface or the USB connectors. Both manual operation and remote control are supported.

For a detailed list of supported sensors, see the specifications document.

You can also use power sensors to trigger a measurement at a specified power level, e.g. from a signal generator.

In a standard test setup, you insert a power sensor between a signal source and the signal analyzer.

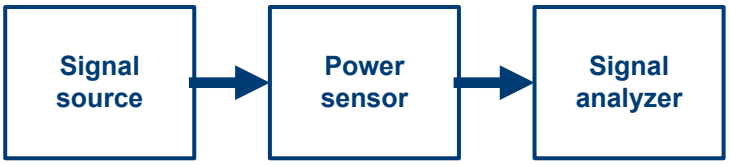
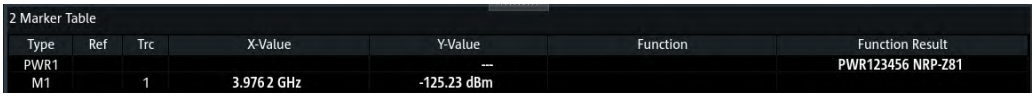


Figure 4-20: Power sensor support – standard test setup

The power sensor measures the power from the signal source very precisely, and can trigger evaluation on the FSWX.

Result display

The results of the power sensor measurements are displayed in the marker table. For each power sensor, a row is inserted. The sensor index is indicated in the "Type" column.



Using the power sensor with several applications

You cannot use a power sensor from the FSWX firmware and the R&S Power Viewer Plus simultaneously. R&S Power Viewer Plus is a virtual power meter to display results of the R&S NRP power sensors.

Using a power sensor as an external power trigger

You can use power sensors to trigger a measurement at a specified power level, e.g. from a signal generator. For a list of supported power sensors, see the specifications document.

With the FSWX, you can connect the power sensors to the "Noise Source Control" / "Power Sensor" interface directly, with no further cables required. Then you can configure the power sensor as an external power sensor trigger.

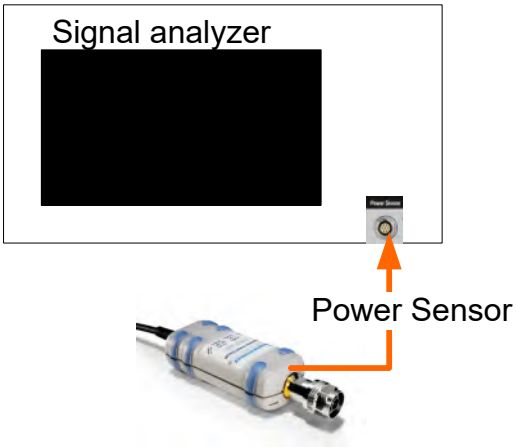


Figure 4-21: Connecting a power sensor using the Noise Source Control / Power Sensor interface

The FSWX receives an external trigger signal when the defined trigger level is measured by the power sensor. Power measurement results are provided as usual.

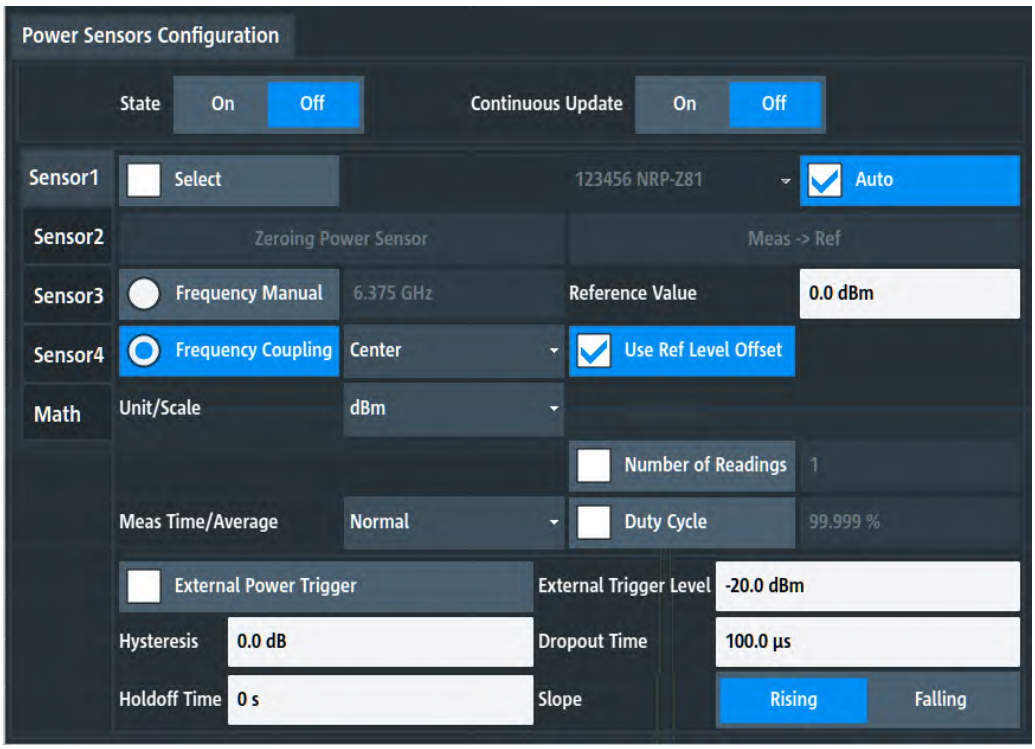
The "Gate Mode" > "Level" is not supported for Rohde & Schwarz power sensors. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus, the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed. For details on gating; see Section 4.3.4.8, "Selective data capture: gated measurements", on page 252.

For details see "How to configure a power sensor as an external (PSE) trigger" on page 201.

4.2.3.2 Power sensor settings

Access: "Overview" > "Input" > "Power Sensors"

You configure each sensor on a separate tab.



Global State 194
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Select 195
Zeroing Power Sensor 195
Frequency Manual 195
Frequency Coupling 195
Unit/Scale 196
Obtaining the reference level from the measurement (Meas -> Ref) 196
Reference Value 196
Use Ref Level Offset 196
Sensor Level Offset 196
Meas Time / Average 196
Average count 197
Duty Cycle 197
External Power Trigger 197
External Trigger Level 197
Hysteresis 197
Holdoff Time 198
Dropout Time 198
Slope 198

Global State
Enables or disables the power measurement for all power sensors. Note that in addition to this general setting, you can enable or disable each power sensor individually using the Select setting on each tab. However, the general setting overrides the individual settings.

Continuous Update
If enabled, the power sensor data is updated continuously during a sweep with a long sweep time, and even after a single sweep has completed.

You cannot enable this function for individual sensors.

Continuous update is not possible if the power sensor is being used as a trigger (see "External Power Trigger" on page 197). In this case, the power sensor ignores the "Continuous Update" setting.

Remote command:
`[SENSe:]PMETer<p>:UPDate[:STATe]` on page 604

Select
Selects the individual power sensor for usage if power sensors are generally enabled (Global State function).

The FSWX indicates the detected **serial numbers** of the power sensors connected to the instrument in a selection list. For each of the four available power sensor indexes ("Sensor1" to "Sensor 4"), which correspond to the tabs in the configuration dialog, you can assign one of the detected serial numbers. The physical sensor is thus assigned to the configuration setting for the selected power sensor index.

In "Auto" mode, the FSWX automatically assigns the first serial number that is not yet assigned to the sensor configuration.

Remote command:
`[SENSe:]PMETer<p>[:STATe]` on page 603
`SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine` on page 597
`SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe]` on page 597
`SYSTem:COMMunicate:RDEVice:PMETer<p>:COUNt?` on page 597

Zeroing Power Sensor
Starts zeroing the power sensor.

For details on the zeroing process refer to "How to zero the power sensor" on page 200.

Remote command:
`CALibration:PMETer<p>:ZERO:AUTO ONCE` on page 598

Frequency Manual
Defines the frequency of the signal to measure. The power sensor has a memory with frequency-dependent correction factors. Thus, the power sensor can measure signals of a known frequency very accurately.

Remote command:
`[SENSe:]PMETer<p>:FREQuency` on page 601

Frequency Coupling
Enables automatic coupling. The FSWX can couple the frequency of the power sensor to the center frequency of the instrument or to the frequency of marker 1 automatically.

Remote command:
`[SENSe:]PMETer<p>:FREQuency:LINK` on page 601

Unit/Scale
Selects the unit of the power display. Available units are dBm, dB, W and percent.

If you select dB or %, the display is relative to the reference value. See "Obtaining the reference level from the measurement (Meas -> Ref)" on page 196 and "Obtaining the reference level from the measurement (Meas -> Ref)" on page 196.

Remote command:
`UNIT<n>:PMETer<p>:POWer` on page 604
`UNIT<n>:PMETer<p>:POWer:RATio` on page 604

Obtaining the reference level from the measurement (Meas -> Ref)
Sets the currently measured power as a reference value for the relative display.

You can also set the reference value manually, see "Reference Value" on page 196.

Remote command:
`CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE` on page 599

Reference Value
Defines the reference value in dBm for relative power sensor measurements.

Remote command:
`CALCulate<n>:PMETer<p>:RELative[:MAGNitude]` on page 599

Use Ref Level Offset
If enabled, the application considers the reference level offset defined for the analyzer for the measured power (see "Shifting the display (Reference Level Offset)" on page 181).

If disabled, the application considers the "Sensor Level Offset" on page 196.

Remote command:
`[SENSe:]PMETer<p>:ROFFset[:STATe]` on page 603

Sensor Level Offset
The application considers the specified offset to the Reference Value for relative power sensor results. Only available if Use Ref Level Offset is disabled.

Remote command:
`[SENSe:]PMETer<p>:SOFFset` on page 603

Meas Time / Average
Selects the measurement time per averaging operation. In general, results are more precise with longer measurement times. The following settings are recommended for different signal types to obtain stable and precise results:

"Short"	Stationary signals with high power (> -40 dBm) High-power signals require only a short measurement time. Short measurement time provides the highest repetition rates.
"Normal"	Signals with lower power (-50 dBm to -40 dBm) or modulated signals
"Long"	Signals with very low power (<-50 dBm), to minimize the influence of noise
"Manual"	Manual mode to define the average count as required (Average count.

Remote command:
[SENSe:]PMETer<p>:MTIMe on page 602
[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] on page 602

Average count
Defines the number of measurements (averages) the power sensor performs for a single sweep. This setting is only available for Meas Time / Average: "Manual".

The values for the average count range from 0 to 256 in binary steps (1, 2, 4, 8, …). For average count = 0 or 1, the power sensor performs a single measurement. The general averaging and sweep count for the trace are independent from this setting.

Results become more stable with a higher average count, particularly if you measure signals with low power. You can use this setting to minimize the influence of noise in the power sensor measurement.

Remote command:
[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt on page 602

Duty Cycle
If enabled, the sensor uses the specified value to correct pulse signals. The power sensor calculates the signal pulse power from the specified value and the mean power. The duty cycle is the ratio of the pulse width to the pulse repetition interval, expressed as a percentage.

Remote command:
[SENSe:]PMETer<p>:DCYCle[:STATe] on page 600
[SENSe:]PMETer<p>:DCYCle:VALue on page 600

External Power Trigger
If enabled, the power sensor creates a trigger signal when the measured power exceeds the defined "External Trigger Level". The FSWX can use this trigger signal as an external power trigger.

Not all power sensors support the trigger function. Refer to the specifications document.

For details on using a power sensor as an external trigger, see "How to configure a power sensor as an external (PSE) trigger" on page 201.

Remote command:
[SENSe:]PMETer<p>:TRIGger[:STATe] on page 608
TRIG:SOUR PSE, see "Trigger Source" on page 259

External Trigger Level
Defines the trigger level for the power sensor trigger.

For details on supported trigger levels, see the specifications document.

Remote command:
[SENSe:]PMETer<p>:TRIGger:LEVel on page 607

Hysteresis
Defines the distance in dB to the trigger level that the trigger source must exceed before the next trigger event occurs. Setting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step size of 1 dB.

Remote command:
[SENSe:]PMETer<p>:TRIGger:HYSTeresis on page 607

Holdoff Time
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote command:
[SENSe:]PMETer<p>:TRIGger:HOLDoff on page 606

Dropout Time
Defines the time that the input signal must stay below the trigger level before triggering again.

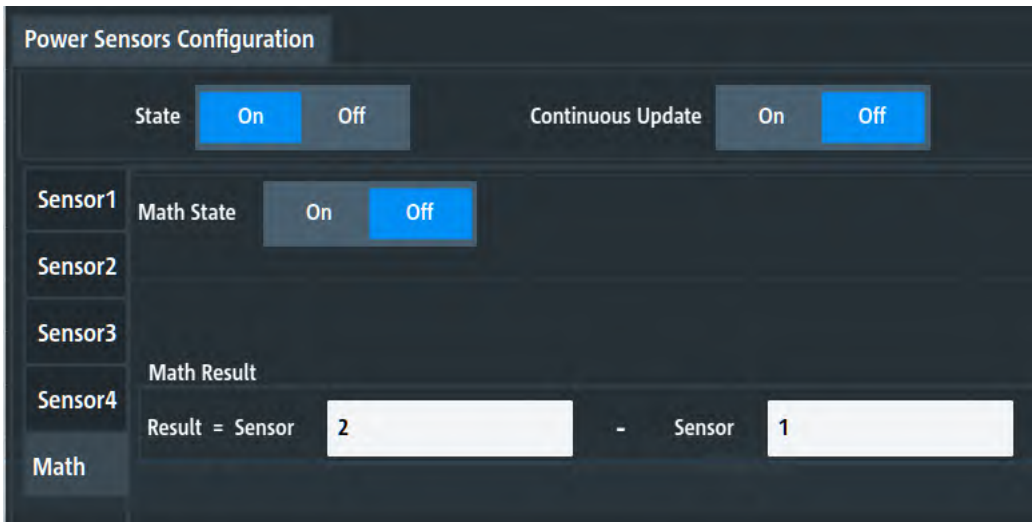
Slope
Defines whether triggering occurs when the signal rises to the trigger level or falls down to it.

Remote command:
[SENSe:]PMETer<p>:TRIGger:SLOPe on page 608

4.2.3.3 Power sensor math

Access: "Overview" > "Input" > "Power Sensors" > "Math"

You can determine the difference between results from multiple power sensors in one measurement using the power sensor math function.



The difference is displayed as the "Function Result" in the "Marker Table".

Remote command:

Querying results: `[SENSe:]PMETer:MATH:RESult?` on page 606

Math State....199
Math Result....199

Math State
Enables or disables the math function for the power sensor results.

Remote command:
`[SENSe:]PMETer:MATH[:STATe]` on page 605

Math Result
Defines the two power sensors whose results are subtracted from another (<Sensor A> - <SensorB>).

Remote command:
<Sensor A>: `[SENSe:]PMETer:MATH:MINuend` on page 605
<Sensor B>: `[SENSe:]PMETer:MATH:SUBTrahend` on page 606

4.2.3.4 How to work with a power sensor

The following step-by-step instructions demonstrate how to set up a power sensor. For details on individual functions and settings see Section 4.2.3.2, "Power sensor settings", on page 193.

The remote commands required to perform these tasks are described in Section 4.14.6.6, "Working with power sensors", on page 596.

How to set up a power sensor

You can configure and use up to 4 external power sensors for precise power measurement. You can enable and disable each power sensor individually.

The following procedure describes in detail how to configure and enable power sensors.

1. Select [Input / Output] "Power Sensors & Probes".

   The "Power Sensors" configuration dialog box is displayed.

2. Select the tab for the power sensor index you want to configure, e.g. "Power Sensor 1".

3. Enable "Select" to analyze the power sensor data according to the current configuration when you enable power measurement globally.

4. From the selection list with serial numbers of connected power sensors, select the sensor to configure.
   To assign newly connected power sensors to a tab automatically (default), enable "Auto".

5. Define the frequency of the signal whose power you want to measure.

a) To define the frequency manually, select "Frequency Manual" and enter a frequency.
b) To determine the frequency automatically, select "Frequency Coupling" and then either "Center", to use the center frequency, or "Marker", to use the frequency defined by marker 1.

6. Select the "Unit/Scale" for the power result display.
7. Select the measurement time to calculate the average, or define the number of measurements to average. To define the number of measurements manually:
   a) Select "Meas Time / Average":"Manual".
   b) Enable "Number of Readings".
   c) Define the number of measurements.
8. To enable the duty cycle correction, enable "Duty Cycle" and enter the correct percentage .
9. If you selected "dB" or "%" as units (relative display), define a reference value:
   a) To set the currently measured power as a reference value, select "Meas -> Ref".
   b) As an alternative, enter a value manually in the "Reference Value" field.
   c) Optionally, define an offset to the reference value to consider for the measured power:
      - Enable "Use Ref Level Offset" to consider the reference level offset defined for the analyzer.
      - Disable "Use Ref Level Offset" and define a "Sensor Level Offset".
10. To use the power sensor as an external power trigger, select the "External Power Trigger" option and define the trigger settings.
    For details see "How to configure a power sensor as an external (PSE) trigger" on page 201.
11. If necessary, repeat steps step 2 to step 10 for another power sensor.
12. Enable the global power sensor "State" at the top of the "Power Sensors" tab to enable power measurement for the selected power sensors.

    The results of the power measurement are displayed in the marker table (Function: "Sensor<x>").

How to zero the power sensor

1. Select [Input / Output] "Power Sensors & Probes".

   The "Power Sensors" configuration dialog box is displayed.
2. Select the tab that is assigned to the power sensor you want to zero.
3. Select "Zeroing Power Sensor".
   A dialog box prompts you to disconnect all signals from the input of the power sensor.

4. Disconnect all signals sending input to the power sensor and select [ENTER] to continue.
5. Wait until zeroing is complete.
   A corresponding message is displayed.

How to configure a power sensor as an external (PSE) trigger

The following step-by-step instructions demonstrate how to configure a power sensor as an external trigger.

To configure a power sensor as an external (PSE) trigger

1. Connect a compatible power sensor to the "Power Sensors" interface on the FSWX. For details on supported sensors see the specifications document.
2. Set up the power sensor as described in "How to set up a power sensor" on page 199.
3. In the "Input" dialog box, on the "Power Sensors" tab, enable "External Power Trigger".
4. Enter the power level at which a trigger signal is generated ("External Trigger Level") and the other trigger settings for the power sensor trigger.
5. Select [Trigger] > "Trigger / Gate Configuration" > "Trigger Source".
6. Select "Source" = "Power Sensor".

   The FSWX triggers when the defined conditions for the power sensor occur. Power measurement results are provided as usual.

4.2.4 Probes

4.2.4.1 Basics on probes

Probes allow you to perform voltage measurements flexibly and precisely on all sorts of devices to be tested, without interfering with the signal. The FSWX base unit and some (optional) applications support input from probes.

Using the optional R&S RT-ZA9 adapter, you can provide input from active modular probes to the "RF Input A" connector.

The R&S RT-ZA9 provides an interface between the probe's BNC socket and the analyzer's N-socket. The USB connection provides the necessary supply voltages for the probe.



To determine whether the probe has been connected properly and recognized by the FSWX, use the `[SENSe:]PROBe<pb>:SETup:STATe?` on page 596 remote control command.

Probe input via the RF input connectors is supported by all FSWX applications, in particular the "Spectrum" application.

Active probes

When using active probes from the R&S RT family, consider the following:

- Active probes require operating power from the instrument and have a proprietary interface to the instrument.
- The FSWX automatically recognizes the probe, no adjustment is required.
- Keep connections as short as possible to maintain the usable bandwidth.
- Observe the operating voltage range.

Microbutton action

You can define an action to be performed by the FSWX when the probe's microbutton (if available) is pressed. Currently, you can perform a single data acquisition via the probe simply by pressing the microbutton.

Impedance and attenuation

The measured signal from the probe is attenuated internally by the probe's specific attenuation. The FSWX compensates the attenuation from RF probes using a predefined "Probe on RF Input" transducer factor. This special transducer factor is automatically activated when you select "RF probe" as the input connector. It is applied before the common RF data processing. The application adjusts the reference level automatically.

The FSWX uses a fixed impedance of 50 Ω for all probes to convert voltage values to power levels.

Multimode function and offset compensation for modular RF probes

The R&S RT-ZM probe family features the MultiMode function which allows you to switch between single-ended, differential, and common mode measurements without reconnecting or resoldering the probe.

Four different input voltages can be measured with the MultiMode feature:

- **P-Mode**: (pos.) Single-ended input voltage (V_p)
  Voltage between the positive input terminal and ground
- **N-Mode**: (neg.) Single-ended input voltage (V_n)
  Voltage between the negative input terminal and ground
- **DM-Mode**: Differential mode input voltage (V_{dm})
  Voltage between the positive and negative input terminal
  $$V_{dm} = V_p - V_n$$
- **CM-Mode**: Common mode input voltage (V_{cm})
  Mean voltage between the positive and negative input terminal vs. ground
  $$V_{cm} = \frac{V_p + V_n}{2}$$

The FSWX supports all probe modes. The mode is configured in the probe settings.

Offset compensation

The R&S RT-ZM probes feature a comprehensive offset compensation function. The DC components can be compensated directly at the probe tip, even before the active probe amplifier. The compensation range is extremely wide: ±16 V (±24 V for P and N modes).

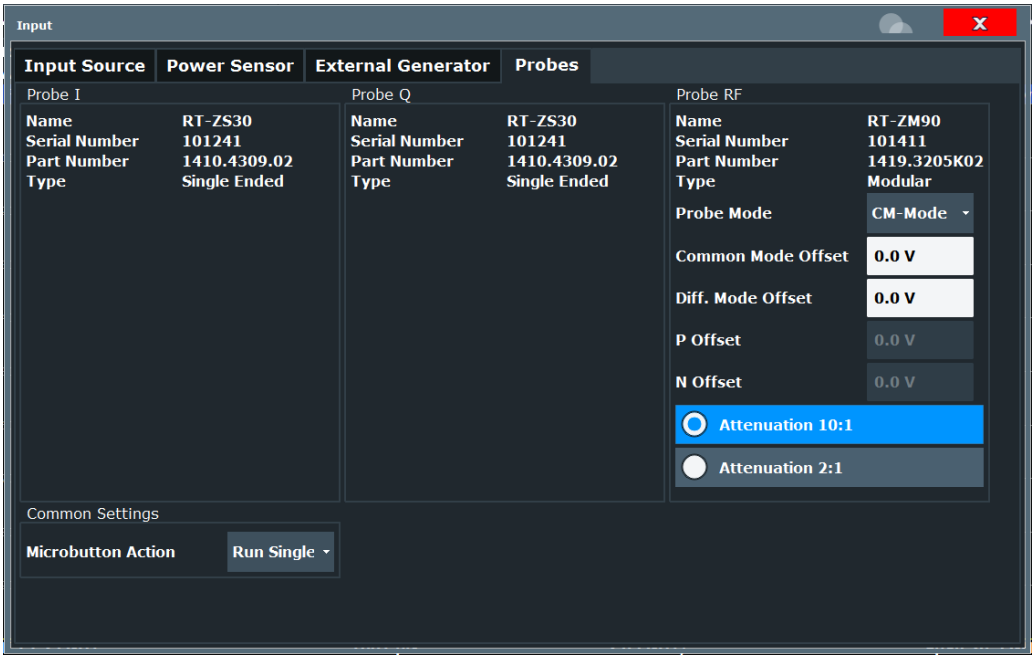
The offset compensation feature is available for every MultiMode setting:

MultiMode setting	Offset compensation	Offset compensation range	Application
DM-Mode	Differential DC voltage	±16 V	Probing single-ended signals, e.g. power rails with high DC component and small AC signal.
CM-Mode	Common mode DC voltage	±16 V	Measurements of signals with high common mode levels, e.g. current measurements with a shunt resistor.
P-Mode	DC voltage at positive input terminal	±24 V	Measurement of single-ended AC signals with high superimposed DC component at the positive input terminal. **Note**: The maximum voltage difference between the positive and negative input terminals is 16 V.
N-Mode	DC voltage at negative input terminal	±24 V	Measurement of single ended AC signals with high superimposed DC component at the negative input terminal. **Note**: The maximum voltage difference between the positive and negative input terminals is 16 V.

If you change the offset for DM-mode or CM-mode, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

4.2.4.2 Probe settings

Access: [IInput / Output] > "Power Sensors & Probes" > "Probes"



For each possible probe connector, the detected type of probe, if any, is displayed.

For more information on using probes with an FSWX, see Section 4.2.4.1, "Basics on probes", on page 201.

For general information on the R&S®RT probes, see the device manuals.

Name....204
Serial Number....204
Part Number....204
Type....205
Mode....205
Common Mode Offset/ Diff. Mode Offset / P Offset / N Offset /....205
Attenuation....205
Microbutton Action....205

Name
Probe name

Remote command:
`[SENSe:]PROBe<pb>:SETup:NAME?` on page 594

Serial Number
Serial number of the probe

Remote command:
`[SENSe:]PROBe<pb>:ID:SRNumber?` on page 591

Part Number
Rohde & Schwarz part number

Remote command:
`[SENSe:]PROBe<pb>:ID:PARTnumber?` on page 591

Type
Type of probe:

- Single-ended
- Differential
- Active Modular

Remote command:
[SENSe:]PROBe<pb>:SETup:TYPE? on page 596

Mode
Mode for multi-mode modular probes. Determines which voltage is measured.

"DM-mode" Voltage between the positive and negative input terminal

"CM-mode" Mean voltage between the positive and negative input terminal vs. ground

"P-mode" Voltage between the positive input terminal and ground

"N-mode" Voltage between the negative input terminal and ground

Remote command:
[SENSe:]PROBe<pb>:SETup:PMODe on page 594

Common Mode Offset/ Diff. Mode Offset / P Offset / N Offset /
Sets the offset for the probe, depending on the used mode (CM and DM mode both use the "Common Mode Offset"). The setting is only available if a differential (R&S RT-ZD) or modular (R&S RT-ZM) probe is connected to the FSWX.

If the probe is disconnected, the offset of the probe is reset to 0.0 V.

Note: If the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

Remote command:
[SENSe:]PROBe<pb>:SETup:CMOFfset on page 592
[SENSe:]PROBe<pb>:SETup:DMOFfset on page 593
[SENSe:]PROBe<pb>:SETup:NMOFfset on page 594
[SENSe:]PROBe<pb>:SETup:PMOFfset on page 595

Attenuation
Defines the attenuation applied to the input at the probe. This setting is only available for modular probes.

"10:1" Attenuation by 20 dB

"2:1" Attenuation by 6 dB

Remote command:
[SENSe:]PROBe<pb>:SETup:ATTRatio on page 592

Microbutton Action
Active Rohde & Schwarz probes (except for R&S RT-ZS10E) have a configurable microbutton on the probe head. By pressing this button, you can perform an action on the instrument directly from the probe.

Select the action that you want to start from the probe:

"Run Single" Starts one data acquisition.

"No action" Prevents unwanted actions due to unintended usage of the microbutton.

Remote command:
[SENSe:]PROBe<pb>:SETup:MODE on page 593

4.2.5 External frontends

4.2.5.1 Outsourcing RF conversion - external frontends

Due to the physical dimensions of modern spectrum analyzers, long RF cables between the DUT and the analyzer are often necessary in complex setups. When measuring high-frequency signals, the long RF cable can lead to unwanted loss.

An external frontend with smaller physical dimensions allows for measurements closer to the DUT. The measurement signal is transferred from the DUT to the analyzer on a lower intermediate frequency (IF), for which loss does not have a major effect. To do so, the RF input signal must be converted to the IF signal.

The FSWX outsources the conversion of the RF signal to the external frontend.
The external frontend downconverts the high-frequency RF input signal to a lower-frequency IF signal using its own internal LO. For all subsequent signal processing steps in the FSWX, this process is transparent.

Outsourcing has two main advantages:

- Extended frequency range: the external frontend can process RF data in a higher frequency range than the FSWX itself supports.
  For example, using an R&S FE110SR external frontend, an FSWX3026 can measure RF signals in a range of 70 GHz to 110 GHz.
- Minimized RF cable loss: in difficult testing environments, long RF cables between the DUT and the FSWX are no longer necessary. You can place the external frontend, which is much smaller than the FSWX, closer to the DUT using much shorter RF cables. The required IF cable between the frontend and the FSWX is not as vulnerable to distortion effects and power loss. Furthermore, since the IF cable is usually part of the fixed setup, any existing frequency response can be calculated in advance. The FSWX can then adapt the actual measurement results automatically.
  A typical application is a test involving a DUT placed in an RF shield box. The external frontend is connected directly to the shield box, while the FSWX is placed in a measurement rack elsewhere in the laboratory.

Prerequisites and restrictions

To use an external frontend, the External Frontend Control (R&S FSW3-KR200) license is required.

Only measurements that support FFT sweeps or I/Q-based measurements, such as the "I/Q Spectrum Analyzer" application, can process input from an external frontend.

For an active external frontend, automatic level or frequency settings are not available.

- Test setup....207
- Using external frontends for FFT sweep measurements....207
- Activation....208
- Configuration....208
- External frontend attenuation vs. analyzer attenuation....209
- LO signal input and output....209
- Calibration and alignment....210
- Diagnostics....210
- Adding external devices to the test setup....211

Test setup

Currently, the FSWX supports the following external frontend types:

- R&S FE110SR
- R&S FE170SR

For details on which instrument models support external frontends, see the instrument's specifications document.

You can use all available RF connectors on the FSWX for external frontend input. You must select the connector the external frontend is connected to in the input settings for the application instance. You cannot use another RF input connector simultaneously for the same application instance. You can connect multiple external frontends to different RF connectors on the FSWX at the same time.

The FSWX controls the external frontend via a LAN connection. The external frontend supports up to 2 LAN/SSL connections. The data is transferred using an IF cable. In addition, the FSWX provides a reference signal to the frontend.

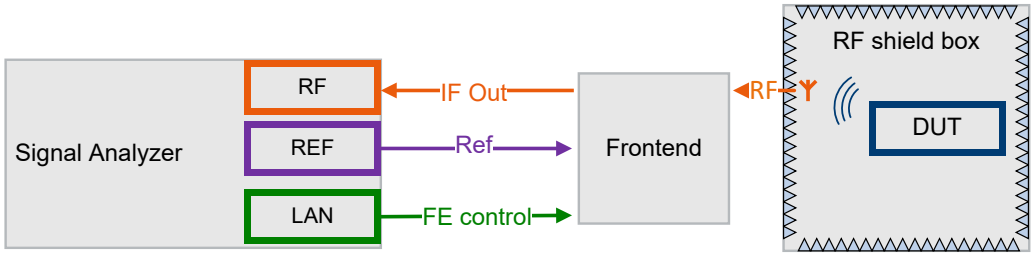


Figure 4-22: Typical setup using an external frontend

For details on setting up the external frontend, see the documentation of the used device.

Using external frontends for FFT sweep measurements

The external frontend downconverts the RF input signal to the IF frequency using its internal LO. It determines the required LO frequency automatically according to the selected frequency band and the reference frequency. During a basic I/Q measurement, the LO remains fixed. The used LO is indicated in the application info panel and the External frontend settings.

For FFT sweep measurements, the frontend adapts the LO during the measurement to cover the entire sweep range. The used IF range is indicated in the application info panel and the External frontend settings.

The external frontend acts as a block downconverter. It mixes one bandwidth segment to the IF at a time. The FSWX sweeps the current segment in FFT sweep mode using several partial spans.

Activation

Activation is a two-step or three-step process. First, global activation allows the application to use an external frontend. The application adapts the available measurement settings to the connected frontend, for example the available frequency range, reference level and attenuation.

If a measurement is active that does not support an FFT sweep, the application automatically selects a basic frequency sweep measurement. For all frequency sweep measurements, the "Sweep type" is set to "FFT".

If no frontend is configured yet, the configuration settings become available. The application info panel indicates "Inp:ExtFe".

If the instrument has multiple RF input connectors, you must enable the external frontend for one of the connectors in the next step.

In the final step, the FSWX connects the configured frontend.

If you disable global activation, the application adapts the measurement settings to the common settings supported by the FSWX.

If an external frontend is configured in the active application instance and you start a new application that supports its use, the external frontend settings are automatically copied. However, you can deactivate the frontend or change the settings for individual applications. Only one application can use the frontend at the same time.

Configuration

You can configure external frontends individually for each application instance. The settings are preserved after presetting the instrument, and are included in savesets. The frontend is controlled and configured by the FSWX using the common measurement settings.

There are some minor differences in the measurement settings if an external frontend is active:

- The available frequency range, reference level and attenuation are adapted to the values supported by the configured frontend.
- Amplitude settings refer to the RF input at the external frontend, not the levels at the RF input of the FSWX, which is the downconverted IF data from the frontend. However, you can also configure attenuation for the analyzer, see "External frontend attenuation vs. analyzer attenuation" on page 209.
- Only mechanical attenuation is available.
  Electronic attenuation, preamplifier, and noise cancellation are not available.
- Input coupling is always AC.
- Impedance is always 50 Ω.
- Only external triggers, I/Q power triggers, and (periodic) time triggers are supported as trigger sources.

- Depending on the bandwidth extension options available on the FSWX, the maximum I/Q bandwidth is 1 GHz.
- If global activation of the external frontend is on, but the connection state of the configured frontend is off, the FSWX application is temporarily "on hold". It is set up for and awaiting input from the external frontend, but the connection is aborted. Thus, further measurement configuration is not possible until the frontend is reconnected, or you disable global activation.
- The hardware of the FSWX is adjusted to the defined reference level for the RF input at the external frontend. It is adjusted optimally for input signals with a crest factor of 10 dB. Thus, the required reference level for an optimal measurement can differ depending on the crest factor of the input signal.
- Input from external frontends cannot be used simultaneously with:
  – I/Q file input

External frontend attenuation vs. analyzer attenuation

If an external frontend is active, you can configure the attenuation of the external frontend and the analyzer separately. In both cases, only mechanical attenuation is available.

Defining attenuation at the analyzer can avoid frequent switching at the mechanical attenuator when you switch between applications with different input settings.

Note, however, that in "Auto" mode, the FSWX determines the required attenuation at the external frontend for an optimal EVM automatically. If you adapt the attenuation at the frontend and the analyzer manually, the EVM can decrease.

LO signal input and output

External frontends provide LO input and output connectors.

You can use these connectors, for example:

- To provide an external signal as LO input to the external frontend
  In the frontend configuration settings, you configure whether the external frontend uses its internal LO frequency or an external LO provided at the "LO IN" connector. Note that if you configure the external frontend to use an external LO signal, the signal must be provided at the frequency indicated in the dialog. Otherwise, the results of the external frontend are inaccurate.
  You cannot use an external LO in an FFT sweep, only in I/Q-based measurements or zero span.
- To provide an LO signal at the external frontend's "LO OUT" connector. The frequency at which the external frontend provides LO output is indicated in the frontend configuration settings.
- To couple multiple external frontends

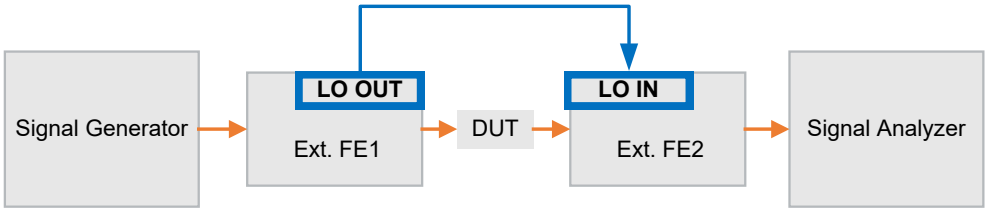


Figure 4-23: Coupled LO frequencies between multiple external frontends

Coupling multiple devices by their used LO signals is useful, for example, in setups with multiple input streams to reduce the phase noise.
To use the same LO signal on coupled external frontends, both devices have to use the same LO frequency for upconversion and downconversion. For coupled frontends of the same type, make sure to select the same frequency band configuration for all frontends.

Shared LO

You can also couple an R&S FE170SR and an R&S FE170ST. However, since they are different types of frontend, they can use different LO signals for the same frequency band setting. In this case, use the "Shared LO" setting, which ensures that both devices use the same LO frequency according to a frequency plan.

Calibration and alignment

The calibration data for the RF input and output signal paths of the frontend are stored on the device. The FSWX reads out the data from the connected frontend and aligns the measured data accordingly. During initial connection, you must calibrate the IF cable used to transfer data from the external frontend to the RF input of the FSWX. Usually, this cable is part of the fixed test setup and is not changed regularly. The calibration data for the IF cable is often provided with the cable as a touchstone (`.s2p`) file. The FSWX can read such files and adapt the measurement results to the frequency response of the cable.

To provide valid results, the frequency response file must provide the S21 parameter for the used frequency range of the external frontend. Frequency response files are usually provided with the IF cable. The calibration data for the IF cable provided with the FSWX is installed on the instrument at the factory. The `.s2p` files are stored on the instrument in `external_frontends/<frontend_type>/touchstonefiles/`.

For example, the files for the IF cable are stored in `external_frontends/FE110SR/touchstonefiles/if_default_cable_1347_7552_00.s2p`.

Diagnostics

You can obtain information on the performance of the connected frontend, and perform a self-test on the frontend directly on the FSWX. You can store the results an `XML` log file.

Adding external devices to the test setup

R&S FE170SR type frontends allow you to connect additional external devices to the signal path before the frontend. External devices can amplify or filter the RF signal before the frontend converts it. Using an IX cable, correction data and device information stored on the external device is transferred to the frontend. Thus, the external frontend can consider the correction data for its signal processing. The FSWX automatically detects the external frontend and any connected external devices during the initial connection. If an external device is connected to the frontend later, a refresh function initiates the detection.

Test setup

Figure 4-24 illustrates a test setup. An external frontend is connected to a FSWX and an antenna, which is mounted inside an RF shield box. An additional band filter is inserted between the DUT and the external frontend.

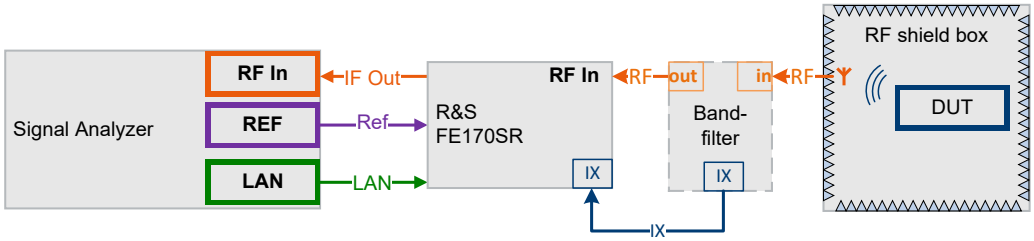


Figure 4-24: Example for a test setup with external devices

Correcting the signal path

IF cable loss can occur in the path between the frontend and the FSWX. The frequency response for the IF cable is usually provided with the cable and considered by the analyzer. External devices can cause additional losses in the signal path between the DUT and the FSWX. If you use the IX cable to connect the external device, the required correction data is automatically passed on from the external device to the frontend. The frontend then considers the data for its internal leveling algorithms and compensates the output values.

For external devices that are not connected to the frontend using an IX cable, you can configure a further correction file for the path between the DUT and the frontend manually.

4.2.5.2 External frontend settings

Access: [Input / Output] > "Input Source Configuration" > "External Frontend"

The following settings are only available if the External Frontend Control (R&S FSW3-KR200) option is installed on the FSWX. They are only available for applications that support FFT sweeps or zero-span measurements.

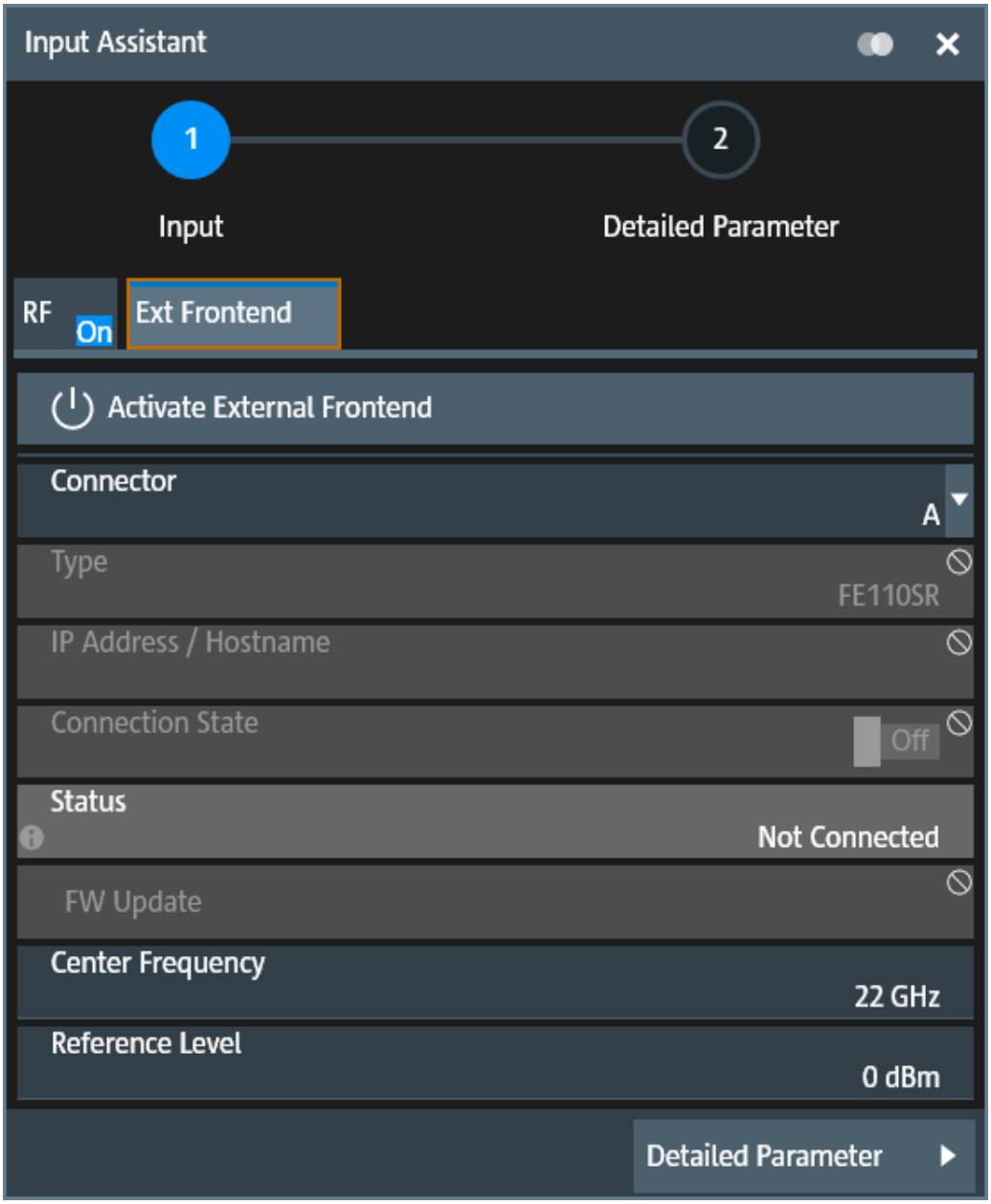
- Basic configuration settings 212
- General settings 214
- LO configuration settings 217

- Diagnostics.....219
- Network configuration.....221
- External Devices.....222

Basic configuration settings

Access: [Input / Output] > "Input Source Configuration" > "External Frontend"

In the basic configuration settings, you define general settings for the use of an external frontend in the application.



For multi-input instruments, you can configure different settings for each RF input connector. Note, however, that only one external frontend can be active in each application instance at the same time.

Activate External Frontend / External Frontend Activated 213
Connector 213
Frontend Type 213
IP Address/ Host Name 213
External frontend Connection State / Status 214
FW Update 214

Activate External Frontend / External Frontend Activated
Enables external frontend usage or indicates the active state of the external frontend.

If enabled, the FSWX allows you to configure and connect an external frontend. The application adapts the available measurement settings to the connected frontend, for example the available frequency range, reference level and attenuation. You cannot use another RF input connector simultaneously for the same application instance.

If no frontend is configured yet, the configuration settings become available. The application info panel indicates "Inp:ExtFe".

When disabled, the frontend is disconnected. The application adapts the measurement settings to the common settings supported by the FSWX.

Remote command:
`INPut:SELect EFR`; see `INPut:SELect` on page 558

Connector
Selects the RF input connector to which the external frontend is connected. Each application can only use a single external frontend at a time. You cannot use another RF input connector simultaneously for the same application instance.

Remote command:
`INPut<ip>:RF:STATe` on page 557

Frontend Type
Defines the type of frontend to be connected. You cannot change the type while the external frontend is in operation.

Currently, the FSWX supports the following external frontend types:
- R&S FE110SR
- R&S FE170SR

Remote command:
`[SENSe<ip>:]EFRontend:CONNection:CONFig` on page 567

IP Address/ Host Name
The IP address or host name of the frontend connected to the FSWX via LAN. The IP address and computer name are indicated on the electronic ink display on the side panel of the frontend.

By default, the TCPIP address is expected. To enter the computer name, toggle "123"/"ABC" to "ABC".

Note: You can change the IP address of the connected frontend directly from the FSWX, in the "Network configuration" on page 221.

Remote command:
[SENSe<ip>:]EFRontend:CONNection:CONFig on page 567

External frontend Connection State / Status
Connects or disconnects the configured frontend for use in a measurement. Note that this setting is only available if global activation of external frontends is enabled. See "Activate External Frontend / External Frontend Activated" on page 213.

The state of the physical connection is indicated in the dialog.

It can take up to 10 seconds for the FSWX to determine that LAN connection failed.

If disabled, the connection to the frontend is disabled temporarily. A running measurement is aborted, the measurement results are indicated as invalid. The measurement settings for the FSWX remain untouched.

Remote command:
[SENSe<ip>:]EFRontend:CONNection[:STATe] on page 566
[SENSe<ip>:]EFRontend:CONNection:CSTate? on page 567

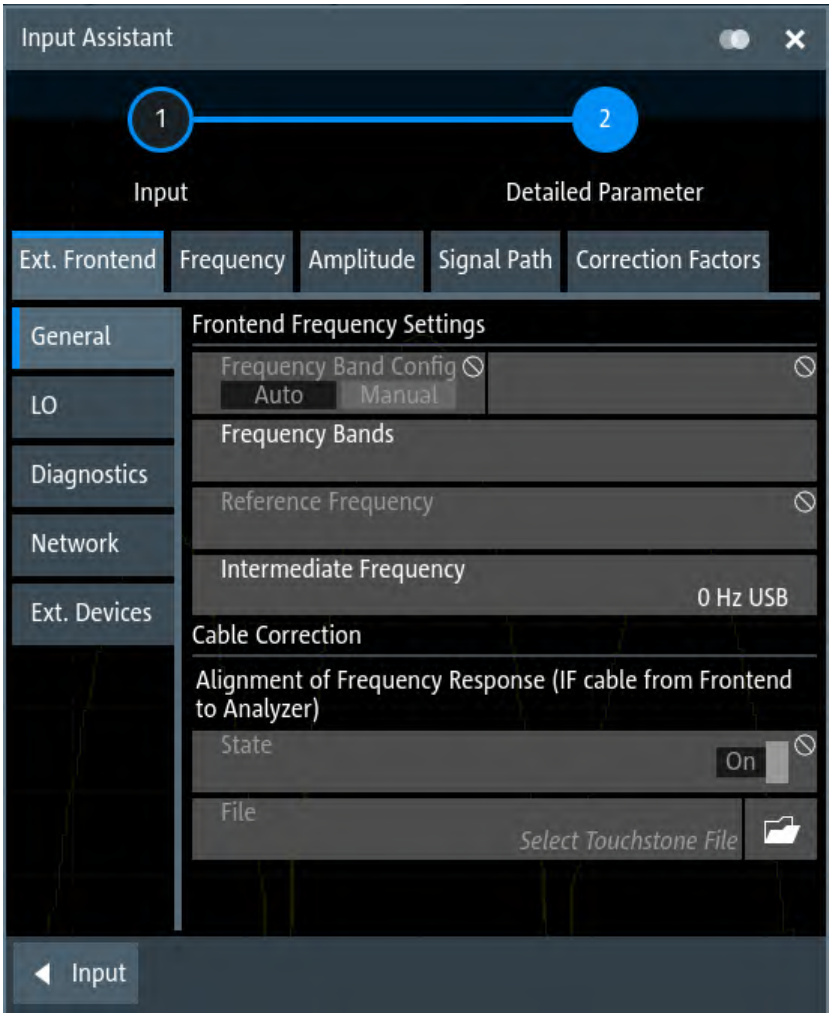
FW Update
When the FSWX establishes a connection to the frontend, it checks the firmware version of the frontend. If the FSWX does not support the firmware installed on the frontend, you are asked to update the frontend firmware. You can either start the firmware update immediately, or abort the connection process and update the firmware on the frontend later. In this case, the frontend is not available for use with the FSWX until you perform the update.

Remote command:
[SENSe<ip>:]EFRontend:FWUPdate on page 578

General settings

Access: [Input / Output] > "Input Source Configuration" > "External Frontend" > "Detailed Parameters" > "General Config"

In the general configuration settings, you define settings concerning the used external frontend frequencies.



Frequency Band Configuration 215
Frequency Band 216
Reference Frequency 216
Intermediate Frequency 216
Cable Correction State 216
Load Cable Correction File 217

Frequency Band Configuration
Defines the intermediate frequency (output) range of the external frontend.

The used Intermediate Frequency and the resulting Frequency Band sideband that you can analyze on the FSWX are indicated for reference.

The selected frequency band configuration is also indicated in the application info panel.

You can select the required IF output range manually, or it can be determined automatically, according to the other frequency settings.

Currently, auto mode always applies the "Spur Optimized" range for R&S FE170SR and R&S FE110SR frontends.

In manual mode, select one of the following IF output ranges:

"Spur Optimized"
(R&S FE170SR/R&S FE110SR only)
The selected IF range avoids unwanted spurious effects.

"EVM Optimized"
(R&S FE170SR only)
The selected IF range provides an optimal EVM result.

"Shared LO" (R&S FE170SR/R&S FE110SR only)
Ensures that multiple external frontends of a different type (R&S FE170SR/ R&S FE170ST or R&S FE110SR/R&S FE110ST) use the same LO frequencies for upconversion and downconversion.

Remote command:
`[SENSe<ip>:]EFRontend:FREQuency:BCONfig:AUTO` on page 569
`[SENSe<ip>:]EFRontend:FREQuency:BCONfig:LIST?` on page 569
`[SENSe<ip>:]EFRontend:FREQuency:BCONfig:SELect` on page 570

Frequency Band
Displays the range of the frequency band supported by the connected frontend (for reference only).

Remote command:
`[SENSe<ip>:]EFRontend:FREQuency:BAND:COUNt?` on page 568
`[SENSe<ip>:]EFRontend:FREQuency:BAND<b>:UPPer?` on page 568
`[SENSe<ip>:]EFRontend:FREQuency:BAND<b>:LOWer?` on page 568

Reference Frequency
Sets the reference frequency that is used for frequency conversion on the frontend. Depending on the connected type of frontend, different values are available.

Remote command:
`[SENSe<ip>:]EFRontend:FREQuency:REFerence` on page 573
`[SENSe<ip>:]EFRontend:FREQuency:REFerence:LIST?` on page 574

Intermediate Frequency
Indicates the currently used intermediate frequency (IF) and sideband (upper/lower) for frequency conversion (for reference only).

This value depends on the "Frequency Band Configuration" on page 215.

Make sure the IF frequency required by the external frontend lies within the IF frequency range of the FSWX.

"USB" Upper sideband

"LSB" Lower sideband

Remote command:
`[SENSe<ip>:]EFRontend:FREQuency:IFRequency[:VALue]?` on page 571
`[SENSe<ip>:]EFRontend:FREQuency:IFRequency:SIDeband?` on page 571

Cable Correction State
Enables correction of the IF signal due to cable loss from the frontend to the analyzer.

Remote command:
`[SENSe<ip>:]EFRontend:ALIGnment<ch>:STATe` on page 576

Load Cable Correction File
Opens a common file selection dialog to load correction data to compensate for signal losses in the cable occurring at different IF signal frequencies.

To provide valid results, the frequency response file must provide the S21 parameter for the used frequency range of the external frontend.

Frequency response files are usually provided with the IF cable. The calibration data for the IF cable provided with the FSWX is installed on the instrument at the factory.

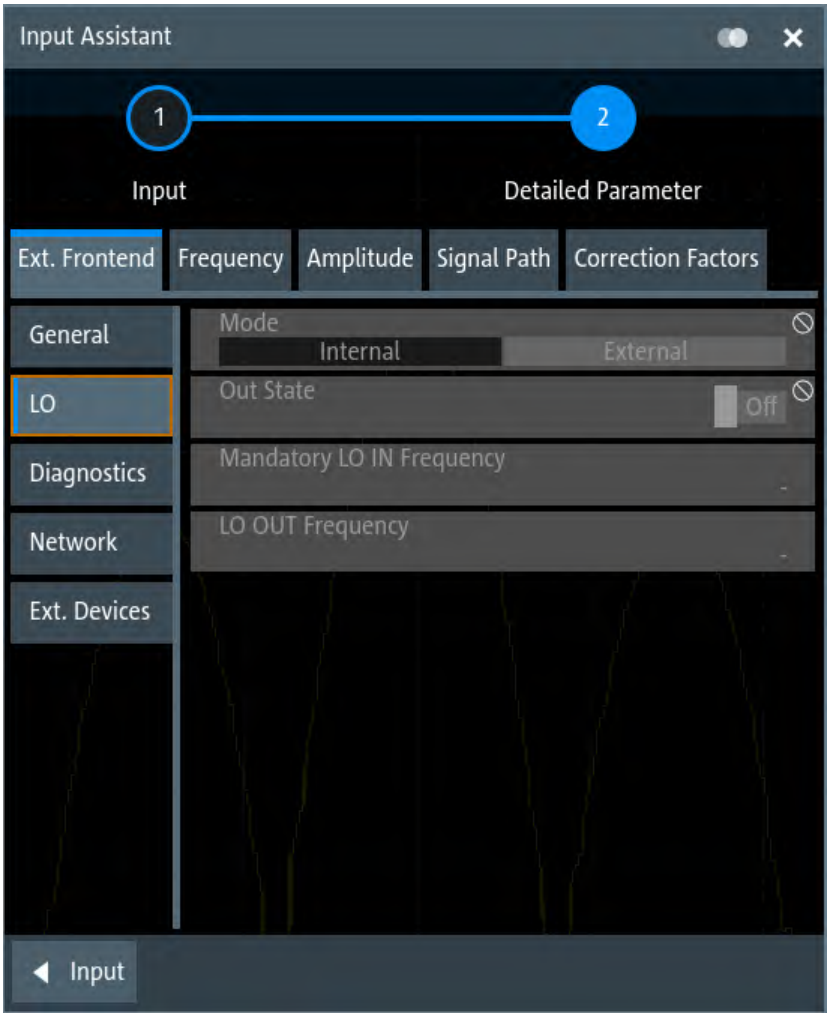
The `.s2p` files are stored on the instrument under `external_frontends/<frontend_type>/touchstonefiles/`. For example, the files for the IF cable are stored under `external_frontends/FE110SR/touchstonefiles/if_default_cable_1347_7552_00.s2p`.

Remote command:
`[SENSe<ip>:]EFRontend:ALIGnment<ch>:FILE` on page 576

LO configuration settings

Access: [Input / Output] > "Input Source Configuration" > "External Frontend" > "Detailed Parameters" > "LO"

In the LO configuration tab, special settings concerning the used LO are available (for zero span measurements only).



LO Mode 218
LO Out State 219
Mandatory LO IN Frequency 219
LO OUT Frequency 219

LO Mode
Determines whether the external frontend uses its internal LO or an external LO.

"External" Uses the external signal provided at the "LO Input" connector of the external frontend. The frequency at which the LO must be input to the external frontend is indicated as "Mandatory LO IN Frequency" on page 219.
If enabled, "LO EXT" is displayed in the application info panel.

"Internal" Uses the internal LO

Remote command:
`[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:MODE` on page 572

LO Out State
Enables or disables output of the LO at the "LO OUT" connector of the external frontend. Which LO is provided depends on the LO Mode. The frequency at which the LO is provided to the connector is indicated as LO OUT Frequency.

Remote command:
`[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:OUTPut:STATe`
on page 573

Mandatory LO IN Frequency
Indicates the required frequency of the LO input at the external frontend when using an external LO. If the coupled device does not provide the external LO at this frequency, the results of the external frontend are inaccurate.

Remote command:
`[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:INPut:FREQuency?`
on page 571

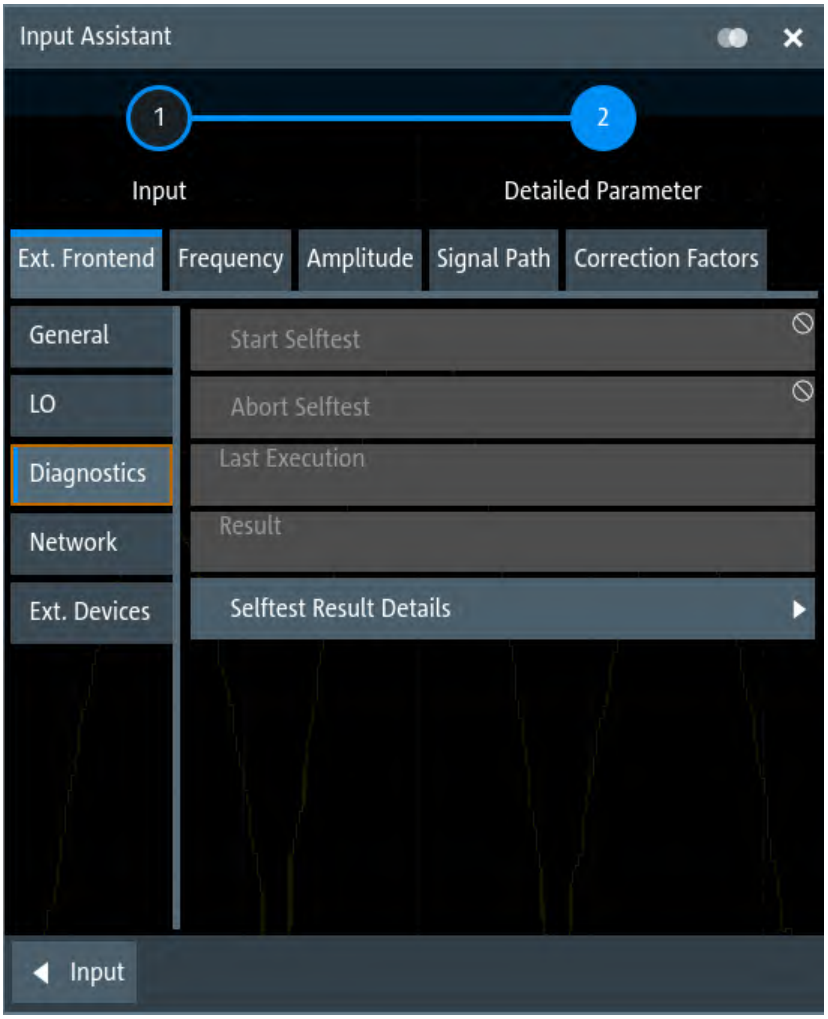
LO OUT Frequency
Indicates the frequency of the LO output, if LO Out State is "ON".

Remote command:
`[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:OUTPut:FREQuency?`
on page 572

Diagnostics

Access: [Input / Output] > "Input Source Configuration" > "External Frontend" > "Detailed Parameters" > "Diagnostics"

The "Diagnostics" tab provides information on the performance of the connected frontend and allows you to perform a self-test on the frontend.



Start Selftest....220
Abort Selftest....220
Last Execution....220
Selftest Results....221

Start Selftest
Performs a self-test on the frontend to compare the current performance and characteristic values with the specified values for the frontend.

Remote command:
`[SENSe:]EFRontend<f>:SELFtest?` on page 578

Abort Selftest
Aborts a running self-test.

Remote command:
not supported

Last Execution
Indicates when the last selftest was executed.

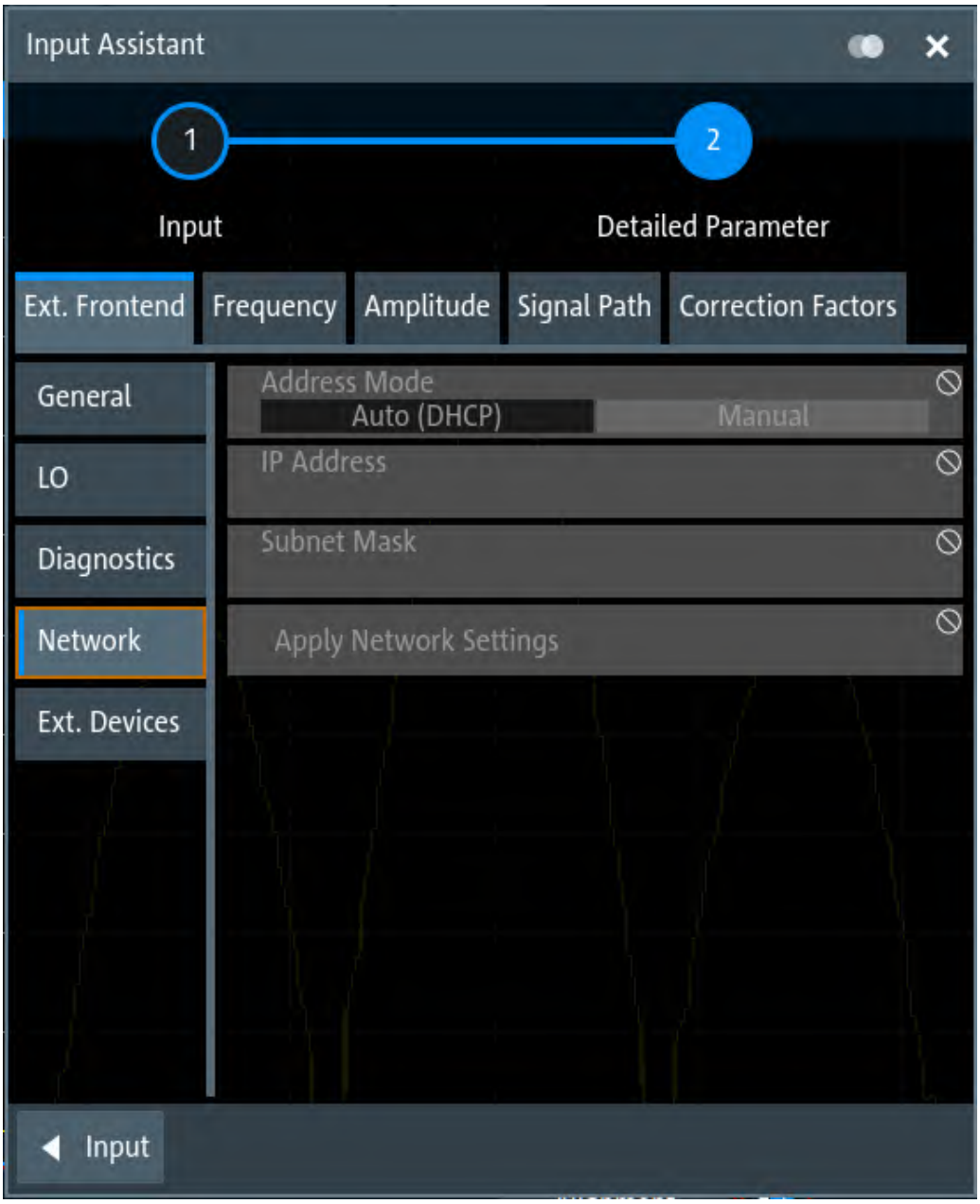
Selftest Results
Indicates the results of a selftest performed on the connected frontend.

Remote command:
`[SENSe:]EFRontend<f>:SELFtest:RESult?` on page 578

Network configuration

Access: [Input / Output] > "Input Source Configuration" > "External Frontend" > "Detailed Parameters" > "Network Config"

After connection, you can assign a static IP address or Select a dynamic IP address for the external frontend directly from the FSWX.



IP Address....222
Subnet Mask....222
DHCP....222
Apply Network Settings....222

IP Address
Defines the IP address of the external frontend. If the DHCP server is used ("DHCP On"), the setting is read-only.

Remote command:
`[SENSe<ip>:]EFRontend:NETWork` on page 574

Subnet Mask
Defines the subnet mask of the external frontend. If the DHCP server is used ("DHCP On"), this setting is read-only.

Remote command:
`[SENSe<ip>:]EFRontend:NETWork` on page 574

DHCP
Switches between DHCP server available (""On) or not available ("Off"). If a DHCP server is available in the network, the IP address and subnet mask of the external frontend are obtained automatically from the DHCP server.

Remote command:
`[SENSe<ip>:]EFRontend:NETWork` on page 574

Apply Network Settings
Any changes to the external frontend network configuration are applied.

Beware that if you change the network information, the connection is aborted and you must re-establish a connection to the frontend (see "External frontend Connection State / Status" on page 214).

Remote command:
`[SENSe<ip>:]EFRontend:NETWork` on page 574

External Devices

Access: [Input / Output] > "Input Source Configuration" > "External Frontend" > "Detailed Parameters" > "External Devices"

You can insert additional external devices in the signal path between the DUT and the external frontend, such as preamplifiers or filters. The external frontend then considers the additional gain or correction values.

When the FSWX initially connects to the external frontend, the instrument automatically detects any devices connected to the external frontend. The FSWX displays information on detected devices in the "External Devices" tab of the dialog.



Refresh External Devices....223
Name....224
Type....224
Frequency Range....224
Gain....224
Correction State....224
Load S2P File....225

Refresh External Devices
Scans the ports of the external frontend and refreshes the display with detected information on connected devices. This function is useful after connecting a new device to the frontend.

Remote command:
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:REFResh
on page 581

Name
Name of the external device for reference.

Remote command:
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:NAME?
on page 583
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:LIST?
on page 580

Type
Type of the detected device for reference.

Currently, the following device types are supported:
- Filter
- Amplifier (R&S FE170SR only)

Remote command:
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:TYPE?
on page 583

Frequency Range
The supported frequency range of the connected device.

Remote command:
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MINimum? on page 582
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MAXimum? on page 581

Gain
For connected external amplifiers only: provided gain.

Remote command:
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?
on page 582

Correction State
Enables or disables the use of an additional correction file for the connected external devices. Additional correction is useful, for example, if you do not use the IX cable to connect the external device to the external frontend. In this case, automatic compensation cannot be applied.

See also "Correcting the signal path" on page 211.

Remote command:
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:STATe on page 580

Load S2P File
Opens a common file selection dialog to load correction data to compensate for signal losses by the external devices occurring at different RF signal frequencies.

To provide valid results, the frequency response file must provide the S21 parameter for the used frequency range of the external devices.

The dialog indicates whether the loaded file is valid or not.

Remote command:
`[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:FILE` on page 579
`[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?` on page 580

4.2.5.3 How to use an external frontend

To configure the use of an external frontend

1. Connect an external frontend to the DUT and the FSWX as described in the frontend manual.
2. Switch to or start a "Spectrum" application instance ([Mode] > "Spectrum").
3. Select [Input / Output] > "Input Source Configuration" > "External Frontend".
4. Select "Activate External Frontend".

   The connection settings become available.
5. Select the "Type" of connected frontend.
6. Enter the IP address or computer name of the connected frontend. The information is indicated on the electronic label on the side panel of the frontend.

   After you enter the IP address, the "Connection State" setting becomes available.
7. Set the "Connection State" to "On".



It can take up to 10 seconds until the FSWX sets up the control connection to the frontend. The displayed status of the control connection in the dialog box switches from "Not Connected" (white) to "Connected" (green). The LAN LED on the front panel of the frontend switches from green to orange.

8. Select "Detailed Parameters".

   The frequency band supported by the connected frontend is displayed on the "General" tab.



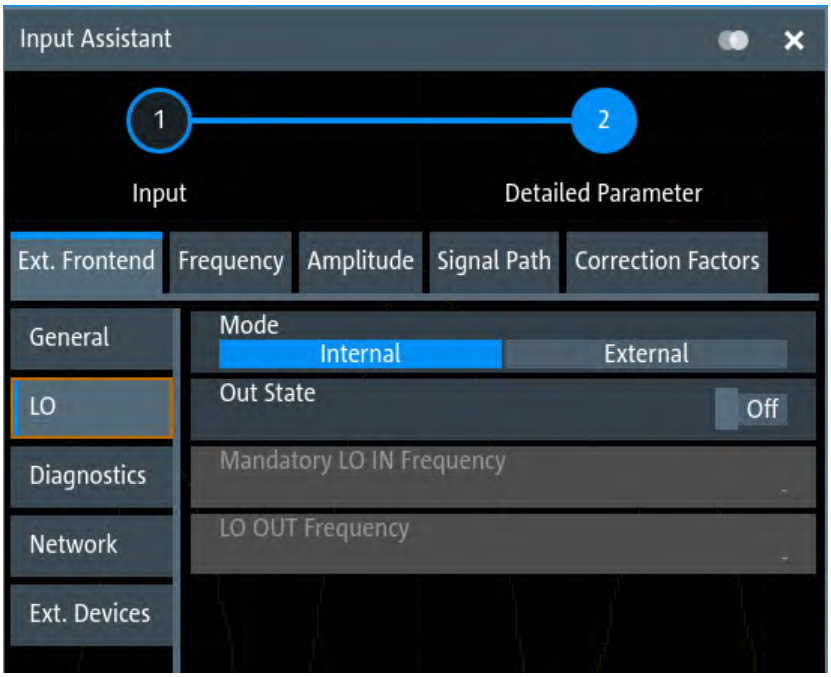
The band determines the used intermediate frequency and resulting frequency band you can analyze. The IF is indicated in the dialog for reference.

9. Select the "Reference Frequency" to be used by the frontend.
10. Optionally, enable compensation for the frequency response of the IF cable from the FSWX to the frontend.
    a) Enable "Alignment of Frequency Response".
    b) Select "File": "Select Touchstone file".
    c) Select an `.s2p` file that contains the frequency response for the used IF cable.
    To provide valid results, the frequency response file must provide the S21 parameter for the used frequency range of the external frontend.
    Frequency response files are usually provided with the IF cable. The calibration data for the IF cable provided with the FSWX is installed on the instrument at the factory.
    The `.s2p` files are stored on the instrument under `external_frontends/<frontend_type>/touchstonefiles/`. For example, the files for the IF cable are stored under `external_frontends/FE110SR/touchstonefiles/if_default_cable_1347_7552_00.s2p`.

d) Set the "Correction State" to "On" to enable the use of the correction file.

The FSWX automatically adapts the measured values from the external frontend to the known cable loss.

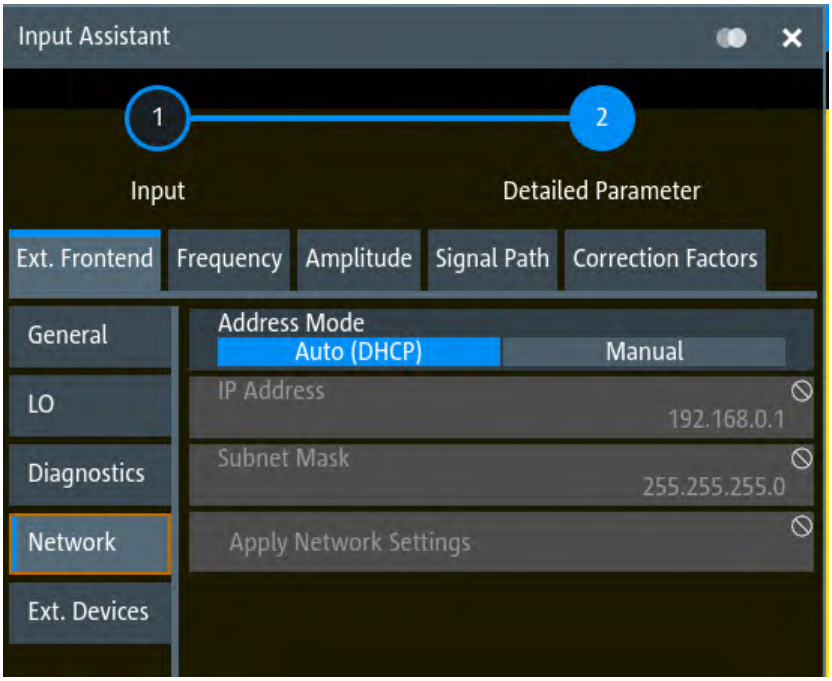
11. Optionally, for zero-span measurements, configure the use of an external LO, or provide the LO as output to other devices.



a) Select the "LO" tab.
b) To use an external LO, select "Mode": "External". Provide an LO at the specified "Mandatory LO IN Frequency" to the "LO IN" connector of the external frontend.
c) To provide LO output, select "Out State": "On". The LO signal is provided at the specified "LO OUT Frequency" at the "LO OUT" connector of the external frontend.

12. Optionally, check the network settings of the FSWX.

a) Select the "Network" tab.
b) Make sure the correct "IP Address" and "Subnet Mask" are assigned.



By default, DHCP is enabled and the IP address of the external frontend is assigned automatically.

13. To change the network settings, proceed as follows:
    a) Select "Address Mode": "Manual").
    b) Adjust the network settings according to your test setup.
    c) Select "Apply Network Settings".

    Note: If you change the network configuration to "Address Mode": "Auto (DHCP)", the connection to the FSWX is aborted. You must re-establish a connection to the frontend as described in step step 4).
    If you have connection issues, see Section 7.5.2, "Problems with connection", on page 1480.

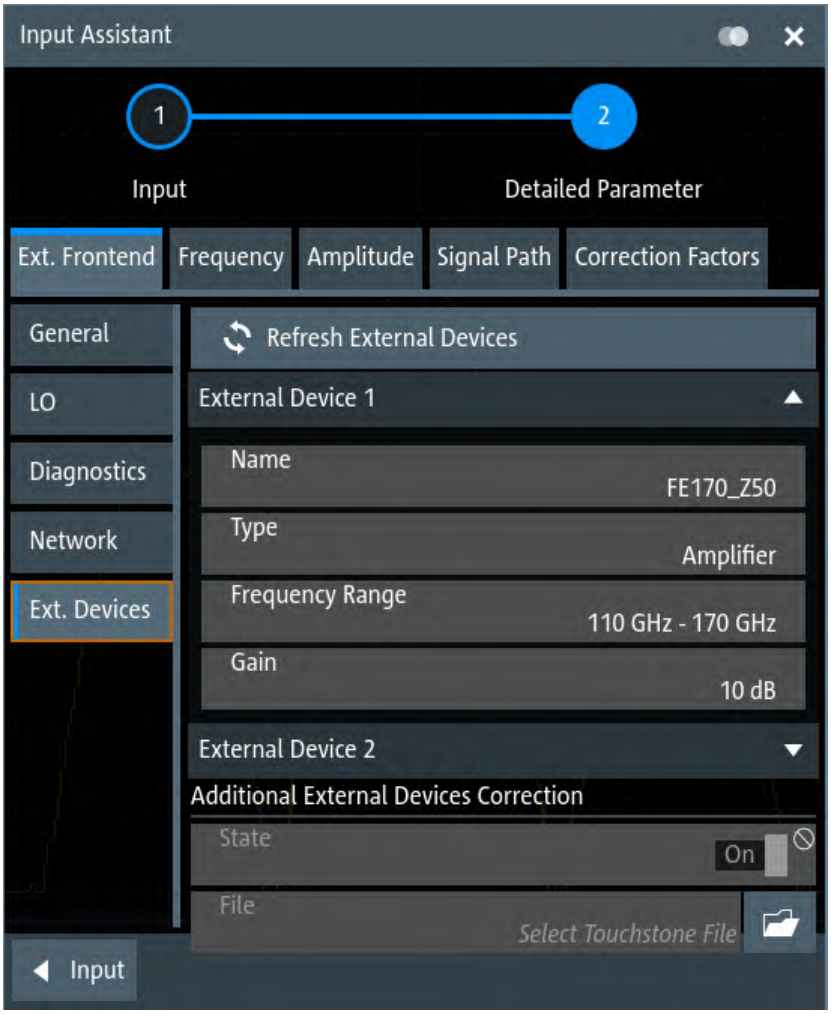
14. Configure the measurement as usual. The amplitude and frequency settings are adapted to the supported values of the external frontend. The reference value refers to the RF input of the external frontend.

To configure the use of additional external devices

R&S FE170SR and R&S FE110SR type frontends allow you to connect additional external devices to the signal path before the frontend.

1. Connect an external device to the DUT and the R&S FE170SR/R&S FE110SR type frontend as described in the frontend manual.
2. Connect the external frontend to the FSWX as described in the frontend manual.
3. Configure the external frontend as described in "To configure the use of an external frontend" on page 225.

4. Select [Input / Output] > "Input Assistant" > "External Frontend" > "Detailed Parameters" > "Ext. Devices".



The detected external devices and the provided information is displayed.

5. If the external frontend was already connected to the analyzer when you connected the external device, select "Refresh External Devices" to update the information.

6. Optionally, if you do not connect the external device to the frontend using the IX cable, enable additional compensation for the external device.

   a) Select "Additional External Devices Correction": "File": "Select Touchstone File".
   b) Select an `.s2p` file that contains the frequency response for the used devices and cables.
      To provide valid results, the frequency response file must provide the S21 parameter for the used frequency range of the external devices.
      The dialog indicates whether the selected file is valid or not.
   c) Set the correction "State" to "On" to enable the use of the correction file.

The external frontend automatically adapts the signal values from the external devices to the known loss.

4.2.6 Signal output

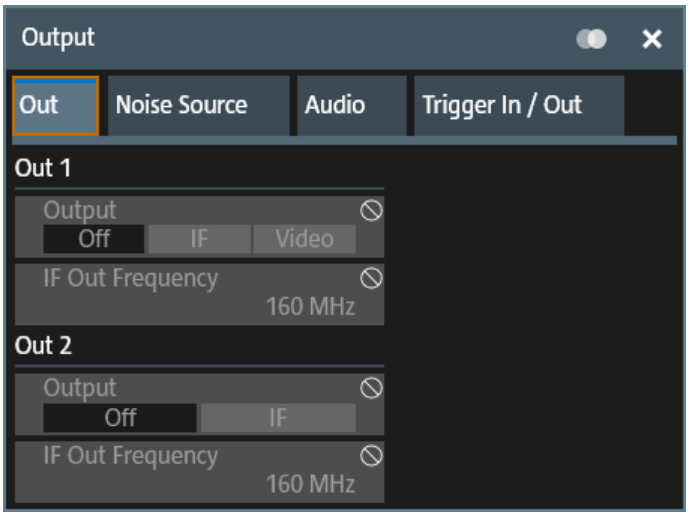
4.2.6.1 Output settings

Access: [Input / Output] > "Output Configuration"

The FSWX can provide output to special connectors for other devices.

For details on connectors, refer to Section 3.4, "Instrument tour", on page 31

Providing trigger signals as output is described in Section 4.2.7.1, "Trigger input/output settings", on page 234.



Out 1 / Out 2 231
Output 231
Noise Source control 232
Audio 232

Out 1 / Out 2
Determines which of the two output connectors is used.

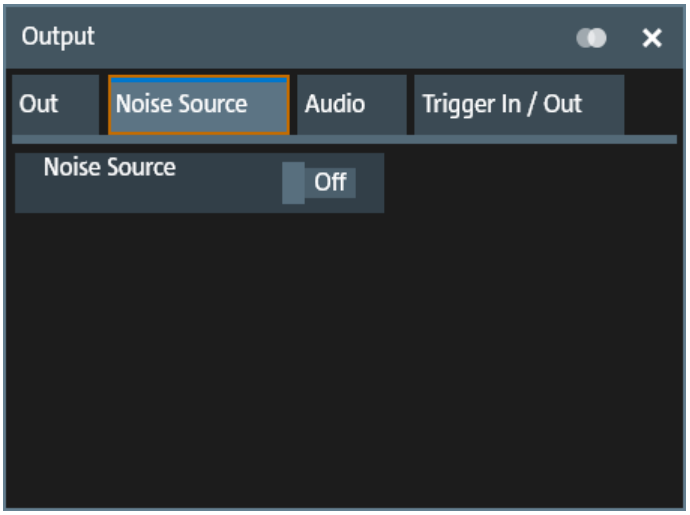
Remote command:
suffix for `OUTPut<up>`

Output
Defines the type of signal available at the selected output connector of the FSWX.

This function is currently not yet available.

"IF"	The measured IF value is provided at the "Out 1" / "Out 2" connector. The IF output is provided at the specified "IF Out Frequency". The default frequency is 160 MHz.
"Video"	The displayed video signal (i.e. the filtered and detected IF signal, 200 mV) is available at the "Out 1" connector.
"Off"	No output is provided.

Noise Source control
Enables or disables the 28 V voltage supply for an external noise source connected to the "Noise Source Control" / "Power Sensor") connector. By switching the supply voltage for an external noise source on or off in the firmware, you can enable or disable the device as required.

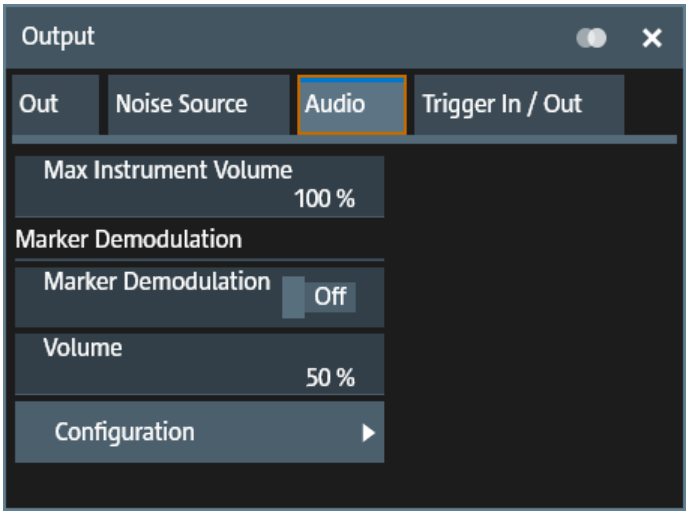


External noise sources are useful when you are measuring power levels that fall below the noise floor of the FSWX itself, for example when measuring the noise level of an amplifier.

In this case, you can first connect an external noise source (whose noise power level is known in advance) to the FSWX and measure the total noise power. From this value, you can determine the noise power of the FSWX. Then, when you measure the power level of the actual DUT, you can deduct the known noise level from the total power to obtain the power level of the DUT.

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 624

Audio
If enabled, the demodulated data at the current marker frequency is output to the "Phones" connector or the built-in loudspeaker.



For more information, see Section 5.4.3.8, "Demodulating marker values and providing audio output (Marker Demodulation)", on page 1212.

Define the output "Volume" using the slider. To protect users from damage, you can restrict the "Max Volume" in percent.

Remote command:
`SYSTem:SPEaker[:STATe]` on page 626
`SYSTem:SPEaker:VOLume` on page 626

4.2.7 Receiving and providing trigger signals

Using one of the "Trigger Input / Output" connectors of the FSWX, the FSWX can use a signal from an external device as a trigger to capture data. Alternatively, the internal trigger signal used by the FSWX can be output for use by other connected devices. Using the same trigger on several devices is useful to synchronize the transmitted and received signals within a measurement.

For details on the connectors see the FSWX "Getting Started" manual.

External trigger as input

If the trigger signal for the FSWX is provided by an external device, the trigger signal source must be connected to the FSWX. Furthermore, the trigger source must be defined as "External" in the FSWX.

Trigger output

The FSWX can provide output to another device either to pass on the internal trigger signal, or to indicate that the FSWX itself is ready to trigger.

The trigger signal can be output by the FSWX automatically, or manually by the user.

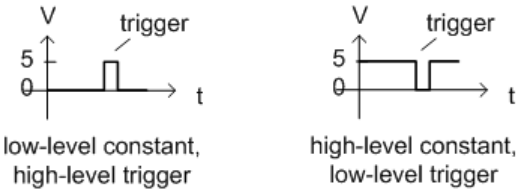
If the trigger signal is output automatically, a high signal is output:

- When the FSWX has triggered due to a sweep start ("Device Triggered")

- When the FSWX is ready to receive a trigger signal after a sweep start ("Trigger Armed")

Manual triggering

If the trigger output signal is initiated manually, the length and level (high/low) of the trigger pulse is also user-definable. Note, however, that the trigger pulse level is always opposite to the constant signal level defined by the output level setting. For example, for "Level" = "High", a constant high signal is output to the connector until you select the "Send Trigger" button. Then, a low pulse is provided.



4.2.7.1 Trigger input/output settings

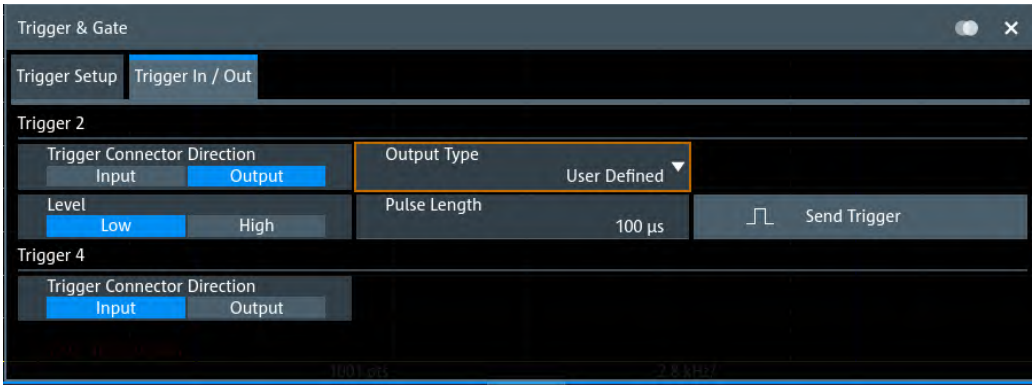
Access: "Overview" > "Trigger/Gate" > "Trigger In/Out"

Or: [Input / Output] > "Output Configuration" > "Trigger In/Out"

The FSWX can use a signal from an external device as a trigger to capture data. The FSWX can also output the used internal trigger signal to any other connected devices.

The trigger input and output functionality of the FSWX depends on how the variable "Trigger Input / Output" connectors 2 and 4 are used.

Providing trigger signals as output is described in detail in Section 4.2.7.2, "How to output a trigger signal", on page 236 and Section 4.2.7, "Receiving and providing trigger signals", on page 233.



Trigger Connector Direction....235
Output Type....235
Constant signal Level....235
Pulse Length....235
Send Trigger....236

Trigger Connector Direction
The trigger input and output functionality depends on how the variable "Trigger Input / Output" connectors are used.

"Input" The signal at the connector is used as an external trigger source by the FSWX.

"Output" The FSWX sends a trigger signal to the output connector to be used by connected devices.
Further trigger parameters are available for the connector.

Remote command:
`OUTPut:TRIGger<tp>:DIRection` on page 627

Output Type
Type of signal to be sent to the output.

"Device Triggered" (Default) Sends a trigger when the FSWX triggers.

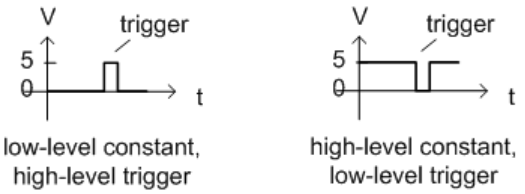
"Trigger Armed" Sends a (high level) trigger when the FSWX is in "Ready for Trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), and by a low-level signal at the "AUX Port" (pin 9).
For details, see "STATus:OPERation register" on page 495.

"User-Defined" Sends a trigger when you select "Send Trigger".
In this case, further parameters are available for the output signal.

Remote command:
`OUTPut:TRIGger<tp>:OTYPe` on page 627

Constant signal Level
Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector (for "Output Type": "User-Defined").

The trigger pulse level is always opposite to the constant signal level defined here. For example, for "Level" = "High", a constant high signal is output to the connector until you select the Send Trigger function. Then, a low-level trigger pulse is output.



Remote command:
`OUTPut:TRIGger<tp>[:UDEFined]:LEVel` on page 627

Pulse Length
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<tp>[:UDEFined]:PULSe:LENGth` on page 628

Send Trigger
Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the Constant signal Level setting. For example, for "Level" = "High", a constant high-level signal is output to the connector until you select the "Send Trigger" function. Then, a low-level trigger pulse is sent.

A graphic on the button indicates which pulse level is sent.

Remote command:
`OUTPut:TRIGger<tp>[:UDEFined]:PULSe:IMMediate` on page 628

4.2.7.2 How to output a trigger signal

Using one of the variable "Trigger Input / Output" connectors, the FSWX can output the internal trigger signal to other connected devices.

For details on the connectors, see Section 3.4, "Instrument tour", on page 31.

To output a trigger to a connected device

1. Connect a device that receives the trigger signal to the configured "Trigger Input / Output" connector.
2. Select "Overview" > ""Trigger/Gate"" > "Trigger In / Out".
3. For the trigger connector you want to use, select Trigger Connector Direction: "Output".
4. Define whether the trigger signal is to be output automatically ("Output Type" = "Device triggered" or "Trigger Armed") or whether you want to start output manually ("Output Type" = "User-defined").
5. For manual output: Specify the constant signal level and the length of the trigger pulse to be output. Note that the level of the trigger pulse is opposite to the constant output "Level" setting (compare the graphic on "Send Trigger").
6. Start a measurement and wait for an internal trigger, or select "Send Trigger".

   The configured trigger is output to the "Trigger Input / Output" connector.

4.3 Impact of RF parameters

4.3.1 Impact of the frequency and span settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

- Defining the scope of the measurement - frequency range 237
- Stepping through the frequency range - center frequency step size 237
- Keeping the center frequency stable - signal tracking 237

4.3.1.1 Defining the scope of the measurement - frequency range

The frequency range defines the scope of the signal and spectrum to be analyzed. You can define the frequency range as a span around a center frequency, or as a range from a start to a stop frequency. Furthermore, you can select the full span comprising the entire possible frequency range, or a zero span. Using the full span option, you can perform an overview measurement over the entire span. Using the "Last Span" function, you can easily switch back to the detailed measurement of a specific frequency range.

For sinusoidal signals, the FSWX can define the center frequency automatically, as the highest frequency level in the frequency span ("Auto Frequency").

4.3.1.2 Stepping through the frequency range - center frequency step size

Using the arrow keys you can move the center frequency in discrete steps through the available frequency range. The "Center Frequency Stepsize" defines the step size by which the center frequency is increased or decreased.



The "Center Frequency Stepsize" also defines the step size by which the value is increased or decreased when you use the rotary knob to change the center frequency. However, the *rotary knob* moves in steps of only *1/10 of the "Center Frequency Stepsize"* to allow for a more precise setting.

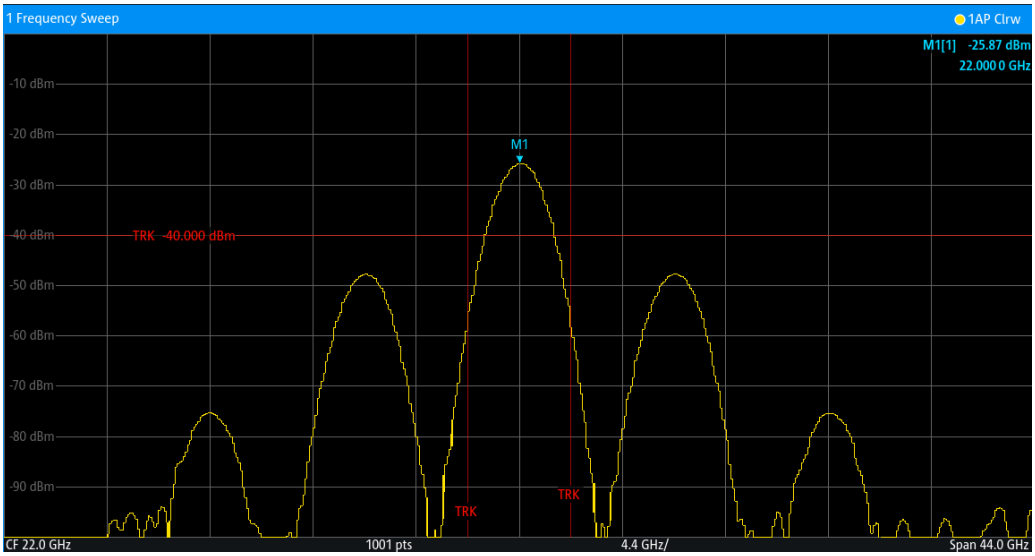
By default, the step size is set in relation to the selected span or resolution bandwidth (for zero span measurements). Sometimes, however, it can be useful to set the step size to other values.



For example, to analyze signal harmonics, you can define the step size to be equal to the center frequency. In this case, each stroke of the arrow key selects the center frequency of another harmonic. Similarly, you can define the step size to be equal to the current marker frequency.

4.3.1.3 Keeping the center frequency stable - signal tracking

Sometimes the signal drifts on the display but you want to keep the center frequency on the signal peak. In this case, you can use the signal tracking function to adjust the center frequency automatically. If enabled, the FSWX monitors the signal trace in a specified bandwidth around the expected center frequency. After each sweep, it searches for the maximum level within the specified bandwidth. Then it sets the center frequency to the frequency with the maximum level. If the FSWX does not find a maximum level above a defined threshold value, the center frequency remains unchanged. The search bandwidth and the threshold value are shown in the diagram by red lines which are labeled as "TRK".



4.3.2 Impact of the vertical axis settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

- Expected input levels: Reference level 238
- Sensitivity of the hardware: RF attenuation 239
- Diagram axis scaling 240

4.3.2.1 Expected input levels: Reference level

The reference level value is the maximum value that the A/D converter can handle without distorting the measured value. Signal levels above this value are not measured correctly, which is indicated by the "IF Overload" status display.

Internally, the FSWX uses the reference level to determine the optimum hardware settings. Thus, define the reference level as the maximum expected RF input level.

When determining the expected input level, consider that the power from *all* input signals contributes to the total power. The reference level must be higher than the total power from all signals.

The FSWX can set the optimum reference level for the current measurement settings automatically ("Auto Level").

The reference level determines the amplitude represented by the topmost grid line in the display. When you change the reference level, the measurement is not restarted; the results are merely shifted in the display. Only if the reference level changes due to a coupled RF attenuation, the measurement is restarted.

In general, the FSWX measures the signal voltage at the RF input. The level display is calibrated in RMS values of an unmodulated sine-wave signal. In the default state,

the level is displayed at a power of 1 mW (= dBm). Via the known input impedance, conversion to other units is possible.

Reference level offset

If the signal is attenuated or amplified before it is fed into the FSWX, you can define an (arithmetic) offset to the reference level so the application shows correct power results. The application shifts all displayed power level results by this value, and changes the scaling of the y-axis accordingly.

To determine the required offset, consider the external attenuation or gain applied to the input signal. For attenuation, define a positive offset so the FSWX increases the displayed power values.

If an external gain is applied, define a negative offset so the FSWX decreases the displayed power values.

Note, however, that the *internal* reference level (used to adjust the hardware settings to the expected signal optimally) ignores any "Reference Level Offset". Thus, it is important to keep in mind the actual power level the FSWX must handle, and not to rely on the displayed reference level.

internal reference level = displayed reference level - offset

Example

1. The initial reference level is 2 dBm with no offset.

   Both the displayed reference level and the internal reference level are 2 dBm.

2. You define an offset of 3 dB.

   The displayed reference level is adjusted to 5 dBm.
   The internal reference level remains at 2 dBm.
   (5 dBm (displayed ref level) - 3 dB (offset) = 2 dBm)

3. You decrease the reference level to 1 dBm.

   The displayed reference level is adjusted to 1 dBm.
   The internal reference level is adjusted to:
   1 dBm (displayed ref level) - 3 dB (offset) = -2 dBm.

4.3.2.2 Sensitivity of the hardware: RF attenuation

The attenuation is meant to protect the input mixer from high RF input levels. The level at the input mixer is determined by the set RF attenuation according to the formula:

"$level_{mixer} = level_{input}$ – RF attenuation"

The mixer supports a maximum level of 0 dBm.

Mixer levels above this value can lead to incorrect measurement results, which is indicated by the "RF Overload" status display. Furthermore, higher input levels can damage the instrument. Therefore, the FSWX determines the required RF attenuation automatically according to the reference level by default.

High attenuation levels also avoid intermodulation. However, the instrument must compensate for attenuation by re-amplifying the signal levels after the mixer. Thus, high attenuation values cause the inherent noise (i.e. the noise floor) to rise and the sensitivity of the analyzer decreases.

The selected RF attenuation has a direct impact on the sensitivity of a signal analyzer. The highest sensitivity is obtained at an RF attenuation of 0 dB. Each additional 10 dB step reduces the sensitivity by 10 dB. That means, the displayed noise increases by 10 dB. To measure a signal with an improved signal-to-noise ratio, decrease the RF attenuation.



For ideal sinusoidal signals, the displayed signal level is independent of the RF attenuation.

Depending on the type of measurement, you must find a compromise between a low noise floor and high intermodulation levels, and protecting the instrument from high input levels. You achieve the best compromise by letting the FSWX determine the optimum level automatically ("Low Noise" or "Low Distortion" optimization mode).

Electronic vs mechanical attenuation

The FSWX contains one mechanical and two electronic attenuators.

By default, the FSWX uses an electronic attenuator for attenuation levels up to 19 dB. For higher levels, the FSWX enables the mechanical attenuator for 20 dB attenuation, and covers the remaining level by electronic attenuation. Together with the mechanical attenuator, the FSWX provides an overall RF attenuation up to 82 dB.

If you disable the mechanical attenuator, the signal path uses only one electronic attenuator, covering levels up to 19 dB.

If you enable the enhanced electronic ranging option, the mechanical attenuator is disabled, but the FSWX provides an overall RF attenuation up to 31 dB. Thus, you can cover a wider dynamic range with the same signal path using electronic attenuation, without the mechanical wear of the attenuator. Especially when measuring signals which require RF attenuation levels around the switching level of 20 dB, you avoid frequent switching of the mechanical attenuator.

4.3.2.3 Diagram axis scaling

In a linear display, the measurement values are distributed linearly throughout the grid. That means the entire range of measured values is divided by the number of rows in the grid (10) and each row corresponds to 1/10 of the total range. Linear scaling is useful to determine precise levels for a small range of values. However, if large and small values appear in the same display, it is difficult to determine individual values precisely or to distinguish values that are close together.

In a logarithmic display, smaller values are distributed among a much larger area of the display, while large values are condensed to a smaller area. Now it is much easier to distinguish several lower values, as they are spread over a wider area. Logarithmic scaling is useful when large ranges of values must be combined in one display. Loga-

rithmic scaling is best applied to measurement values in logarithmic units (dB, dBm etc.).

In addition to linear or logarithmic scaling, you can set the vertical axis to display either absolute or relative values. Absolute values show the measured levels, while relative values show the difference between the measured level and the defined reference level. Relative values are indicated in percent for linear scaling, and in dB for logarithmic scaling.

4.3.3 Impact of the bandwidth, filter and sweep settings

The bandwidth, filter and sweep settings are closely related and interdependent. Which values are available for resolution bandwidth (RBW) and video bandwidth (VBW) depends on the selected filter type. The RBW and VBW settings have an impact on other measurement parameters. The following equation shows the interdependency of these settings:

$T_{MIN} = K*Span/RBW^2$

Where:

- T_{min} = minimum sweep time
- K = Filter constant
  By default, a Gaussian filter is used.

The FSWX sets the RBW, the VBW and the sweep time automatically according to the set span. By default, the values are coupled.

Thus, the following settings are applied:

- RBW = Span/100
- VBW = RBW

When defining the bandwidth and filter settings, consider the impact of the individual settings on the other settings and the measurement result. The following sections describe the impact in more detail.

- Separating signals by selecting an appropriate resolution bandwidth 241
- Smoothing the trace using the video bandwidth 242
- Coupling VBW and RBW 243
- Coupling span and RBW 243
- How data is measured: the sweep type 244
- Which data can pass: filter types 245
- How long the data is measured: sweep time 246
- How much data is measured: sweep points and sweep count 246
- How often data is measured: sweep mode 247

4.3.3.1 Separating signals by selecting an appropriate resolution bandwidth

The resolution bandwidth defines the 3-dB bandwidth of the resolution filter to be used. A sine-wave RF signal is displayed according to the passband characteristic of the resolution filter (RBW). That means, the signal display reflects the shape of the filter.

A basic feature of a signal analyzer is being able to separate the spectral components of a mixture of signals. The resolution at which the individual components can be separated is determined by the resolution bandwidth. Selecting a resolution bandwidth that is too large can make it impossible to distinguish between spectral components, i.e. they are displayed as a single component. Smaller resolution bandwidths, however, increase the required sweep time.

Two signals with the same amplitude can be resolved if the resolution bandwidth is smaller than or equal to the frequency spacing of the signal. If the resolution bandwidth is equal to the frequency spacing, the spectrum display screen shows a level drop of 3 dB precisely in the center of the two signals. Decreasing the resolution bandwidth makes the level drop larger, which thus makes the individual signals clearer.

You obtain the highest sensitivity at the smallest bandwidth (1 Hz). If you increase the bandwidth, the sensitivity decreases proportionally to the change in bandwidth. Increasing the bandwidth by a factor of 3 increases the displayed noise by approximately 5 dB (4.77 dB precisely). If you increase the bandwidth by a factor of 10, the displayed noise increases by a factor of 10, i.e. 10 dB.

If there are large level differences between signals, the resolution is determined by selectivity and by the selected resolution bandwidth. The measure of selectivity used for signal analyzers is the ratio of the 60-dB bandwidth to the 3-dB bandwidth (= shape factor).

For the FSWX, the shape factor for bandwidths is < 5, i.e. the 60-dB bandwidth of the 30 kHz filter is <150 kHz.

The higher spectral resolution with smaller bandwidths is won by longer sweep times for the same span. The sweep time has to allow the resolution filters to settle during a sweep at all signal levels and frequencies to be displayed.

If the RBW is too large, signal parts that are far away (e.g. from a different signal) are considered in the measurement and distort the results. The noise increases.

If the RBW is too small, parts of the signal are lost. As the displayed signal always reflects the shape of the filter, select a bandwidth large enough so the displayed signal reflects the entire shape of the filter.

4.3.3.2 Smoothing the trace using the video bandwidth

The video filters are responsible for smoothing the displayed trace. Using video bandwidths that are small compared to the resolution bandwidth, only the signal average is displayed and noise peaks and pulsed signals are repressed. When measuring pulsed signals, it is advisable to use a video bandwidth that is large compared to the resolution bandwidth (VBW = 10 x RBW). Then the amplitudes of pulses are measured correctly.

The level of a sine-wave signal is not influenced by the video bandwidth. A sine-wave signal can therefore be freed from noise by using a video bandwidth that is small compared with the resolution bandwidth, and thus be measured more accurately.

RMS/Average detector and VBW

If an RMS detector is used, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS or average detector no longer occurs. However, the VBW is still considered when calculating the sweep time. Small VBW values lead to a longer sweep time. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS detector. Normally, if you use the RMS detector, you should increase the sweep time to get more stable traces.

If an average detector is used, the video bandwidth in the hardware is only bypassed if the video filter is set to "Auto" mode. Use this mode to avoid duplicate trace averaging with small VBWs.

4.3.3.3 Coupling VBW and RBW

The video bandwidth can be coupled to the resolution bandwidth automatically. In this case, if the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

Coupling is recommended if a minimum sweep time is required for a selected resolution bandwidth. Narrow video bandwidths require longer sweep times due to the longer settling time. Wide bandwidths reduce the signal/noise ratio.

Table 4-22: Overview of RBW/VBW ratios and recommendations for use

Ratio RBW/VBW	Recommendation for use
1/1	Recommended for sinusoidal signals Default setting for automatic coupling.
0.1	Recommended when the amplitudes of pulsed signals are to be measured correctly. The IF filter is exclusively responsible for the pulse shape. No additional evaluation is performed by the video filter.
10	Recommended to suppress noise and pulsed signals in the video domain.
Manually set (0.001 to 1000)	Recommended for other measurement requirements

4.3.3.4 Coupling span and RBW

The resolution bandwidth can be coupled to the span setting, either by a manually defined factor or automatically. If the span is changed, the resolution bandwidth is automatically adjusted. The automatic coupling adapts the resolution bandwidth to the currently set frequency span/100.

The 6 dB bandwidths 200 Hz, 9 kHz and 120 kHz and the available channel filters are not changed by the coupling.

With a span/RBW ratio of 100 and a screen resolution of 1000 pixels, each frequency in the spectrum is displayed by 10 pixels. A span/RBW ratio of 1000 provides the highest resolution.

4.3.3.5 How data is measured: the sweep type

In a standard analog **frequency sweep**, the local oscillator of the analyzer sweeps the applied signal quasi analog from the start to the stop frequency to determine the frequency spectrum.

Alternatively, the analyzer can sample signal levels over time at a defined frequency and transform the data to a spectrum by fast Fourier transform (**FFT**). Although this measurement method requires additional calculations, it can provide results much faster than the frequency sweep, in particular for small RBWs.

Which sweep mode is appropriate for the current measurement depends on the span, RBW, VBW and sweep time settings. By default ("Auto" sweep type), the FSWX automatically uses the sweep type with the highest sweep rate depending on these measurement settings.

Restrictions for FFT mode

FFT mode is not available when using 5-pole filters, channel filters or RRC filters, or the quasi-peak detector. In this case, sweep mode is used.

Optimization

In FFT mode, FFT analysis is performed to determine a spectrum of frequencies. Several analysis steps are required to cover the entire span. The subspan which is covered by one FFT analysis depends on the RBW. You cannot define the subspan directly, but it can be optimized according to measurement requirements.

Narrow subspans provide a higher dynamic range. They also allow you to perform measurements near a carrier with a reduced reference level. With a wide subspan, the carrier and the wanted signal are likely to be measured at the same time. In this case, the powers of both signals are summarized. The reference level must be high enough to consider this factor. With a narrow subspan, measuring both signals at the same time is less likely to happen, so you can reduce the reference level.

For an optimal dynamic range, the narrowest possible subspan (depending on the RBW) is used. Furthermore, the autorange function for the internal IF gain calculation is activated to obtain the best control range of the A/D converter.

However, the narrower the subspan, the more steps are required to cover the entire span. Thus, the analysis and calculation time increases. To **optimize the measurement speed**, the widest possible subspan (depending on the RBW) is used. Set the "Sweep Time" to "Auto" to optimize the sweep rate.

For general-purpose measurements, an "Ultimate" mode is available, which provides a **compromise between a large dynamic range and a fast sweep**. In this case, a medium-sized subspan is used. The autorange function for the internal IF gain calculation is disabled. Set the reference level accordingly to optimize the control range for the A/D converter.

For **highly transient signals**, the recommended "Transient" mode increases the measurement speed with a trade-off in dynamic range.

Optimization for zero span sweeps

For normal sweeps in the time domain (zero span), the optimization mode determines the selection of the A/D converter prefilter, which depends on the RBW.

In **"Dynamic" mode**, the narrowest possible prefilter is used.

In **"Ultimate" mode**, a medium-sized prefilter is used.

In **"Transient" mode**, a slightly wider prefilter is used.

In **"Speed" mode**, the widest possible prefilter is used.

Number of subspans

Several analysis steps are required to cover the entire span, in particular if the span exceeds the maximum I/Q bandwidth for a single measurement. In this case, each FFT analysis covers a subspan. You cannot define the subspan directly, but it can be optimized according to measurement requirements, as described above. The number of required subspans is indicated in the "Sweep Configuration" dialog box. Thus, you can determine the required measurement time for an individual span (and thus sweep point) as:

<Meas time subspan> = <sweep time> / <no. of subspans>

4.3.3.6 Which data can pass: filter types

The filter is irrelevant when measuring individual narrowband signals, as long as the signal remains within the RBW. However, the measurement result for broadband signals is very dependent on the selected filter type and its shape. If the filter is too narrow, the signal is distorted by the filter. If the filter is too wide, multiple signals can no longer be distinguished. Generally, the smaller the filter width and the steeper its edges, the longer the settling time and thus the longer the sweep time must be.

All resolution bandwidths are realized with digital filters. Normal (3dB) Gaussian filters are set by default. Some communication standards require different filters.

For a list of available filter types, see the specifications document.

Normal (3 dB) Gaussian filters

Gaussian filters provide a good compromise between steep edges and a short settling time. This filter is suitable for most measurement tasks and is used by default.

The available Gaussian (3 dB) filters are listed in the FSWX specifications document.

Channel filters

Channel filters are fairly steep but require a long settling time; they are useful for pulse measurements in the time domain.

RRC filters

Root-raised cosine filters are similar in shape to channel filters and are required by some measurement standards.

5-Pole filters

5-Pole filters are broad and allow for a large bandwidth to pass.

4.3.3.7 How long the data is measured: sweep time

Each filter has a settling time that must be awaited to obtain correct results. Since the resolution bandwidth and video bandwidth define the filter, the smaller of the two determines the minimum sweep time required for the measurement. Allowed values depend on the ratio of span to RBW and RBW to VBW.

If the selected sweep time is too short for the selected bandwidth and span, level measurement errors occur. In this case, the FSWX displays the error message "Sweep time too low", and marks the indicated sweep time with a red bullet. Furthermore, a status bit in the `STATus:QUEStionable:TIME` status register indicates an error.

The sweep time can be coupled to the span (not zero span), video bandwidth (VBW) and resolution bandwidth (RBW) automatically. If the span, resolution bandwidth or video bandwidth change, the sweep time is automatically adjusted.



Note that the sweep time only indicates how long data is captured. The time required to process the captured data can be considerably longer, in particular for FFT mode. For FFT mode, an estimated duration is indicated behind the sweep time in the application panel (for RF measurements only).

4.3.3.8 How much data is measured: sweep points and sweep count

By default, 1001 data points are determined in a single sweep. During the next sweep, 1001 new data points are collected, and so on. The number of **sweep points** defines how much of the entire span is covered by a single data point. By increasing the number of sweep points, you can increase the reliability of the individual data points. Thus, the accuracy of the analyzed results increases, as well. However, these data points are all stored on the instrument, occupying a large amount of memory. And each sweep point increases the overall measurement time.

The sweep count defines the number of sweeps to perform in single sweep mode. Values from 0 to 200000 are allowed. For a value of 0 or 1, 1 sweep is performed. The sweep count applies to all the traces in a diagram.

If you set the trace configuration to "Average", "Max Hold" or "Min Hold", the sweep count or average count also determines the number of averaging or maximum search procedures (see "Analyzing several traces - trace mode" on page 285).

For details on how the number of sweep points and the sweep count affect the trace results on the screen, see "Mapping samples to sweep points with the trace detector" on page 278.

4.3.3.9 How often data is measured: sweep mode

The sweep mode determines how often the spectrum is swept. In "Single Sweep" mode, you define a certain number of sweeps to perform (sweep count). In ("Continuous Sweep" mode, the sweep is repeated continuously.

By default, the application collects the data for the specified number of sweeps and displays the corresponding trace. When the next sweep is started, the previous trace is deleted.

However, the application can also retain the data from a single sweep run and display it together with the new data ("Continue Single Sweep" mode). Particularly when using the trace configurations "Average" or "Max Hold", this mode takes previously recorded measurements into account for averaging/maximum search (see "Analyzing several traces - trace mode" on page 285).

4.3.4 Conditional measurement start: trigger settings

In a basic measurement with default settings, the sweep is started immediately. However, sometimes you want the measurement to start only when a specific condition is fulfilled, for example, a signal level is exceeded, or in certain time intervals. For these cases, you can define a trigger for the measurement. In FFT sweep mode, the trigger defines when the data acquisition starts for the FFT conversion.

You can define an offset to delay the measurement after the trigger event, or to include data before the actual trigger event in time domain measurements (pre-trigger offset).

For complex tasks, advanced trigger settings are available:

- Hysteresis to avoid unwanted trigger events caused by noise
- Holdoff to define exactly which trigger event causes the trigger in a jittering signal
- Trigger sequence to combine two separate trigger conditions

Configuring trigger output is described in Section 4.2.7, "Receiving and providing trigger signals", on page 233.

- Initiating a measurement: trigger source....247
- Pretrigger and posttrigger: trigger offset....248
- Avoiding unwanted triggers by level: trigger hysteresis....248
- Stabilizing triggers in pulsed signals: trigger dropout time....249
- Reducing the number of triggers in time: Trigger holdoff....250
- Combining trigger conditions: Trigger sequence....250
- Determining the exact trigger point - TPIS....252
- Selective data capture: gated measurements....252

4.3.4.1 Initiating a measurement: trigger source

The trigger source defines which source must fulfill the condition that triggers the measurement. For "Free Run" measurements, no trigger is defined. The measurement runs continuously.

Basically, the source can be:

- Time: the measurement is repeated in a regular interval
- Power: the FSWX checks an input signal for a defined power level

  The trigger signal can be any of the following:
  - The input signal at one of various stages in the signal analysis process - before or after the input mixer, after the video filter etc.
  - A signal from an external device via one of the trigger input connectors on the instrument
  - A signal from a power sensor, see "Using a power sensor as an external power trigger" on page 192.

4.3.4.2 Pretrigger and posttrigger: trigger offset

You can define an offset to delay the measurement after the trigger event, or to include data before the actual trigger event in time domain measurements (pre-trigger offset). Pre-trigger offsets are possible because the FSWX captures data continuously in the time domain, even before the trigger occurs.

4.3.4.3 Avoiding unwanted triggers by level: trigger hysteresis

Setting a hysteresis for the trigger helps avoid unwanted trigger events caused by noise, for example. The hysteresis is a threshold to the trigger level. The signal must fall below this threshold on a rising slope or rise above it on a falling slope before another trigger event occurs.

Example:

In the following example, the signal does not drop below the hysteresis (threshold) before it reaches the trigger level again. Thus, the second possible trigger event on the rising edge is ignored. On the falling edge, however, two trigger events occur. The signal exceeds the hysteresis before it falls to the trigger level the second time.

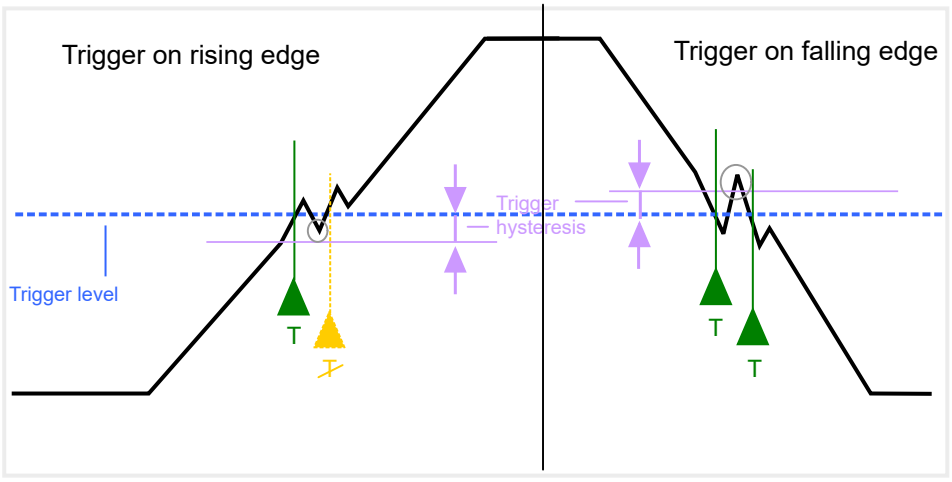


Figure 4-25: Effects of the trigger hysteresis

4.3.4.4 Stabilizing triggers in pulsed signals: trigger dropout time

If a modulated signal is instable and produces occasional "dropouts" during a burst, you can define a "dropout" time. The dropout time is the minimum duration that the input signal must stay below the trigger level before triggering again. Defining a dropout time helps you stabilize triggering when the analyzer is triggering on undesired events.

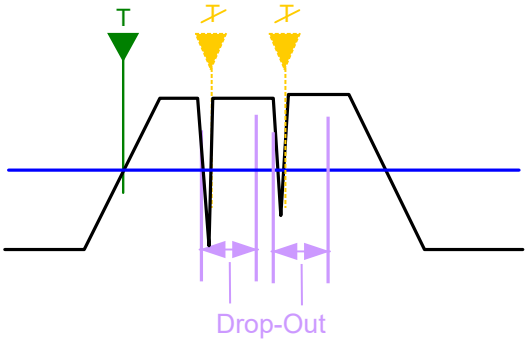


Figure 4-26: Effect of the trigger dropout time

Dropout times for falling edge triggers

If you set a trigger to a falling edge ("Slope" = "Falling"), the measurement starts when the power level falls below a certain level. You can use this setting, for example, to trigger at the end of a burst, similar to triggering on the rising edge for the beginning of a burst.

If you define a dropout time, the power level must remain below the trigger level at least for the duration of the dropout time (as defined above). However, if you define a dropout time that is longer than the pulse width, this condition cannot be met before the final pulse. Thus, a trigger event does not occur until the pulsed signal is over.

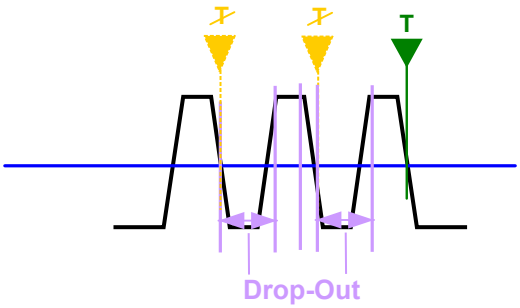


Figure 4-27: Trigger dropout time for falling edge trigger

For gated measurements, you cannot define a combination of a falling edge trigger and a dropout time.

4.3.4.5 Reducing the number of triggers in time: Trigger holdoff

The trigger holdoff defines a waiting period before the next trigger after the current one will be recognized.

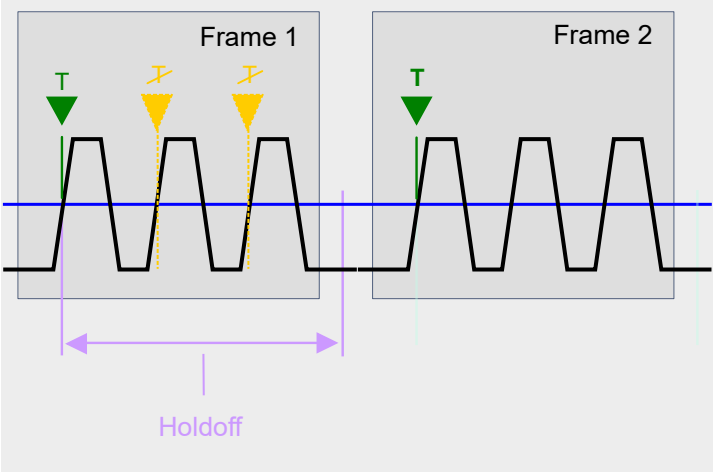


Figure 4-28: Effect of the trigger holdoff

4.3.4.6 Combining trigger conditions: Trigger sequence

You can combine two separate trigger conditions with an optional delay time and an optional reset time to a trigger sequence. A trigger action, such as a sweep, only occurs when the complete set of trigger conditions is fulfilled. A trigger sequence is also referred to as an *a ->b trigger*.

For a trigger sequence, you configure a trigger a and a trigger b. After the a-trigger conditions have been met, and an optional minimum delay has passed, the b-trigger with independent conditions is enabled. The instrument waits until the b-trigger conditions occur. The b-trigger causes the trigger event, and the sequence starts again. The b-trigger can only cause the trigger event if it occurs after the a-trigger and the delay time.

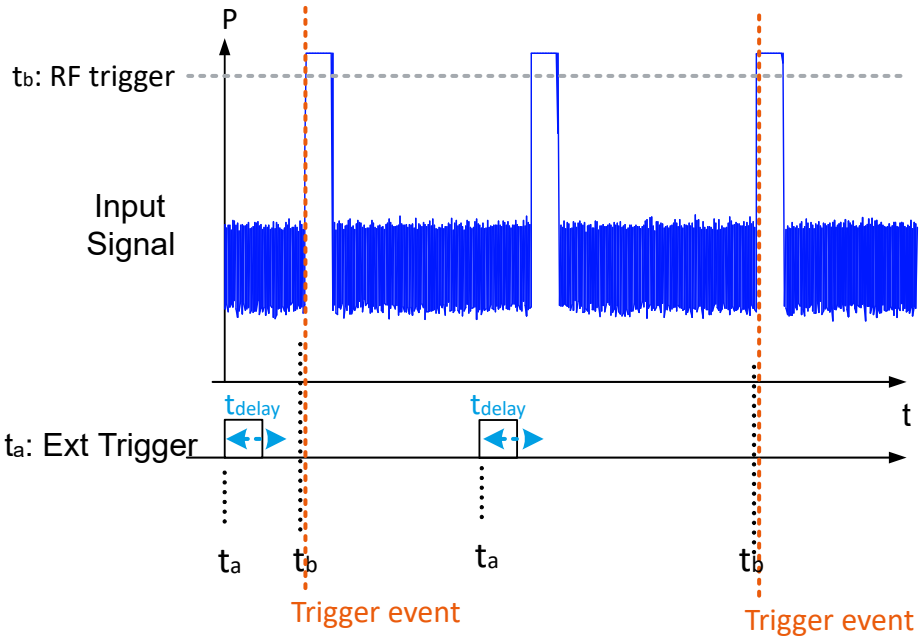


Figure 4-29: Trigger sequence

Optionally, you can configure a reset after the a-trigger if a maximum timeout is exceeded. For example, if you expect an irregular b-trigger, you can configure a reset condition to restart the sequence after a timeout.

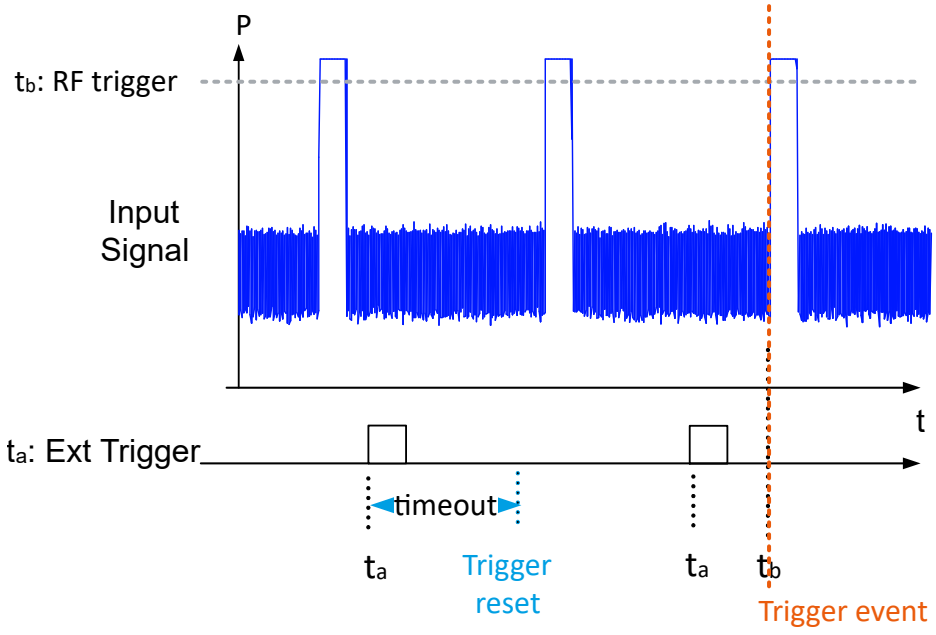
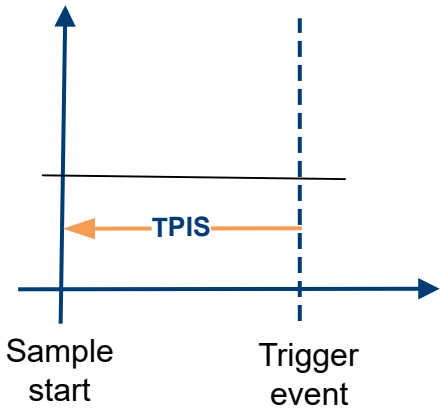


Figure 4-30: Trigger sequence with reset after timeout

You configure the trigger parameters for triggers a and b in separate tabs of the dialog box. Some trigger parameters are configured globally for both triggers. Global parameters are located outside of the subtabs.

4.3.4.7 Determining the exact trigger point - TPIS

The FSWX usually samples with a much higher sample rate than the specific application actually requires. Thus, the trigger point determined internally is much more precise than the one determined from the (downsampled) data in the application. You can query the time offset from the sample start to the actual trigger event (trigger point in sample = TPIS).



Optionally, the FSWX can set the measured trigger event to the actual trigger point with the sample.

4.3.4.8 Selective data capture: gated measurements

Similar to a gate that provides an opening in a fence, a gated measurement lets data from the input signal pass in defined areas only. The *gate* controls exactly when data is included in the measurement results and when not. The gate is opened by the trigger source, which is also the gate source.

Gates can be used in two different modes:

- **Level:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the gate source drops below the gate level.
  Using a pulsed gate signal in level mode, the following behavior can be achieved: When the gate source signal is active, the input signal data is collected; when the gate signal is inactive, the input signal is ignored.
- **Edge:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the defined gate length is reached.

Restrictions

- The gate mode "Level" is not supported for Rohde & Schwarz power sensors. The signal sent by these sensors merely reflects the instant the level is first exceeded, rather than a time period. However, only time periods can be used for gating in level mode. Thus, the trigger impulse from the sensors is not long enough for a fully gated measurement; the measurement cannot be completed. For details on power sensors, see "Using a power sensor as an external power trigger" on page 192.

In addition, you can define a delay time so that the first few sweep points after the gate opening are ignored.

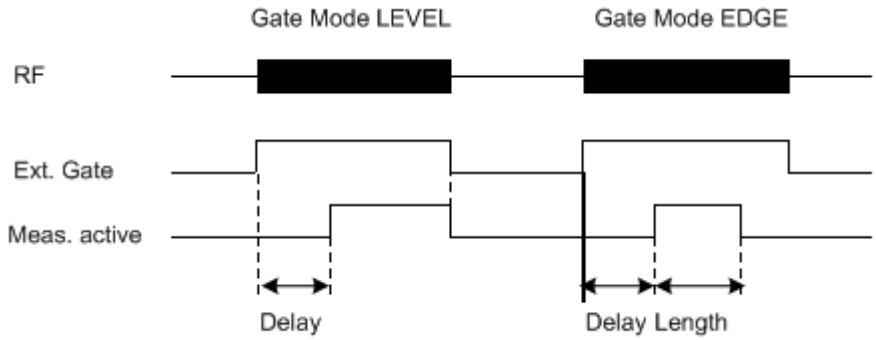


Figure 4-31: Effects of gate mode, gate delay and gate length

Example:

Use a gate in sweep mode and stop the measurement while the gate signal is inactive. Thus, the spectrum for pulsed RF carriers does not contain the superposition of frequency components generated during switching. Similarly, you can analyze the spectrum for an inactive carrier. Use an external gate or the internal power trigger to control the sweep.

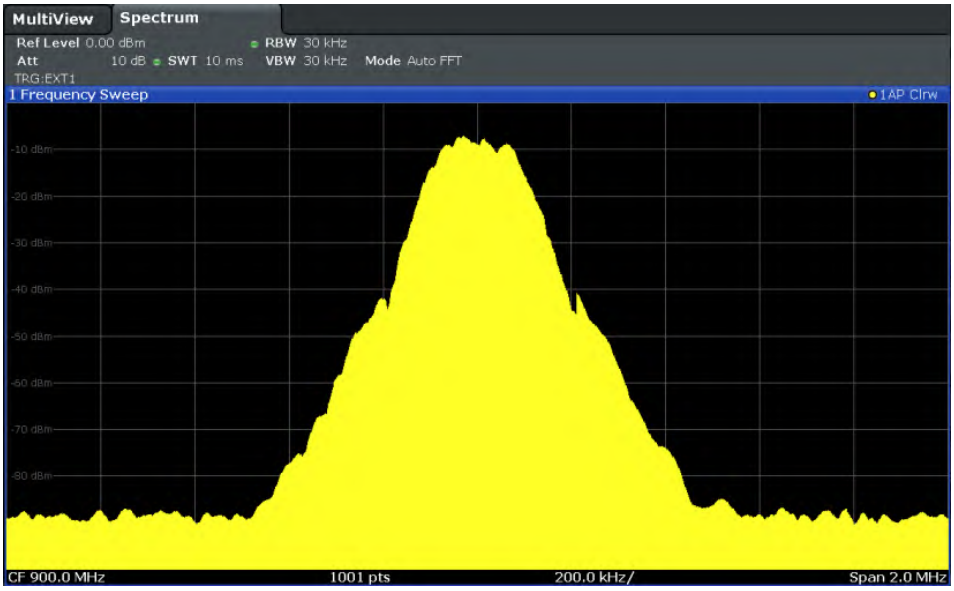


Figure 4-32: GSM signal with gate off

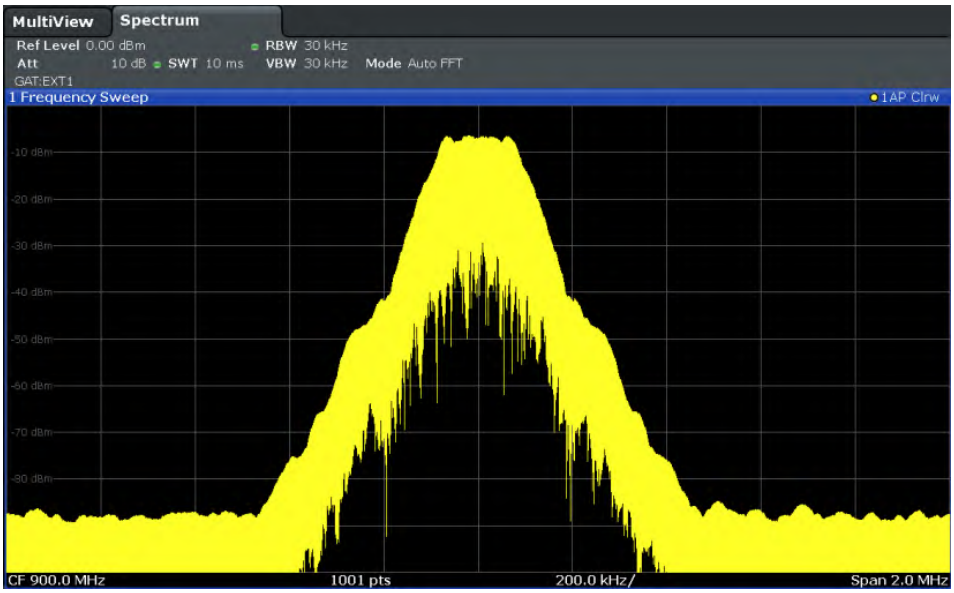


Figure 4-33: GSM signal with gate on

Gated sweep operation is also possible for zero span measurements. Thus, you can display level variations of individual slots, for instance in burst signals, versus time.

To indicate that a gate is used for the sweep, "GAT" and the gate source is displayed in the application panel.

Continuous gating

With common gating, a measurement is performed each time the trigger event occurs. However, when using an external trigger, the measurement time for a single gate is restricted by the repetition rate of the external trigger.

Using continuous gating, you can perform several measurements periodically after each external trigger event. This function can speed up the measurement significantly. After the first external trigger event, a specified number of gate periods are generated internally, in a specified interval, without requiring additional trigger events. Only after the specified number of measurements have been performed, the FSWX waits for the next external trigger event.

Example:

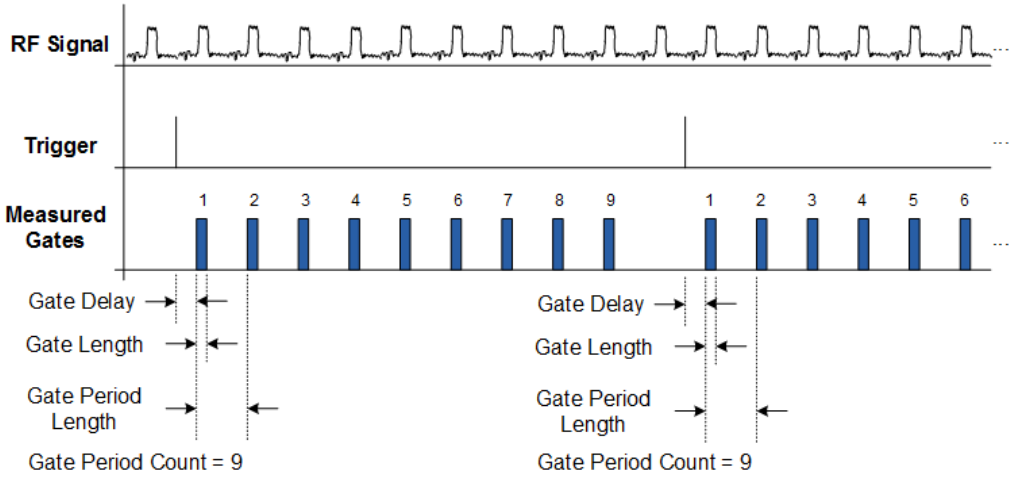


Figure 4-34: Continuous gating for a gate period count of 9

Continuous gating is useful, for example, if you want to measure a periodic signal which occurs after a specific trigger event. Using gate periods, you can average the individual periods of the signal for several trigger events.

Continuous gating can also improve the measurement speed. Since you no longer have to wait for the next external trigger events, you can measure several periodic bursts after a single trigger event.

Restrictions for continuous gating

While continuous gating reduces the number of required external trigger events, not every sweep constellation can be performed using just one external trigger event. Note the following restrictions:

- The number of gates is limited to 1023. If the required measurement time exceeds the duration of 1023 gates, a new external trigger event is necessary for each subsequent 1023 gates.
- In "Sweep Mode Type: Sweep", more than one external trigger event can be necessary due to hardware segmentation of the sweep.
- In "Sweep Mode Type: FFT", more than one external trigger event can be necessary, but the covered span with one external trigger event is normally larger than in "Sweep Mode Type: Sweep".
  In FFT mode, it is recommended that you activate the "Optimization mode: Speed", as it further reduces the required number of external trigger events.

Triggered gated measurements

By default, the gate is opened by the trigger source, which is also the gate source. However, you can also use different sources for a general trigger and the beginning of the individual gates. In this case, the trigger source defines when measurement is possible, and the gate source determines which data is measured.

Example:

A rotating antenna can be used as a general (external) trigger source, for example. Only when the antenna reaches a specified position, measurement is possible. A second external trigger can then be used to control the gating periods to measure a burst signal.

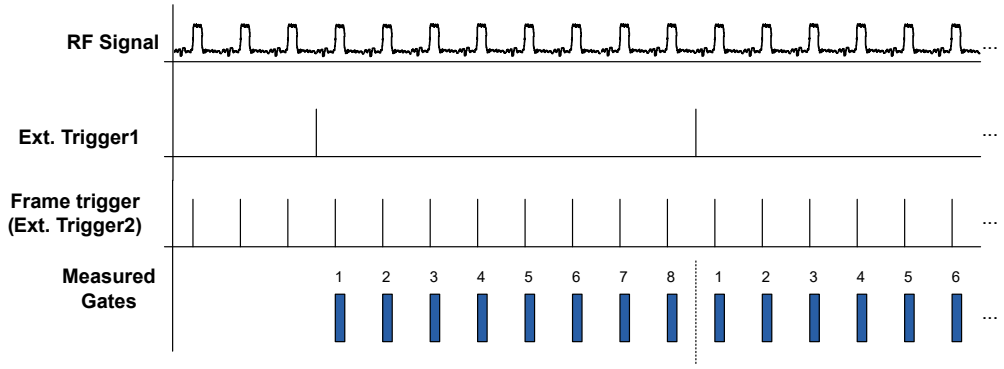


Figure 4-35: Triggered gated measurement

Triggered gated measurements are only available in applications based on frequency sweeps (not I/Q-data-based), such as the "Spectrum" application.

4.3.5 Optimizing measurements

4.3.5.1 Minimizing the measurement duration

If you want to minimize the measurement duration, try the following methods to optimize the measurement:

- Reduce the **span** of the measurement to the relevant parts of the signal only.
- Increase the **RBW** to minimize the measurement time. However, consider the requirements of the standard if you need to measure according to standard.
- Take advantage of the **sweep optimization mode** in the sweep settings if you do not require the larger dynamic range (see "Sweep Optimization (expert parameter)" on page 970).
- Reduce the **sweep time** and thus the amount of data to be captured and calculated. However, consider the requirements regarding the standard deviation.
- To obtain better average power results in less time, use an **RMS detector (or peak detector) with a higher sweep time** instead of trace averaging. Furthermore, enforce the use of the **sweep type "FFT"**, as opposed to "Auto". In "Sweep" mode, the averaging effect of the RMS detector can be less efficient.
- When performing multiple measurements, use **multiple application instances** to switch between measurements rather than changing the settings within one application instance repeatedly.
  Take advantage of the **"Sequencer"** function to switch between multiple measurements automatically or continuously (see also Section 4.1.1.2, "Running a sequence of measurements - the Sequencer concept", on page 103).

Additional information

An application note discussing measurement speed optimization is available from the Rohde & Schwarz website:

1EF90: Speeding up Spectrum Analyzer Measurements

4.3.5.2 Improving averaging results

To obtain better average power results in less time, use an **RMS detector (or peak detector) with a higher sweep time** instead of trace averaging. Furthermore, enforce the use of the **sweep type "FFT"**, as opposed to "Auto". In "Sweep" mode, the averaging effect of the RMS detector can be less efficient.

In FFT mode, FFTs are calculated per bin and combined using the RMS detector. For trace averaging, on the other hand, the local oscillator must be switched repeatedly for each trace, which takes additional time.

Generally, a higher **sweep time** leads to more data to be averaged and thus stabilizes the results. In FFT mode, a higher sweep time means more FFTs are calculated and combined per bin.

Thus, in the same capture time, the FFT mode with an RMS detector can provide better results than an averaged trace.

4.4 Trigger settings

Triggering means to capture the interesting part of the signal. Choosing the right trigger type and configuring all trigger settings correctly allows you to detect various incidents in your signals.

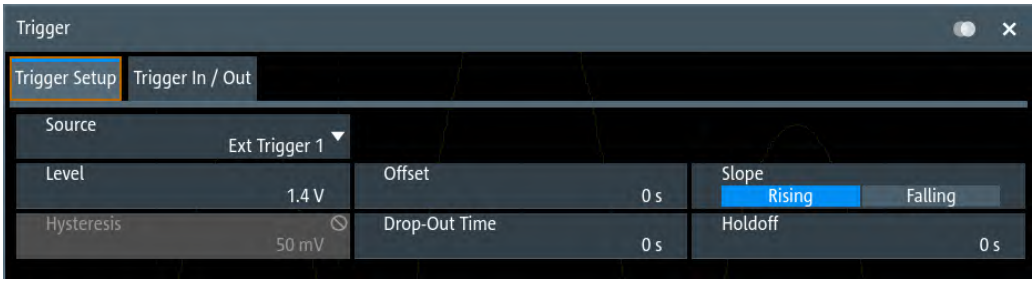
For background information, see Section 4.3.4, "Conditional measurement start: trigger settings", on page 247 and Section 4.3.4.8, "Selective data capture: gated measurements", on page 252.

Configuring trigger output is described in Section 4.2.7, "Receiving and providing trigger signals", on page 233.

- Trigger setup....258
- How to determine the required trigger parameters....262
- How to configure a triggered measurement....263

4.4.1 Trigger setup

Access: "Overview" > "Trigger/Gate"



For step-by-step instructions on configuring triggered measurements, see Section 4.4.3, "How to configure a triggered measurement", on page 263.

Trigger Source....259
└ Free Run....259
└ Ext Trigger1 to 4....259
└ Video....259
└ Power....260
└ I/Q Power....260
└ Time....260
└ Power Sensor....260
Trigger Level....261
Repetition Interval....261
Trigger Offset....261
Slope....261
Hysteresis....262

Drop-Out Time....262
Trigger Holdoff....262
Correct TPIS.... 262

Trigger Source
Selects the trigger source. If you select a trigger source other than "Free Run", the trigger source is indicated in the application panel.

For more information, see Section 4.3.4.1, "Initiating a measurement: trigger source", on page 247.

Note: When triggering is enabled, the squelch function is automatically disabled.

For an active external frontend, only external triggers, I/Q power triggers and (periodic) time triggers are supported as trigger sources. See "Activate External Frontend / External Frontend Activated" on page 213.

Remote command:
"Trigger Source" on page 259

Free Run ← Trigger Source
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

In the "Spectrum" application, "Free Run" is the default trigger source setting.

Remote command:
`TRIG:SOUR IMM`

Ext Trigger1 to 4 ← Trigger Source
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified "Trigger Level".

"Ext Trigger 1"
Trigger signal from the "Trigger 1 Input" connector.

"Ext Trigger 2"
Trigger signal from the "Trigger 2 In / Out" connector.
Note: You must configure the connector for input in the trigger input/output settings.
See Section 4.2.7.1, "Trigger input/output settings", on page 234.

"Ext Trigger 3"
Trigger signal from the "Trigger 3 Input" connector.

"Ext Trigger 4"
Trigger signal from the "Trigger 4 In / Out" connector.
Note: You must configure the connector for input in the trigger input/output settings.
See Section 4.2.7.1, "Trigger input/output settings", on page 234.

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`

Video ← Trigger Source
Defines triggering by the video signal, i.e. the filtered and detected version of the input signal (the envelope of the IF signal), as displayed on the screen.

Define a trigger level from 0 % to 100 % of the diagram height. The absolute trigger level is indicated by a horizontal trigger line in the diagram, which you can also move graphically to change the trigger level.

A fixed hysteresis of ±5 % of the specified trigger value (in V) is applied to the video trigger level automatically and cannot be changed.

Video mode is only available in the time domain, and not for I/Q-based data.

Remote command:
`TRIG:SOUR VID`

Power ← Trigger Source
The FSWX starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger threshold depends on the defined trigger level, and on the RF attenuation and preamplification. A reference level offset, if defined, is also considered. The trigger bandwidth at the intermediate frequency depends on the RBW and sweep type. For details on available trigger levels and trigger bandwidths, see the instrument specifications document.

For measurements on a fixed frequency (e.g. zero span or I/Q measurements), the third IF represents the center frequency.

This trigger source is only available for RF input.

Note: Note that in "Auto" sweep type mode, due to a possible change in sweep types, the trigger bandwidth can vary considerably for the same RBW setting.

Remote command:
`TRIG:SOUR POW`

I/Q Power ← Trigger Source
This trigger source is only available for I/Q measurements and in applications that process I/Q data.

Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

The trigger bandwidth corresponds to the analysis bandwidth setting for I/Q data acquisition.

Remote command:
`TRIG:SOUR IQP`

Time ← Trigger Source
Triggers in a specified Repetition Interval.

Remote command:
`TRIG:SOUR TIME`

Power Sensor ← Trigger Source
Uses an external power sensor as a trigger source. This option is only available if a power sensor is connected and configured.

For a power sensor trigger, you define the trigger level in the power sensor settings.

For more information, see Section 4.2.3.2, "Power sensor settings", on page 193.

Remote command:
TRIG:SOUR PSE

Trigger Level
Defines the trigger level for the specified trigger source.

For details on supported trigger levels, see the specifications document.

For gated measurements using a coupled trigger, the trigger level setting also defines the gating trigger level.

Remote command:
TRIGger<ip>[:SEQuence]:LEVel:POWer on page 632
TRIGger[:SEQuence]:LEVel[:EXTernal<tp>] on page 631
TRIGger[:SEQuence]:LEVel:VIDeo on page 632

Repetition Interval
Defines the repetition interval for a time trigger.

The shortest interval is 2 ms.

Set the repetition interval to the exact pulse period, burst length, frame length or other repetitive signal characteristic. If you cannot set the required interval with the available granularity, configure a multiple of the interval that is supported. Thus, the trigger remains synchronized to the signal.

Remote command:
TRIGger[:SEQuence]:TIME:RINTerval on page 635

Trigger Offset
Defines the time offset between the trigger event and the start of the sweep.

For more information, see Section 4.3.4.2, "Pretrigger and posttrigger: trigger offset", on page 248.

Offset > 0:	Start of the sweep is delayed
Offset < 0:	Sweep starts earlier (pretrigger) Only possible for zero span and if gated trigger is disabled. The maximum allowed range is limited by the sweep time: $Pretrigger_{max}$ = $sweep\ time_{max}$

Remote command:
TRIGger[:SEQuence]:HOLDoff on page 630

Slope
Defines whether triggering occurs when the signal rises to the trigger level or falls down to it.

This setting is available for all trigger sources except time.

Remote command:
TRIGger[:SEQuence]:SLOPe on page 633

Hysteresis
Defines the distance in dB to the trigger level that the trigger source must exceed before the next trigger event occurs. Setting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step size of 1 dB.

For more information, see Section 4.3.4.3, "Avoiding unwanted triggers by level: trigger hysteresis", on page 248.

Remote command:
`TRIGger<ip>[:SEQuence]:POWer:HYSTeresis` on page 633

Drop-Out Time
Defines the time that the input signal must stay below the trigger level before triggering again.

For more information, see Section 4.3.4.4, "Stabilizing triggers in pulsed signals: trigger dropout time", on page 249.

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 630

Trigger Holdoff
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

For more information, see Section 4.3.4.5, "Reducing the number of triggers in time: Trigger holdoff", on page 250.

Remote command:
`TRIGger[:SEQuence]:POWer:HOLDoff` on page 632

Correct TPIS
If enabled, the trigger event is set to the actual trigger point within the sample (TPIS). See also Section 4.3.4.7, "Determining the exact trigger point - TPIS", on page 252.

This setting is available for all trigger sources except "Free Run".

Remote command:
`TRIGger[:SEQuence]:CTPis` on page 629

4.4.2 How to determine the required trigger parameters

The following step-by-step instructions demonstrate how to determine the required trigger parameters manually.

1. Select "Overview" > ""Trigger/Gate"".
2. Determine the parameters that you want to use to define the trigger and gate conditions from the preview diagram, for example:
   - The length of a burst or slot
   - The upper or lower power level of a pulse
   - The maximum noise level

- The power level or time at which a certain incident occurs

3. 

   Set the transparency of the dialog box so that you can see the results of the measurement in the background.

4. Try out different trigger settings as described in How to configure a triggered measurement.
   Check the effect of the current settings on the main measurement in the background.

5. If the results are as you expected, close the dialog box to keep the changes. Otherwise, correct the settings as necessary.

4.4.3 How to configure a triggered measurement

A triggered measurement starts only when the trigger conditions are fulfilled. The following step-by-step instructions demonstrate how to configure a triggered measurement manually.

For remote operation, see Section 4.14.7, "Configuring triggered and gated measurements", on page 629.

To define a time trigger

A time trigger initiates measurements in a regular time interval.

1. Select "Overview" > "Trigger/Gate".
2. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "Time".
3. Define the "Repetition interval", the time after which a new measurement is started.

To define an external trigger

An external trigger provides a trigger signal from a connected device.

For information on how to configure a power sensor to provide an external trigger to the FSWX, see "How to configure a power sensor as an external (PSE) trigger" on page 201.

1. Connect an external device that provides the trigger signal to one of the "Trigger Input" connectors on the FSWX.
   For details on the connectors, see Section 3.4, "Instrument tour", on page 31.
2. For "Trigger Input / Output" connectors, define their use for input:
   a) Select "Overview" > ""Trigger/Gate"" > "Trigger In / Out".
   b) Select Trigger Connector Direction: "Input".
3. Select "Overview" > ""Trigger/Gate"" > "Trigger Setup".

4. Define the "Trigger Source" = "External".
5. Configure the external trigger as described for the other power triggers.

To define a power trigger

A power trigger initiates measurements when the signal reaches a specific level.

1. Select "Overview" > ""Trigger/Gate"" > "Trigger Setup".
2. Define the "Trigger Source" = "Power".
   Alternatively, define "Trigger Source" = "Video". The video signal corresponds to the envelope of the IF signal. It data is processed by the resolution and video filters and the selected detector.
3. Define which RF "Input" connector provides the trigger signal. You can only select an active input connector (see).
4. Define the "Trigger Level": the power level at which the measurement starts.
   For a "Video" trigger source, you can move the level line graphically to define the level. If you define the value numerically, enter a percentage of the full diagram height as the level.
5. Define whether the signal must cross the trigger level on a falling or on a rising edge ("Slope") to trigger the measurement.
6. To start the measurement with a time delay, define a "Trigger Offset".
7. To reject triggers due to noise or jittering in the signal, define a "Hysteresis" that is larger than the expected noise or jittering. After the previous trigger, the signal must exceed this threshold before the next level crossing triggers a new measurement.
8. To skip multiple triggers in a burst, define a "Holdoff" time that must pass between two triggers. Define a holdoff time that is slightly larger than the burst.

To define a trigger sequence

A trigger sequence initiates measurements only when two combined trigger events occur in a defined order.

1. Select "Overview" > ""Trigger/Gate"".
2. Select "Trigger Sequence": "Trigger a->b" (with or without a "Reset on Timeout").
3. Optionally, define a timeout after trigger a ("Reset on Timeout"). If the timeout is exceeded, the trigger sequence is reset and waits for another trigger a.
4. To define a minimum time span between trigger a and trigger b, define a "Trigger b Delay".
5. To start the measurement with a time delay, define a "Trigger Offset".
6. To skip multiple triggers in a burst, define a "Holdoff" time that must pass between trigger b and the next trigger a. Define a holdoff time that is slightly larger than the burst.

7. In the "Trigger Setup a" tab, define the remaining trigger parameters for the first trigger, as described in the previous procedures.
8. In the "Trigger Setup b" tab, define the remaining trigger parameters for the second trigger, as described in the previous procedures.

4.5 Adjusting settings automatically

Access: [Auto Set]

The FSWX can adjust some settings automatically according to the current measurement settings. To do so, it performs a measurement. You can configure this measurement.

For an active external frontend, automatic settings are not available. See "Activate External Frontend / External Frontend Activated" on page 213.

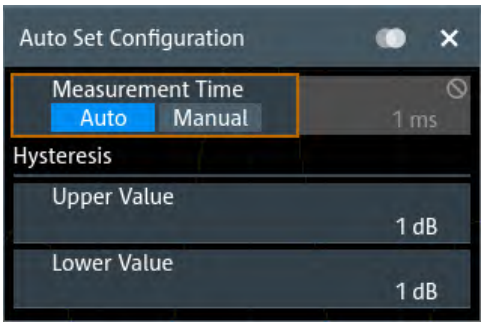
Adjusting settings automatically during triggered measurements

When you select an auto adjust function, the FSWX performs a measurement to determine the optimal settings. If you select an auto adjust function for a triggered measurement, you are asked how you want the FSWX to behave:

- (Default:) The measurement for adjustment waits for the next trigger.
- The measurement for adjustment starts without waiting for a trigger.
  The trigger source is temporarily set to "Free Run". After the measurement is completed, the original trigger source is restored. The trigger level is adjusted as follows for "Power" triggers:
  <Trigger level> = <Reference level> - 15 dB

Remote command:

`[SENSe<ip>:]ADJust:CONFigure:TRIGger` on page 643



Setting the reference level automatically (Perform Auto Level)..... 266
Adjusting the center frequency automatically (Perform Auto Frequency)..... 266
Adjusting all determinable settings automatically (Perform Auto All)..... 266
Measurement Time Mode / Measurement Time..... 266
Upper Level / Lower Level Hysteresis..... 267
Perform Phase & Time Self-Alignment..... 267

Setting the reference level automatically (Perform Auto Level)
To determine the required reference level, the FSWX performs a level measurement on the selected input connector.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

You can change the measurement time for the level measurement, if necessary.

See "Measurement Time Mode / Measurement Time" on page 266.

Remote command:
`[SENSe<ip>:]ADJust:LEVel` on page 644

Adjusting the center frequency automatically (Perform Auto Frequency)
The FSWX adjusts the center frequency automatically.

The optimum center frequency is the frequency with the highest signal-to-noise ratio in the frequency span. As this function uses the signal counter, it is intended for use with sinusoidal signals.

For more information, see Section 5.4.3.2, "Measuring a precise frequency (signal count marker)", on page 1196.

This function is not available during signal tracking.

For more information, see Section 4.3.1.3, "Keeping the center frequency stable - signal tracking", on page 237.

Remote command:
`[SENSe<ip>:]ADJust:FREQuency` on page 644

Adjusting all determinable settings automatically (Perform Auto All)
The FSWX adjusts all possible settings automatically according to the current measurement settings, including:

- "Perform Auto Frequency"
- "Perform Auto Level"

Remote command:
`[SENSe<ip>:]ADJust:ALL` on page 641

Measurement Time Mode / Measurement Time
Defines the duration of the measurement to determine the optimal settings.

In "Auto" mode, the measurement time is reset to the default value.

In "Manual" mode, define the measurement duration in seconds.

Note: The maximum measurement duration depends on the currently selected measurement and the installed (optional) hardware. Thus, the measurement duration that the FSWX actually requires to determine the automatic settings can be shorter than the value you define here.

Remote command:
`[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation:MODE` on page 642
`[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation` on page 641

Upper Level / Lower Level Hysteresis
When the FSWX adjusts the reference level automatically using the "Perform Auto Level" function, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis.

The "Upper Value" defines an upper threshold that the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

The "Lower Value" defines a lower threshold that the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Remote command:
`[SENSe<ip>:]ADJust:CONFigure:HYSTeresis:UPPer` on page 643
`[SENSe<ip>:]ADJust:CONFigure:HYSTeresis:LOWer` on page 642

Perform Phase & Time Self-Alignment
Self-aligns the FSWX signal paths in phase and time. The measured values are then used as a reference for subsequent measurements. Alignment is important for phase-aligned or time-aligned measurements on multiple signal paths, such as phase difference or group delay between different inputs. Phase and time self-alignment requires a successful general self-alignment on the instrument.

This function is only available for applications that support multi-input.

Perform phase and time self-alignment after:
- Switching application instances
- Changing the frequency for any of the RF inputs
- Changing the reference level or other amplitude settings for any of the RF inputs
- Changing the sampling rate or analysis bandwidth

Remote command:
`[SENSe<ip>:]ADJust:PTIMe` on page 644

4.6 Running measurements

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- Starting multiple application instances....268
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- Linking measurements (CrossACT)....271

4.6.1 Starting a measurement

[RUN SINGLE] / Run Single Sweep....267
[Run Cont] / Continuous Sweep....268
Continue Single Sweep....268

[RUN SINGLE] / Run Single Sweep
After triggering, the sweep starts and repeats continuously until the defined number of sweeps are finished.

While the measurement is running, the Run Single key and the "Run Single Sweep" softkey are highlighted. Abort the running measurement by selecting Run Single or "Run Single Sweep" again. The results are not deleted until a new measurement starts.

Note: If the "Sequencer" is active, the [Run Single] key controls the "Sequencer", not individual sweeps. [Run Single] starts the "Sequencer" in single mode.
If the "Sequencer" is off, only the evaluation for the currently displayed application instance is updated.

For details on the "Sequencer", see Section 4.1.1.2, "Running a sequence of measurements - the Sequencer concept", on page 103.

Remote command:
`INITiate<n>[:IMMediate]` on page 647

[Run Cont] / Continuous Sweep
After triggering, the sweep starts and repeats continuously until you press [Run Cont] or "Continuous Sweep" again.

While the measurement is running, the [Run Cont] key and the "Continuous Sweep" softkey are highlighted. The results are not deleted until a new measurement starts.

Note: If the "Sequencer" is active, the [Run Cont] key controls the "Sequencer", not individual sweeps. [Run Cont] starts the "Sequencer" in continuous mode.

Remote command:
`INITiate<n>:CONTinuous` on page 646

Continue Single Sweep
After triggering, repeats the defined number of sweeps, without deleting the trace of the last measurement.

While the measurement is running, the "Continue Single Sweep" softkey and the [Run Single] key are highlighted. Abort the running measurement by selecting the highlighted softkey or key again.

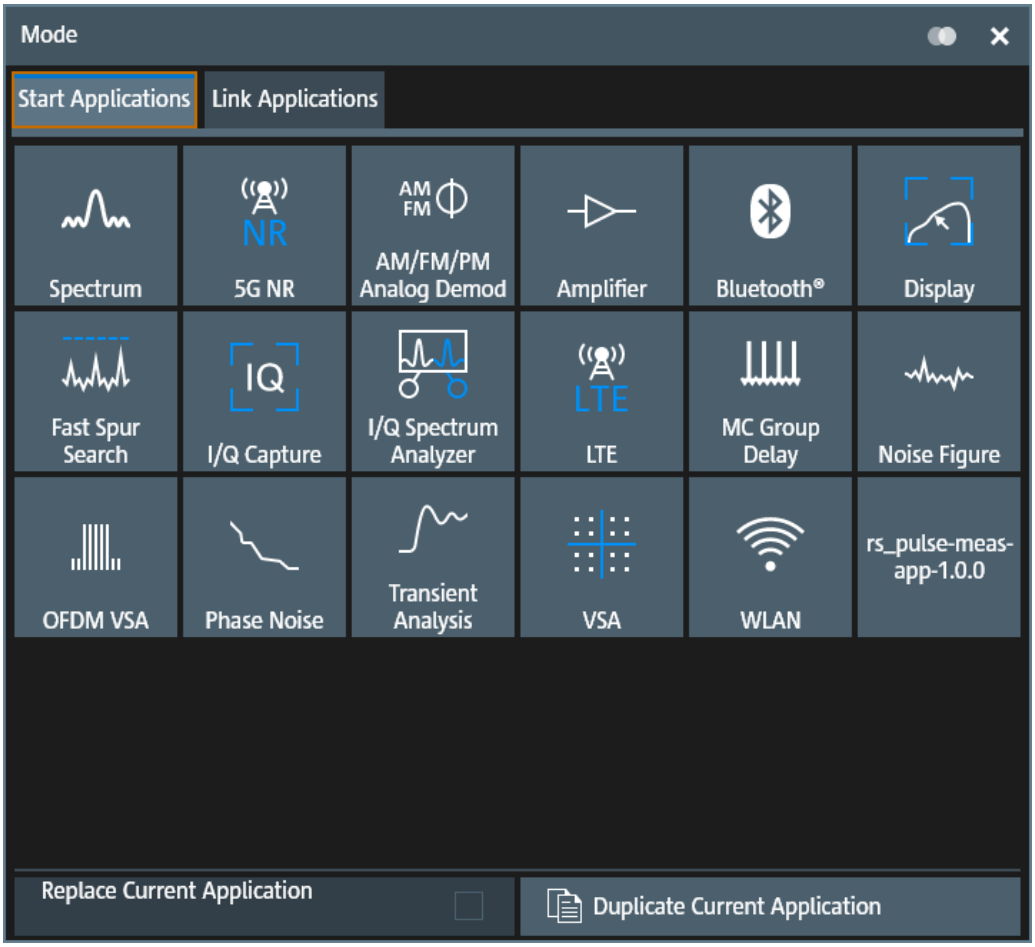
Remote command:
`INITiate<n>:CONMeas` on page 645

4.6.2 Starting multiple application instances

Access: [Mode]

The default application when you start the FSWX is "Spectrum".

For a list of available applications, see Section 4.1.1.3, "Available applications", on page 105.



When you select an application, a new application instance is created which determines the measurement settings for that application. Each application instance is displayed in a separate tab on the screen.

For background information, see Section 4.1.1, "Multiple measurement tasks - application instances", on page 102.

New application instance 269
Replace Current Application 269
Duplicate Current Application 270

New application instance
The selected application is started as a new instance, in a new tab in the display.

Remote command:
`INSTrument:CREate[:NEW]` on page 541
`INSTrument[:SELect]` on page 544

Replace Current Application
If enabled, the application you select replaces the currently active application instance, using the same application tab in the display.

Remote command:
`INSTrument:CREate:REPLace` on page 542

Duplicate Current Application
Duplicates the currently active application instance. A new instance of the same application with the identical measurement settings is started. The name of the new instance is the same as the copied application, extended by a consecutive number (e.g. "Spectrum" -> "Spectrum 2").

Remote command:
`INSTrument:CREate:DUPLicate` on page 541

4.6.3 Running a sequence of measurements

You can only run a single measurement at any time, namely the one in the currently active application instance. However, to perform the configured measurements consecutively, the FSWX provides a "Sequencer" function.

For background information, see Section 4.1.1.2, "Running a sequence of measurements - the Sequencer concept", on page 103.

- Sequencer settings 270
- How to set up the Sequencer 271

4.6.3.1 Sequencer settings



The "Sequencer" menu is available from the toolbar.

Sequencer state 270
Continuous Sequence 270
Run Single Sequence 270
Run Channel Defined Sequence 271

Sequencer state
Enables or disables the "Sequencer". If enabled, the FSWX starts running measurements sequentially according to the selected "Sequencer" mode immediately. The currently selected mode softkey is highlighted blue. During an active "Sequencer" process, the selected mode softkey is highlighted orange.

Remote command:
`SYSTem:SEQuencer` on page 546
`INITiate:SEQuencer:IMMediate` on page 545
`INITiate:SEQuencer:ABORt` on page 544

Continuous Sequence
If enabled, the FSWX runs the measurements in each active application instance one after the other, repeatedly, in the same order, until you stop the "Sequencer".

Run Single Sequence
The FSWX runs each measurement once, until all measurements in all active application instances have been performed.

Run Channel Defined Sequence
First, the FSWX runs a single sequence. Then, it repeats only application instances in continuous sweep mode.

4.6.3.2 How to set up the Sequencer

To run the configured measurements one after the other, the FSWX provides a "Sequencer" function.

1. Configure an application instance for each measurement configuration as required, including the sweep mode.
2. In the toolbar, select the "Sequencer" icon.

   The "Sequencer" menu is displayed.
3. Toggle the "Sequencer" softkey to "On".

   A continuous sequence starts immediately.
4. To change the "Sequencer" mode and start a new sequence immediately, select "Continuous Sequence" on page 270 or "Run Single Sequence" on page 270.

   The measurements configured in the currently active application instances are performed one after the other in the order of the tabs until you stop the "Sequencer". The result displays in the individual application instances are updated as the measurements are performed.

To stop the Sequencer

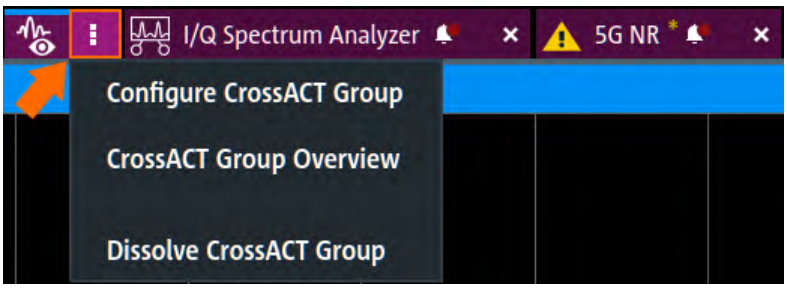
► To stop the "Sequencer" temporarily (not for a channel-defined sequence), press the highlighted [Run Single] or [Run Cont] key. To continue the "Sequencer", press the key again.
To stop the "Sequencer" permanently:

a) Select the "Sequencer" icon on the toolbar.
b) Toggle the "Sequencer" softkey to "Off".

4.6.4 Linking measurements (CrossACT)

"Cross-Application Control and Triggering" ("CrossACT") allows multiple applications to capture data synchronously.

When you create a "Cross-Application Control and Triggering" group, a "CrossACT" group function menu is displayed.



For details on "Cross-Application Control and Triggering", see Section 4.1.2, "Cross-Application Control and Triggering (CrossACT)", on page 108.

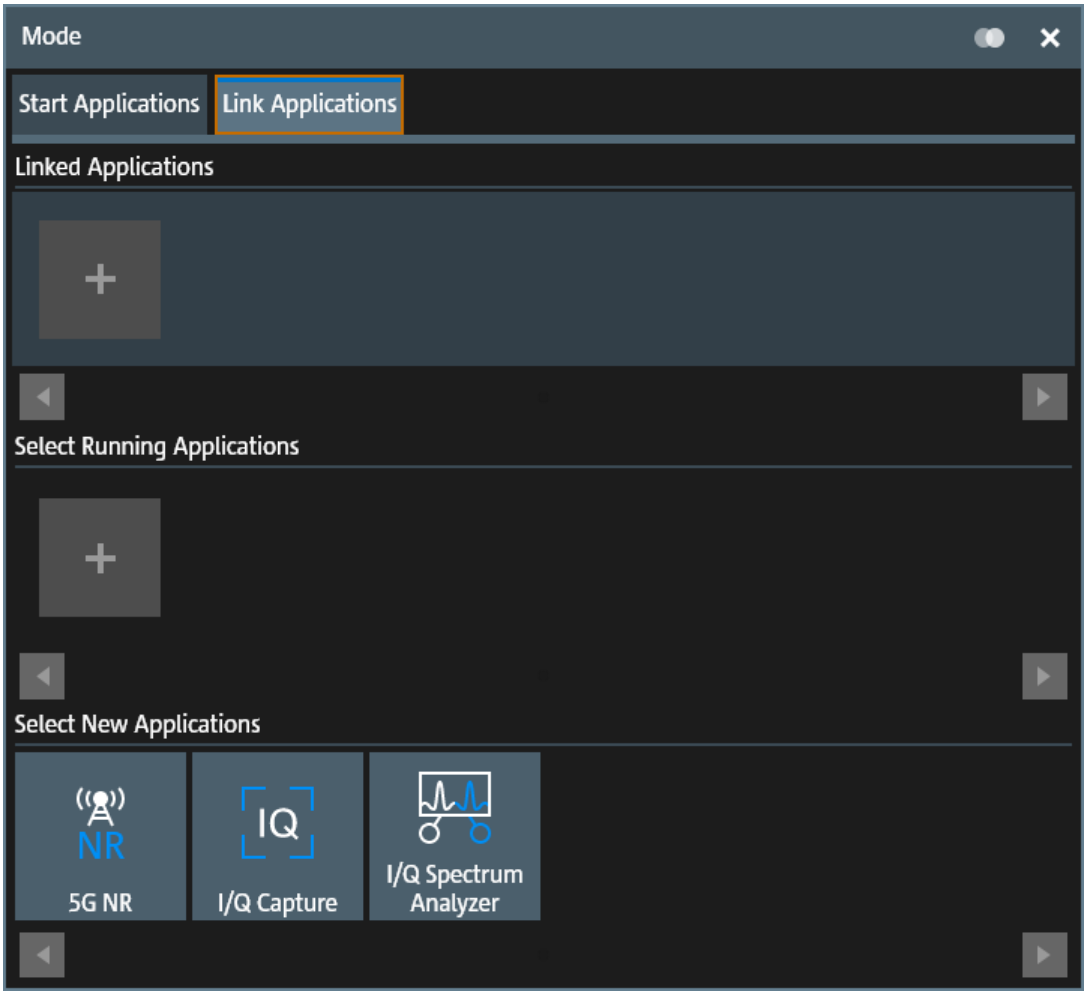
For step-by-step instructions on working with "CrossACT" groups, see Section 4.6.4.3, "How to control and trigger linked applications", on page 275.

4.6.4.1 Configuring a CrossACT Group (Link Applications)

Access: > "Configure CrossACT Group"

Or: [Mode] > "Link Applications"

"Cross-Application Control and Triggering" (or *"CrossACT"*) allows you to link measurements in different applications or application instances.



For a list of supported applications, see Section 4.1.2.4, "Restrictions and limitations of CrossACT", on page 113.

Linked Applications 273
Select Running Applications 274
Select New Applications 274

Linked Applications
Shows the application instances that are currently included in the "CrossACT" group.

Select the "+" icon to add the selected running or new application instances to the "CrossACT" group. At least two applications must be selected to create a "CrossACT" group. The application that is selected first becomes the primary (left-most) application.

Remote command:
To show the group contents:
`INSTrument:LINK<lg>:LIST?` on page 550
To add an application instance:
`INSTrument:LINK<lg>` on page 548
`INSTrument:LINK<lg>:ADD` on page 549

Select Running Applications
Shows the application instances that are currently running and support the "CrossACT" functionality.

Select the "+" icon to remove a selected linked application instance from the "CrossACT" group and make it an independent application.

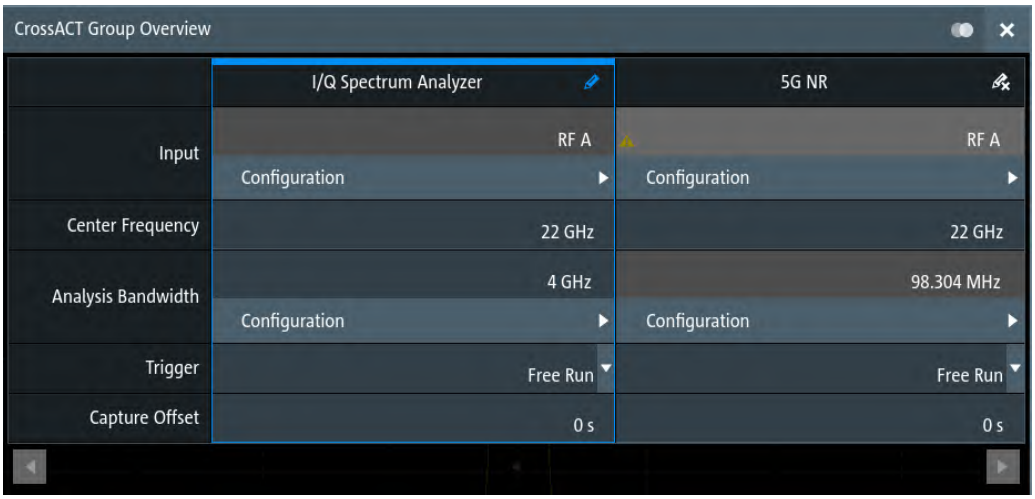
Remote command:
To add an application instance:
`INSTrument:LINK<lg>` on page 548
To remove an application instance:
`INSTrument:LINK<lg>:REMove` on page 551

Select New Applications
Shows the applications that support the "CrossACT" functionality and can be added to the "CrossACT" group.

Remote command:
`INSTrument:LINK<lg>` on page 548

4.6.4.2 CrossACT Group Overview

The "CrossACT Group Overview" provides an overview of the main parameters for each application instance in the "CrossACT" group. Select a parameter to edit it directly, or "Configuration" to open the dialog for the corresponding application instance.



Note that when you initially create a "CrossACT" group, the primary application is the starting point for the "Trigger" parameter and the conflict check. See "Conflicting parameters in CrossACT" on page 113.

The "Trigger" parameters are coupled for all application instances in the "CrossACT" group. For all but one application in the group, the "Trigger" is set to "Follow", as they rely on another application for their trigger. All other parameters are independent.

For details, see Section 4.1.2.3, "Processing CrossACT measurements", on page 111.

4.6.4.3 How to control and trigger linked applications

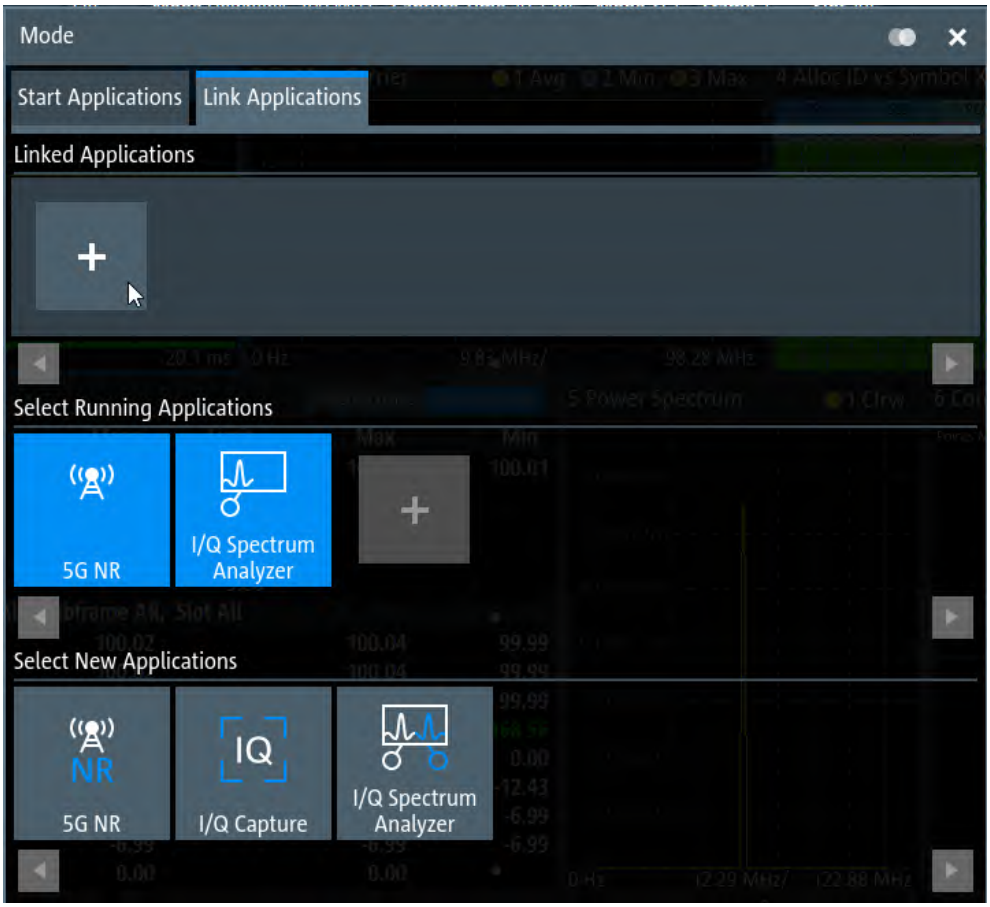
The following step-by-step instructions demonstrate how to use "Cross-Application Control and Triggering". For details on the individual settings and functions, see Section 4.6.4.1, "Configuring a CrossACT Group (Link Applications)", on page 272.

To link measurements via the Mode dialog

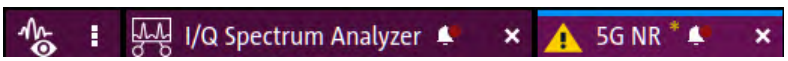
1. Select [Mode] > "Link Applications".

   A dialog box opens that contains all applications that support "CrossACT" and are currently available on your FSWX.

2. Select the application that you want to control the "CrossACT" group with.
3. Select at least one more running or new application.
4. In the "Linked Applications" area, select the "+" icon.



A colored area encloses the selected tabs in a "CrossACT" group, preceded by the "CrossACT" icon.



5. Repeat step 3 and step 4 to add further applications to the "CrossACT" group.

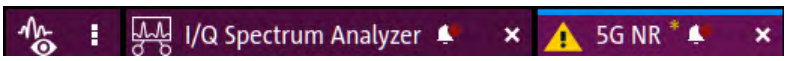
   The colored area is extended to include all applications in the group.

To link measurements via drag&drop

1. Determine two active applications that support "CrossACT", for example "I/Q Spectrum Analyzer" and "5G NR".
2. Select the second application tab and drag it over the first application tab until an orange area appears, then drop it on the left or the right.



   The two applications are grouped in a "CrossACT" group. The application on the left is the primary application.
   A colored area encloses the two tabs in the "CrossACT" group, preceded by the "CrossACT" visualization icon.

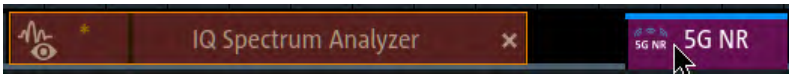


3. You can drag further applications that support the function into the "CrossACT" group. However, note the Section 4.1.2.4, "Restrictions and limitations of CrossACT", on page 113.

   The colored area is extended to include all applications in the group.

To remove an application instance from a CrossACT group

► Drag the application tab outside the colored area.



   The application instance becomes a stand-alone instance that is not linked to any others.
   If the remaining group contains only one application, the "CrossACT" group is dissolved and the colored area is removed.

To dissolve a CrossACT group

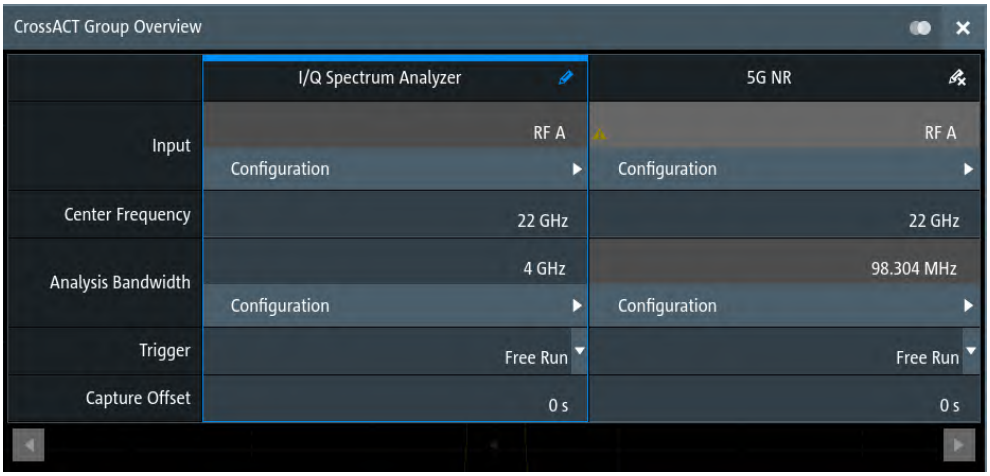
When you remove the second to last application and the "CrossACT" group only consists of a single application, the group is automatically dissolved. You can also dissolve the group without removing the applications individually.

► Select the "CrossACT" function menu > "Dissolve CrossACT Group".

To configure a CrossACT measurement

1. Select the "CrossACT" function menu > "CrossACT Group Overview".

   The "CrossACT Group Overview" is displayed. It provides an overview of the main parameters for each application instance in the "CrossACT" group.



2. Select a parameter to edit it directly, or to open the configuration dialog for the corresponding application instance.

   If you change the trigger source for one application instance, it is used for the whole "CrossACT" group. For all other applications in the group, the "Trigger" is set to "Follow".
   Any other parameters of the application instances in the group are not changed when you change the setting for one member.

4.7 Laying out the result display

You can evaluate measurement results in many different ways, for example graphically, as a summary table or statistical evaluations. Each type of evaluation is displayed in a separate window in the application tab. Each application instance, that is: each tab, can display up to 16 individual windows. To arrange the diagrams and tables on the screen, the Rohde & Schwarz "Display Configuration" function helps you find the target position simply and quickly.

For information on how to lay out the result displays using the "Display Configuration" function, see Section 3.6.3, "Displaying results", on page 77.

For details on evaluation methods, see the individual application manuals.

4.8 Visual aids for graphical results

Graphical results are powerful, but can become complex. Some visual aids can help you analyze the data more easily.

- Trace settings determine which results are displayed.
- Markers can highlight individual results.
- Peak searches determine maximum or minimum signal values quickly.
- Lines can help you evaluate the results at a glance.
- Zoom functions show specific details of the measurement results.

- Trace configuration 278
- Marker usage 304
- Peak value search 312
- Display lines for fixed values 314
- Limit lines for value ranges 318
- Zoomed displays 333

4.8.1 Trace configuration

A trace is a collection of measured data points. The trace settings determine how the measured data is analyzed and displayed on the screen.

- Impact of the trace settings 278
- How to configure a standard trace 299
- How to configure the RMS X-Corr trace detector 300
- How to display and configure a spectrogram 300
- How to configure the color mapping 302

4.8.1.1 Impact of the trace settings

Some background knowledge on traces is provided here for a better understanding of the required configuration settings.

- Mapping samples to sweep points with the trace detector 278
- X-value of the sweep point 283
- Analyzing several traces - trace mode 285
- How many traces are averaged - sweep count + sweep mode 286
- How trace data is averaged - the averaging mode 287
- Removing anomalies: Trace smoothing 288
- Detecting changes over time - persistence and density 289
- Working with spectrograms 290

Mapping samples to sweep points with the trace detector

A trace displays the values that the FSWX measures at the sweep points (also known as measurement points in some applications). However, the number of samples that the FSWX takes during a measurement can be much larger than the number of sweep points that the application displays in the measurement trace.

Example:

Assume the following measurement parameters:

- Sample rate: 32 Msample/s
- Sweep points: 1000
- Measurement time: 100 ms
- Span: 5 GHz

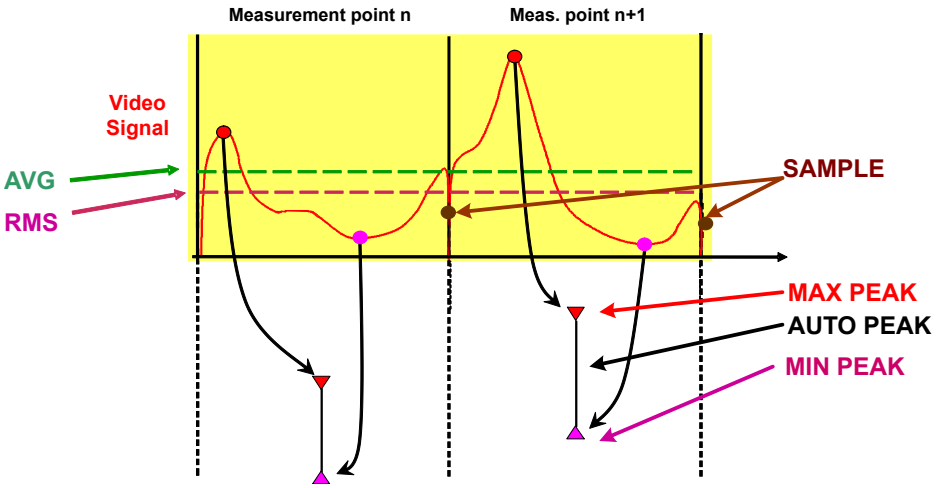
During a single measurement, 3.2 * 10^6 samples are collected and distributed to 1000 sweep points, i.e. 3200 samples are collected per sweep point. For each sweep point, the application analyzes the measured data for a frequency span of 5 MHz (span/ <sweep points>).

Note that if you increase the number of sweep points, the frequency span analyzed for each point in the trace decreases. The trace becomes more reliable, and the analyzed results become more accurate. However, for detectors that average the samples within the span, the trace becomes less stable because fewer samples are averaged.

For details, see Section 4.3.3.8, "How much data is measured: sweep points and sweep count", on page 246.

Obviously, the application must reduce the data to determine which of the samples are displayed for each sweep point. Reducing the data is the trace detector's task. The trace detector can analyze the measured data using various methods.

For each frequency point in the trace, the application displays the result of the selected detector for that sweep point.



You can define the trace detector to be used for the individual traces manually, or the FSWX can select the appropriate detector automatically.

The detectors of the FSWX are purely digital. All detectors work in parallel in the background, which means that the measurement speed is independent of the detector combination used for different traces.

However, select a measurement time that is sufficient for the detector that requires the longest measurement time.

Auto detector

In auto mode, the FSWX selects the appropriate detector according to the defined trace mode and average mode:

Trace mode	Detector
"Clear Write"	Auto peak
"Max Hold"	Positive peak
"Min Hold"	Negative peak
"Average"	Sample peak (for average mode "Power": RMS)
"View"	–
"Blank"	–

The trace information indicates the detector used for the specific trace by an abbreviation. Not all detector types are supported by all applications available for the FSWX.

Table 4-23: Detector types

Detector	Abbrev.
"Positive Peak"	"Pk"
"Negative Peak"	"Mi"
"Auto Peak"	"Ap"
"RMS"	"Rm"
"RMS X-Corr"	"RX"
"Average"	"Av"
"Sample"	"Sa"

For background information on the "RMS", see Section 4.1.5.2, "RMS X-Corr detector", on page 161.

Measurement time

The measurement time defines how long the FSWX measures the signal at the individual frequencies. Each detector needs a different period of time to charge and discharge fully. The individual requirements on the measurement time are described for each detector.

- Positive peak and negative peak detector 281
- Auto peak detector 281
- RMS detector 281
- Average detector 282
- Sample detector 283

Positive peak and negative peak detector

The "Positive Peak" detector determines the largest of all positive peak values that are measured at the individual sweep points and are combined in one sample point.

The "Negative Peak" detector determines the smallest of all negative peak values that are measured at the individual sweep points and are combined in one sample point.

Tips regarding measurement time:

- For unmodulated signals, you can use the shortest possible measurement time.
- For pulsed signals, the measurement time must be longer than the expected pulse length. The measurement time must cover at least one pulse.

Auto peak detector

The "Auto Peak" detector combines the "Positive peak and negative peak detector" on page 281. The maximum and the minimum values determined for each sample point are displayed.

Available in the "Spectrum" application, but not for the "Spectrum Emission Mask" measurement.

RMS detector

The "RMS" detector calculates the root mean square of all samples combined in a sweep point. The detector uses the whole IF envelope to calculate the power for each sweep point. The IF envelope is digitized using a sample rate which is at least five times the selected resolution bandwidth. Based on the sample values, the detector calculates the power for each sweep point using the following formula:

$$P_{RMS} = \frac{U_{RMS}^2}{R} = \frac{\left(\sqrt{\frac{1}{N} * \sum_{i=1}^{N} s_i^2}\right)^2}{R} = \frac{1}{N * R} * \sum_{i=1}^{N} s_i^2$$

Where:

- P_{RMS} = power represented by a sweep point
- N = number of A/D converter values (samples) per sweep point
- R = electrical impedance
- s_i = linear digitized video voltage at the output of the A/D converter

For logarithmic scaling, after the power has been calculated, the application converts the power units into decibels and displays the value for a sweep point.

$$P(dBm) = 30dBm + 10 \cdot log_{10} \cdot P_{RMS} = 30dBm + 10 \cdot log_{10}(\frac{1}{N * R} * \sum_{i=1}^{N} s_i^2)$$

Where:

- P (dB) = logarithmic power represented by a sweep point

Each sweep point thus corresponds to the root mean square of the measured values combined in the sweep point.

The RMS detector supplies the power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal). The detector does not require correction factors to measure the power of the different signal classes, as other detectors do.

Tips regarding measurement time:

- For unmodulated signals, you can use the shortest possible measurement time.
- For modulated signals, the measurement time must be long enough to make sure that the averaging considers all variations due to the modulation characteristics of the signal.
- For pulsed signals, the measurement time must be long enough to capture a sufficient number of pulses. For averaging, a sufficient number of pulses is greater than 10.

The RMS detector and the video bandwidth

When using the "RMS" detector in the "Spectrum" application, the FSWX bypasses the video bandwidth (VBW) hardware. The VBW settings become unavailable.

Video filtering together with the RMS detector would result in logarithmic averaging.

However, if the application determines the measurement time automatically, it still considers the VBW. The application sets the measurement time to the minimum time required by the current VBW setting. Thus, it achieves a similar averaging effect, while providing a correct RMS power result.

Average detector

The "Average" detector calculates the linear average of all samples combined in a sweep point.

The "Average" detector averages the linear video voltage (the envelope of the IF signal) over the measurement time. Averaging is digital. The detector sums up the digitized values of the video voltage, and divides the sum by the number of samples at the end of the measurement time. The result corresponds to filtering with a rectangular window in the time domain, and to filtering with sin x/x characteristic in the frequency domain. For linear display, the average value is displayed.

$$P_{Avg} = \frac{U_{Avg}^2}{R} = \frac{1}{R} * \left(\frac{1}{N} * \sum_{i=1}^{N} s_i \right)^2$$

Where:

- P_{AVG} = power represented by a sweep point
- N = number of A/D converter values per sweep point
- R = electrical impedance
- s_i = linear digitized video voltage at the output of the A/D converter

For logarithmic scaling, after calculating the power, the application converts the power units into decibels, and displays the value as a sweep point.

$$P(dBm) = 30dBm+10\cdot log_{10}\cdot P_{Avg} = 30dBm+10\cdot log_{10}(\frac{1}{R}*\left(\frac{1}{N}*\sum_{i=1}^{N} s_i\right)^2)$$

Where:

- P (dBm) = logarithmic power represented by a sweep point

Each sweep point thus corresponds to the average of the measured values combined in the sweep point.

The average detector supplies the average value of the signal, irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal).

Tips regarding measurement time:

- For unmodulated signals, you can use the shortest possible measurement time.
- For modulated signals, the measurement time must be long enough to make sure that the averaging considers all variations due to the modulation characteristics of the signal.
- For pulsed signals, the measurement time must be long enough to capture a sufficient number of pulses. For averaging, a sufficient number of pulses is greater than 10.

Sample detector

The "Sample" detector selects and displays a single sample (always the first or always the last) from all samples that are combined in the sweep point. All other measured values for the sample point are ignored.

X-value of the sweep point

As described in "Mapping samples to sweep points with the trace detector" on page 278, the number of samples taken during a sweep can be much larger than the number of sweep points that are displayed in the measurement trace.

To determine the x-value of the sweep point, two different methods are available:

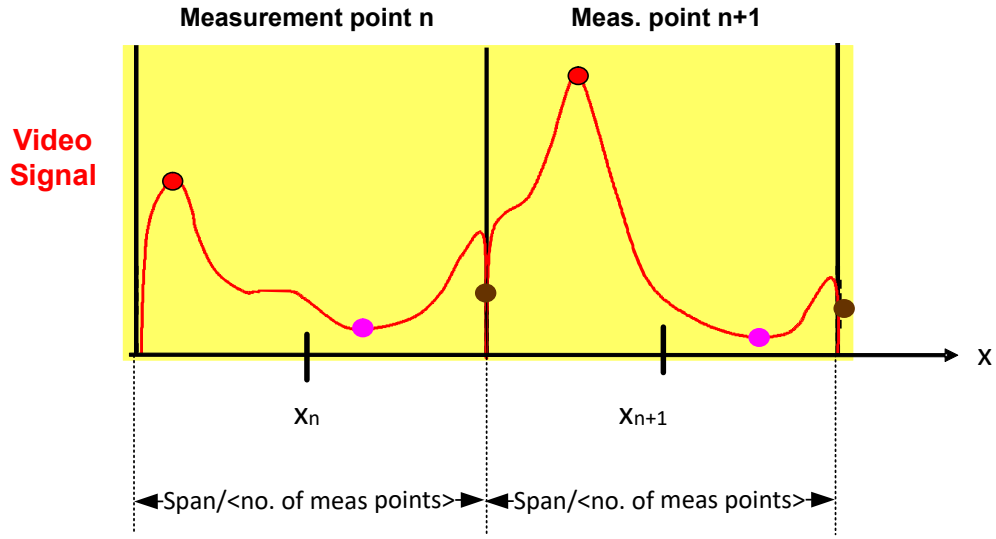
- Start/stop
- Bin-centered

Start/stop

The default (legacy) method for trace values in the frequency domain. The x-value of the first sweep point corresponds to the starting point of the full measurement span. The x-value of the last sweep point corresponds to the endpoint of the full measurement span. All other sweep points are divided evenly between the first and last points. The distance between two sweep points is span/(<no_sweep_points> -1).

Bin-centered

The default method for all marker values. The full measurement span is divided by the number of sweep points. The result is the span that is evaluated for an individual sweep point, also referred to as a *bin*. The x-value of the sweep point is then defined as the x-value at the center of the bin (bin/2).



Using the bin-centered method, the first and last x-values of the trace are not identical to the exact starting and endpoint of the measurement span. The distance between two sweep points corresponds to the width of the bin, or span/(<no_sweep_points>).

Marker values are always determined using the bin-centered method. Markers placed on the first and last x-values of the measured span indicate the same results as the first and last trace point.

Example:

Assume the following measurement parameters:

- Start frequency: 1.000 GHz
- Stop frequency: 6.000 GHz
- => Span: 5 GHz
- Sweep points: 1000
- =>bin: 5 MHz (span/<sweep points>)

The first trace point is displayed at (<f_{start}> + bin/2) = 1.0025 GHz.

The last trace point is displayed at (<f_{stop}> - bin/2) = 5.9975 GHz.

A marker placed at 1.000 GHz indicates the same result as a marker placed at 1.0025 GHz, since no other value is available.

For trace values in the frequency domain, you can select which method is used to determine the x-values in the frequency domain, namely:

- In the result displays
- When exporting traces
- For the `TRACe:DATA:X?` command

Note the possible minor discrepancy between marker values and trace values using the start/stop method.

Analyzing several traces - trace mode

If the FSWX performs several sweeps one after the other, or sweeps continuously, the trace mode determines how the application processes the data for subsequent traces. After each sweep, the trace mode determines whether:

- The data is frozen ("View")
- The data is hidden ("Blank")
- The data is replaced by new values ("Clear Write")
- The data is replaced selectively ("Max Hold", "Min Hold", "Average")

Each time you change the trace mode, the selected trace memory is cleared.

The trace mode also determines the detector type if the detector is set automatically, see "Mapping samples to sweep points with the trace detector" on page 278.

The FSWX supports the following trace modes:

Clear/write....285
Max Hold....285
Min Hold....285
Average....286
View....286
Density....286
Blank....286

Clear/write
Overwrite mode: the application overwrites the trace for each sweep (default).

You can select all available detectors.

Max Hold
The application determines the maximum value over several measurements and displays the result. The application saves the sweep result in the trace memory only if the new value is greater than the previous one.

The "Detector" is automatically set to "Positive Peak".

This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up with each sweep until all signal components are detected in a kind of envelope.

This mode is not available for statistic measurements.

Min Hold
The application determines the minimum value from several measurements and displays the result. The application saves the sweep result in the trace memory only if the new value is lower than the previous one.

The "Detector" is automatically set to "Negative Peak".

This mode is useful, for example, to make an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed, whereas you can detect a CW signal by its constant level.

This mode is not available for statistic measurements.

Average
The application determines the average over several measurements and displays the result.

The "Sweep/Average Count" determines the number of averaging procedures.

The "Detector" is automatically set to "Sample".

This mode is not available for statistic measurements.

View
The application freezes and displays the current content of the trace memory.

If a trace is frozen, any measurement settings you change, apart from scaling settings, do not affect the displayed trace. A yellow asterisk on the tab label (Spectrum 2*) indicates that the displayed trace no longer matches the current measurement settings.

If you change any parameters that affect the scaling of the diagram axes, the FSWX automatically adapts the trace data to the changed display range. Thus, you can zoom into the diagram after the measurement to show details of the trace.

Density
The statistical frequency of a particular trace value is color-coded. Thus, you can detect rare or frequent effects in the signal. Only one trace per window can use the "Density" detector. The density is calculated based on the "Clear/write" trace. You cannot enable an additional "Clear/write" trace in the same window.

When you enable a "Density" trace, the Persistence option is automatically also enabled for the trace.

For details, see "Detecting changes over time - persistence and density" on page 289.

Blank
The FSWX removes the selected trace from the display.

How many traces are averaged - sweep count + sweep mode

In "Average" trace mode, the sweep count and sweep mode determine how many traces are averaged. The more traces are averaged, the smoother the trace is likely to become.

The algorithm for averaging traces depends on the sweep mode and sweep count.

- **Sweep count = 0** (default)
  - In "Continuous" sweep mode, a continuous average is calculated for 10 sweeps, according to the following formula:

$$Trace = \frac{9 * Trace_{old} + MeasValue}{10}$$

Figure 4-36: Equation 1

Due to the weighting between the current trace and the average trace, past values have practically no influence on the displayed trace after about 10 sweeps. With this setting, signal noise is effectively reduced without the need for restarting the averaging process after a change of the signal.

– In "Single" sweep mode, the current trace is averaged with the previously stored averaged trace. No averaging is carried out for the first sweep but the measured value is stored in the trace memory. The next time a sweep is performed, the trace average is calculated according to the following formula:

$$Trace = \frac{Trace_{old} + MeasValue}{2}$$

The averaged trace is then stored in the trace memory.

- **Sweep count = 1**
  The currently measured trace is displayed and stored in the trace memory. No averaging is performed.
- **Sweep count > 1**
  For both "Single" sweep mode and "Continuous" sweep mode, averaging takes place over the selected number of sweeps. In this case the displayed trace is determined during averaging according to the following formula:

$$Trace_n = \frac{1}{n} \cdot \left[\sum_{i=1}^{n-1} (T_i) + MeasValue_n \right]$$

Figure 4-37: Equation 2

Where n is the number of the current sweep (n = 2 ... sweep count)
The application does not average the first sweep, but stores the measured values in the trace memory. With increasing n, the displayed trace becomes increasingly smoother, since more individual sweeps are averaged.
After the selected number of sweeps, the application saves the average trace in the trace memory. Until this number of sweeps is reached, the application displays a preliminary average. When the averaging length defined by the sweep count is reached, the application continues to average in continuous sweep mode or for "Continuous Single Sweep", according to the following formula:

$$Trace = \frac{(N-1) * Trace_{old} + MeasValue}{N}$$

Where N is the sweep count

How trace data is averaged - the averaging mode

When the trace is averaged over several sweeps (Trace mode: "Average"), the application can use different methods to determine the trace average.

With logarithmic averaging, the dB values of the display voltage are averaged or subtracted from each other with trace mathematical functions.

With linear or power averaging, the level values in dB are converted into linear voltages or powers before averaging. Voltage or power values are averaged or offset against each other and reconverted into level values.

For stationary signals, the two methods yield the same result.

Logarithmic averaging is recommended to make sine-wave signals clearly visible against noise. With this type of averaging, noise suppression is improved while the sine-wave signals remain unchanged.

For noise or pseudo-noise signals, the positive peak amplitudes are decreased in logarithmic averaging due to the characteristic involved. The negative peak values are increased relative to the average value. If the distorted amplitude distribution is averaged, a value is obtained that is smaller than the actual average value. The difference is -2.5 dB.

This low average value is usually corrected in noise power measurements by a 2.5 dB factor. Therefore the FSWX offers the selection of linear averaging. The trace data is linearized before averaging, then averaged and logarithmized again for display on the screen. The average value is always displayed correctly irrespective of the signal characteristic.

Removing anomalies: Trace smoothing

A video bandwidth filter (VBW) is a hardware-based method of smoothing the trace. However, other sweep and bandwidth settings can be coupled to the VBW. For some signals, possibly you cannot select a VBW to obtain the required smoothing effect. Therefore, a software-based trace smoothing function is also available.

(Software-based) **smoothing** is a way to remove anomalies visually in the trace that can distort the results. The smoothing process is based on a moving average over the complete measurement range. The number of samples included in the averaging process (the *aperture* size) is variable and is a percentage of all samples that the trace consists of.

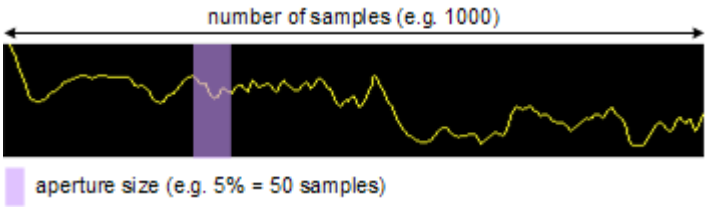


Figure 4-38: Sample size included in trace smoothing

The application smoothes the trace only after the measurement has been finished and the data has been analyzed and written to a trace. Thus, smoothing is just an enhancement of the trace display, not of the data itself. Smoothing is always applied after averaging the trace, as averaging happens during the measurement itself.

Effects of smoothing on postprocessing functions

Note that in Spectrum mode, all functions performed after the sweep, such as limit checks, markers, or channel power measurements, are based on the smoothed trace data. Thus, the results differ from results based on the original trace.

You can turn trace smoothing on and off for all traces individually and compare, for example, the raw and the smooth trace.

Linear smoothing is based on the following algorithm:

$$y'(s)=\frac{1}{n}\left(\sum_{x=s-\frac{n-1}{2}}^{x=s+\frac{n-1}{2}} y(x)\right)$$

Equation 4-2: Linear trace smoothing

With:

s = sample number

y(s) = group delay, "magnitude" or "gain"

x = sample offset from s

n = aperture size

Detecting changes over time - persistence and density

Persistence and density describe the effect of previous traces remaining visible in the display before fading away.

Historical term

The term persistence has its origins in cathode ray tube devices (CRTs). It describes the time period one point on the display stays illuminated after it has been lit by the cathode ray. The higher the persistence, the longer you could observe the illuminated point on the display.

For a signal with constant frequency and level characteristics, you cannot see the effects of persistence on the trace. As soon as the power or frequency of a signal changes slightly, however, the effect of persistence becomes visible through color changes or changes in the shape of the trace.

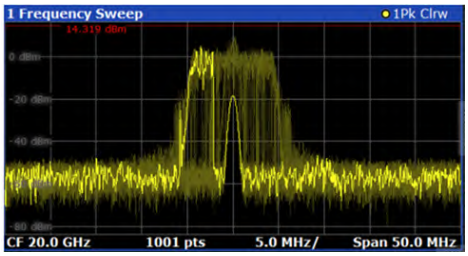
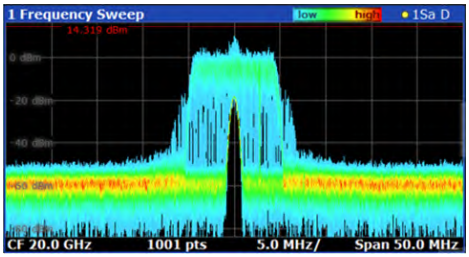
You can hide or show the effect of persistency for individual traces.

Persistence vs density

The persistence option keeps trace values from previous sweeps visible using different shades of the original trace color. Thus, you can recognize short events more easily. Persistence is also available for averaged traces or when using the "RMS X-Corr" detector.

The density mode provides a color-coding of how often a particular trace point occurs in multiple sweeps. Density mode is based on the "Clear Write" trace. The color-coding legend is indicated in the diagram header. The range is from low occurrence to high occurrence, with no specific values provided.

In both cases, the number of sweeps to consider is defined by the "Sweep Count". For "Sweep Count"=0, the values from all sweeps in a continuous sweep sequence are considered. In single sweep mode, no persistence is displayed.

Persistence	Density
	

When you enable a "Density" trace, the "Persistence" option is automatically also enabled for the trace. However, you can enable the "Persistency" option for other trace modes, as well. The "Persistence" option is not supported for the "Auto Peak" detector.

Evaluating persistency diagrams

You can use all zoom functions in the persistency diagrams.

Markers are only available for the most recent trace, not on persistent trace values. When you enable a marker or use marker functions, they are automatically placed on the most recent trace.

You can create screenshots of the persistency diagrams. However, you cannot store or export the trace values for persistent traces.

Restrictions and limitations

The persistency and density traces provide a general overview of rare effects in the signal. They do not provide a numeric value of occurrences for individual trace values. You cannot determine the variation of the data for an individual sweep point in a single sweep. In particular when using a "Sample" detector, rare occurrences of individual data values are not always detected.

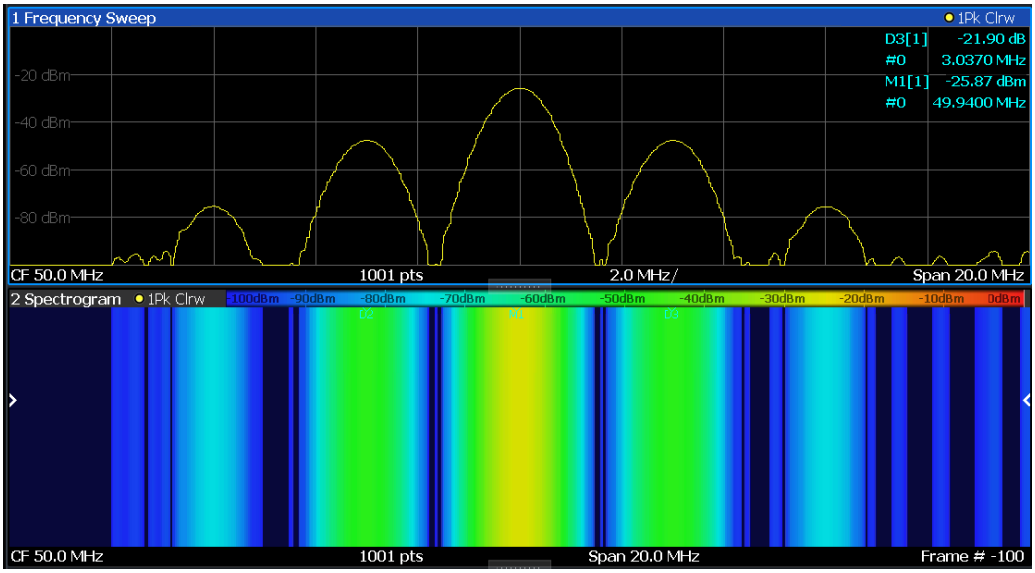
Working with spectrograms

In addition to the standard "level versus frequency" or "level versus time" traces, the FSWX also provides a spectrogram display of the measured data.

A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. A third dimension, the power level, is indicated by different colors. Thus, you can see how the strength of the signal varies over time for different frequencies.

The FSWX also provides three-dimensional spectrograms, which are described in "Three-dimensional spectrograms" on page 294. Most basic information described in the following sections applies similarly to both two- and three-dimensional spectrograms.

Example:



In this example, you see the spectrogram for the calibration signal of the FSWX, compared to the standard spectrum display. Since the signal does not change over time, the color of the frequency levels does not change over time, i.e. vertically. The legend above the spectrogram display describes the power levels that the colors represent.

Result display

The spectrogram result can consist of the following elements:

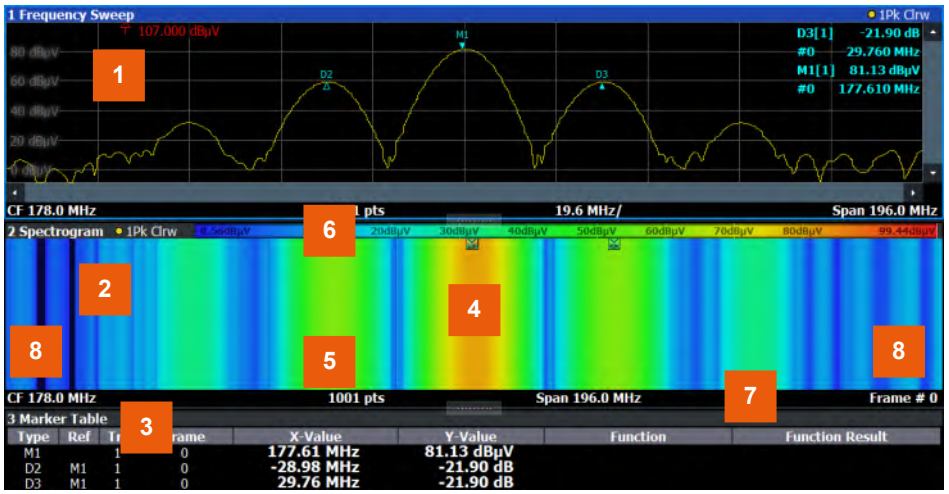


Figure 4-39: Screen layout of the spectrogram result display

1 = Spectrum result display
2 = Spectrogram result display
3 = Marker list
4 = Marker

5 = Delta marker
6 = Color map
7 = Timestamp / frame number
8 = Current frame indicator

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- Markers in the spectrogram 293
- Three-dimensional spectrograms 294
- Color maps 296

Timeframes

The time information in the spectrogram is displayed vertically, along the y-axis. Each line (or trace) of the y-axis represents one or more captured sweeps and is called a **timeframe** or simply "frame". As with common spectrum traces, a detector combines several measured values in one sweep point. See "Mapping samples to sweep points with the trace detector" on page 278.

Frames are sorted in chronological order, beginning with the most recently recorded frame at the top of the diagram (frame number 0). With the next sweep, the previous frame moves further down in the diagram, until the maximum number of captured frames is reached. The application updates the display continuously during the measurement, and stores the measured trace data in the history buffer. Spectrogram displays continue even after single measurements, unless you clear them manually.

In three-dimensional spectrograms, frames are displayed vertically. The most recently recorded frame (frame 0) is added at the front of the display (in the default position). For more information, see "Three-dimensional spectrograms" on page 294.

The maximum number of frames that you can capture is summarized in Table 4-24.

Table 4-24: Correlation between number of sweep points and number of frames stored in the history buffer

Sweep points	Max. history depth
≤1250	20000
2001	12488
4001	6247
8.001	3124
16.001	1562
32.001	781

You cannot configure the scaling of the time axis (y-axis). However, you can enlarge the spectrogram display by maximizing the window using the "Split/Maximize" key.



Frame analysis - Frame count vs. sweep count

As described for standard spectrum sweeps, the sweep count defines how many sweeps to analyze to create a single trace. Thus, for a trace in "Average" mode, for example, a sweep count of 10 means that the application averages 10 sweeps to create a single trace, or frame.

The *frame count* determines how many frames the application plots during a single sweep measurement (as opposed to a continuous sweep). For a frame count of 2, for example, the application plots 2 frames during each single sweep. For continuous sweep mode, the frame count is irrelevant; the application plots one frame per sweep until the measurement stops.

If you combine the sweep count and frame count settings in our example, the application performs 20 sweeps for each single sweep measurement. The first 10 are averaged to create the first frame, the next 10 are averaged to create the second frame.

Obviously, increasing the sweep count increases the accuracy of the individual traces. Increasing the frame count increases the number of traces in the diagram.

Especially for "Average" or "Min Hold" and "Max Hold" trace modes, the number of sweeps that the application analyzes to create a single trace affects the accuracy of the results. Thus, you can also define whether the results from frames in previous traces are considered in the analysis for each new trace ("Continue Frame").

Tracking absolute time - timestamps

Instead of the frame count, the application can also display the absolute time (that is: a *timestamp*) at which it captured a frame. While the measurement is running, the timestamp shows the system time. In single sweep mode or if you stop the sweep, the timestamp shows the time and date at the end of the sweep. Thus, you can identify the individual frames by their timestamp or their frame count.

When active, the timestamp replaces the display of the frame number in the diagram footer (see Figure 4-39).

Displaying individual frames

The spectrogram diagram contains all stored frames since it was last cleared. Arrows on the left and right border of the spectrogram indicate the currently selected frame. The spectrum diagram always displays the spectrum for the currently selected frame.

The diagram footer indicates the current frame number, or a timestamp, if activated. The current frame, displayed at the top of the diagram, is frame number 0. Older frames further down in the diagram are indicated by a negative index, e.g. *-10*. You can display the spectrum diagram of a previous frame by changing the current frame number.

Markers in the spectrogram

Markers and delta markers are shaped like diamonds in the spectrogram. They only appear in the spectrogram if the marker position is inside the visible area of the spectrogram. If more than two markers are active, the marker values are displayed in a separate marker table.

Markers in three-dimensional spectrograms are slightly different and are described in "Markers in three-dimensional spectrograms" on page 296.

In the spectrum result display, the markers are slightly different if a spectrogram is active.



Figure 4-40: Spectrum result display

1 = Markers and their frequency and level values
2 = The frame number indicates the position of the marker in time

In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. You can assign each to a different frame. Therefore, in addition to the frequency, you also define the frame number when activating a new marker. If you do not specify a frame number, the marker is positioned on the currently selected frame. All markers that are positioned on a visible frame are visible. Special search functions are available for spectrogram markers.

In the "Spectrum" result display, only the markers positioned on the currently selected frame are visible. In "Continuous Sweep" mode, only markers positioned on frame 0 are visible. To view markers that are positioned on a frame other than frame 0 in the "Spectrum" result display, you must stop the measurement and select the corresponding frame.

Three-dimensional spectrograms

A common spectrogram shows the frequency on the x-axis, while the y-axis shows the time (in frames). The power level is indicated by different colors of the 2-dimensional points.

In the 3-dimensional spectrogram, the power is indicated by a value in a third dimension, the z-axis. The color mapping is maintained for the point in the 3-dimensional result display.

This new display provides an even better overview of how the strength of the signal varies over time for different frequencies.

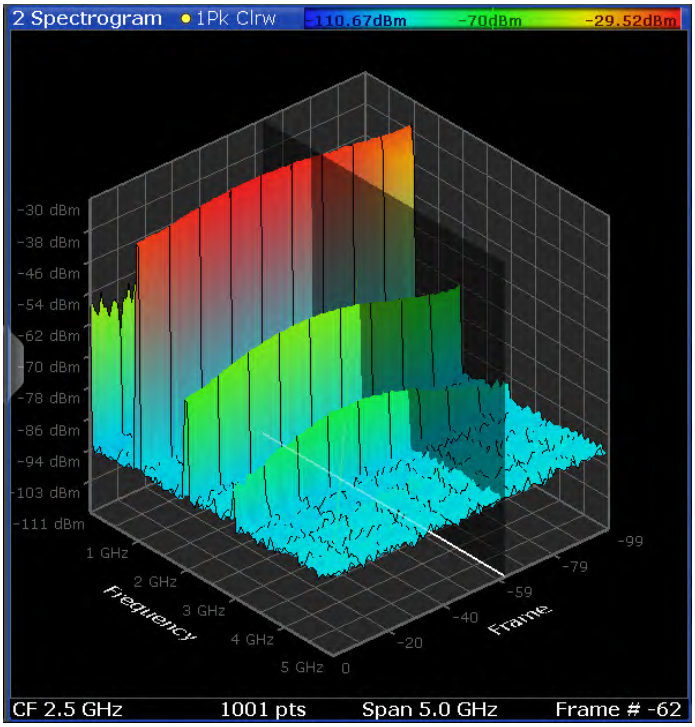


Figure 4-41: Three-dimensional spectrogram

You can define the number of frames displayed on the time (y-) axis. For 2-dimensional spectrograms, the number of frames is determined automatically according to the size of the window. All other spectrogram settings are identical for 3-dimensional and 2-dimensional spectrograms.

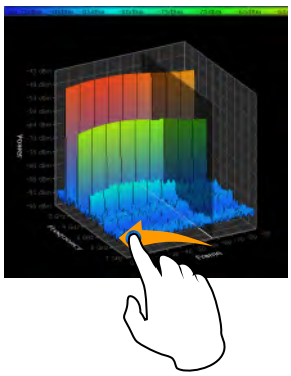
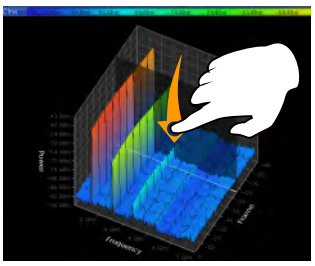
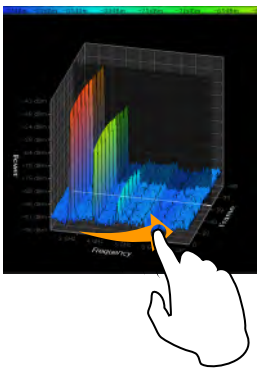
When the measurement stops or is completed, the currently selected frame is indicated by a gray vertical plane. (As opposed to the small white arrows at the borders of the 2-dimensional display.) The "Spectrum" diagram always displays the spectrum for the currently selected frame.

By default, the most recently recorded frame (frame 0) is selected, and added at the front of the diagram.

Rotating the spectrogram in three dimensions

Depending on which aspect of the spectrogram is of interest, you can rotate the display to have a closer look at the frequency, the time, or the power dimension. Simply drag your finger or the mouse pointer over the spectrogram in the direction that you want to rotate it. You can rotate the display left or right, up and down. Note, however, that the degree of rotation is restricted in the upward direction to avoid confusing views. If you rotate the spectrogram such that you see the frequency-frame-plane directly from above, the display is identical to the 2-dimensional spectrogram.

Table 4-25: Effect of rotating the spectrogram in three dimensions

		
Rotation to the left > focus on frame	Rotation down > focus on frequency and frame	Rotation to the right > focus on frequency

Markers in three-dimensional spectrograms

In three-dimensional spectrograms, the markers are indicated by the common arrows used in the "Spectrum" display, for example. New markers are automatically placed on the current frame. You can move the markers to any position in all dimensions of the diagram. When you select a marker on the screen, three-dimensional cross-hairs indicate the position on all axes.

Sometimes, a marker can be hidden by other frames. If necessary, rotate the spectrogram or select a different frame as the current frame.

Color maps

Spectrogram displays assign power levels to different colors to visualize them. The legend above the spectrogram display describes the power levels that the colors represent. Similarly, "Persistence Spectrum" displays assign colors to the relative numbers of occurrence (percentage) of specific power levels.

The color display is highly configurable to adapt the spectrograms to your needs. You can define:

- Which colors to use ("Color Scheme")
- Which value range to apply the color scheme to
- How the colors are distributed within the value range, i.e. where the focus of the visualization lies (shape of the color curve)

The application automatically assigns the individual colors to the power levels.

The color scheme

- **Hot**

  Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high levels.
- **Cold**



Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high levels.
The "Cold" color scheme is the inverse "Hot" color scheme.

- **Radar**



Uses a color range from black over green to light turquoise with shades of green in between. Dark colors indicate low levels, light colors indicate high levels.

- **Grayscale**



Shows the results in shades of gray. Dark gray indicates low levels, light gray indicates high levels.

The value range of the color map

If the measured values only cover a small area in the spectrogram, you can optimize the displayed value range. Then it becomes easier to distinguish between values that are close together. Display only parts of interest.

The shape and focus of the color curve

The color-mapping function assigns a specified color to a specified power level in the "Spectrogram" display. By default, the application distributes the colors on the color map evenly. However, to visualize a certain area of the value range in greater detail than the rest, you can set the focus of the color mapping to that area. You change the focus by changing the shape of the color curve.

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear. If you shift the curve to the left or right, the distribution becomes nonlinear. The slope of the color curve increases or decreases. One end of the color palette then covers a large range of results, while the other end distributes several colors over a relatively small result range.

You can use this feature to put the focus on a particular region in the diagram and to be able to detect small variations of the signal.

Example:

In the color map based on the linear color curve, the range from -100 dBm to -60 dBm is covered by blue and a few shades of green only. The range from -60 dBm to -20 dBm is covered by red, yellow and a few shades of green.

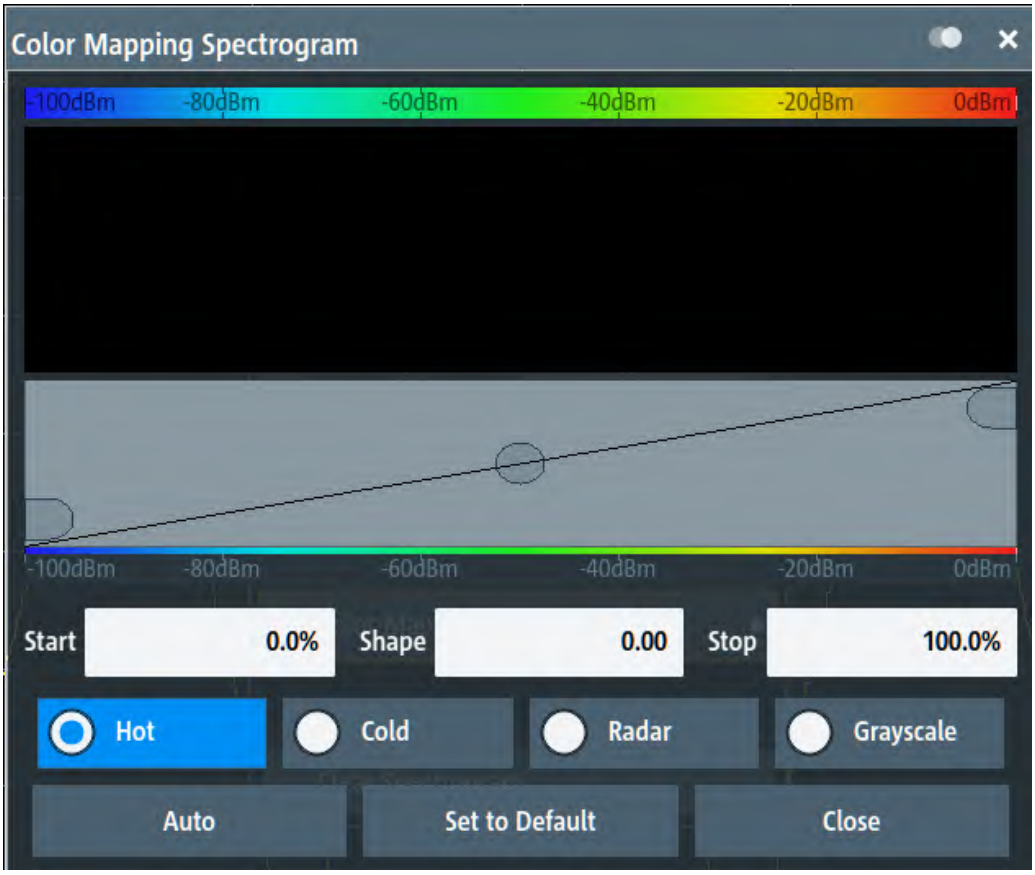


Figure 4-42: Spectrogram with (default) linear color curve shape = 0

The sample spectrogram is dominated by blue and green colors. After shifting the color curve to the left (negative value), more colors cover the range from -100 dBm to -60 dBm (blue, green and yellow). This range occurs more often in the example. The range from -60 dBm to -20 dBm is dominated by various shades of red only.

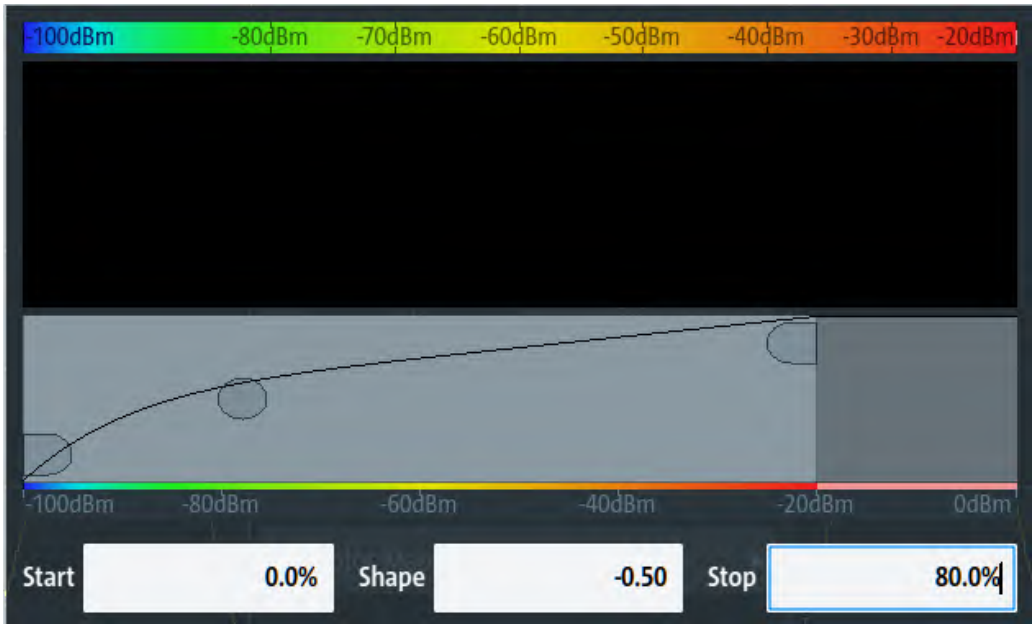


Figure 4-43: Spectrogram with nonlinear color curve (shape = -0.5)

4.8.1.2 How to configure a standard trace

Step-by-step instructions on configuring the trace settings are provided here.

For details on individual functions and settings see Section 5.4.4.1, "Trace configuration", on page 1215.

The remote commands required to perform these tasks are described in "Configuring standard traces" on page 669.

You configure trace settings in the "Traces" dialog box.

To display the "Traces" dialog box, do one of the following:

- Select "Overview" > "Analysis" > "Traces"
- Select [Trace] > "Trace Configuration"

1. For each trace, select the trace "Mode" and "Detector". Traces with the trace mode "Blank" are not displayed.
2. To configure several traces to predefined display modes in one step, select the required function:
   - "Preset All Traces"
   - "Max | Avg | Min"
   - "Max | ClrWrite | Min"

   For details see "Predefined Trace Settings - Quick Config" on page 1219.
3. For "Average" trace mode, define the averaging parameters:
   a) Select "Trace Average".
   b) Define the number of sweeps to average in the "Sweep / Average Count" field.

c) If you use linear scaling, select the "Average Mode": "Manual" and "Linear".

4. To improve the trace stability, in the "Sweep Configuration", increase the number of "Sweep Points" or the "Sweep Time".

   All configured traces (not set to "Blank" mode) are displayed after the next sweep.

How to copy traces

1. Select [Trace] > "Copy Trace".
2. Select the "Source" trace to copy.
3. Select the "Copy To" trace to which you want to apply the settings.

   The settings from the source trace are applied to the destination trace. The newly configured trace (if not set to "Blank") is displayed after the next sweep.

4.8.1.3 How to configure the RMS X-Corr trace detector

Step-by-step instructions on configuring the RMS X-Corr trace detector are provided here.

Prerequisites:

- Optional applications require an additional license that includes cross-correlation (X-Corr).
- RF-based measurement (not I/Q-based)

For details on the detector, see Section 4.1.5.2, "RMS X-Corr detector", on page 161.

1. Select [Trace] > "Trace Configuration".
2. For one of the traces, select "Detector": "RMS X-Corr".

   Note: You can enable further traces with other detectors for the same measurement.
3. Select [Sweep] > ""Sweep Configuration"".
4. Enter a suitable "X-Corr Factor".

   The signal should rise out of the noise floor significantly.

4.8.1.4 How to display and configure a spectrogram

Step-by-step instructions on how to display and configure a spectrogram are provided here. For details on individual functions and settings see Section 5.4.4.3, "Spectrogram settings", on page 1223.

The remote commands required to perform these tasks are described in "Configuring spectrograms" on page 678.

The following tasks are described here:

- "To display a spectrogram" on page 301

- "To remove the spectrogram display" on page 301
- "To set a marker in the spectrogram" on page 301
- "To configure a spectrogram" on page 302
- "To select a color scheme" on page 302
- "To set the value range graphically using the color range sliders" on page 303
- "To set the value range of the color map numerically" on page 303
- "To set the color curve shape graphically using the slider" on page 304
- "To set the color curve shape numerically" on page 304

To display a spectrogram

1. In the "Overview", select "Display Config", then drag the evaluation type "Spectrogram" to the diagram area.
   Alternatively:
   a) Select [Trace] > "Spectrogram Configuration".
   b) Toggle "State" to "On".
2. To clear an existing spectrogram display, select "Clear Spectrogram".
3. Start a new measurement using [Run Single] or [Run Cont].
   The spectrogram is updated continuously with each new sweep.
4. To display the spectrum diagram for a specific timeframe:
   a) Stop the continuous measurement, or wait until the single sweep completes.
   b) Double-click the frame number in the diagram footer.
   c) Enter the required frame number in the edit dialog box.
   Note that the most recent sweep is frame number 0, all previous frames have negative numbers.

To remove the spectrogram display

1. Select [Trace] > "Spectrogram Configuration".
2. Toggle the "State" to "Off".
   The standard spectrum display is restored.

To set a marker in the spectrogram

1. While a spectrogram is displayed, select [Marker].
2. Enter the frequency or time (x-value) of the marker.
3. Enter the frame number to set the marker to, for example *0* for the current frame, or *-2* for the second to last frame. Note that the frame number is always 0 or a negative value.
   You only see the marker in the spectrum diagram if it is defined for the currently displayed frame. In the "Spectrogram" result display, you see all markers that are positioned on a visible frame.

To configure a spectrogram

1. Configure the spectrogram frames:
   a) Select [Trace] > "Trace Average".
   b) In the "Sweep / Average Count" field, define how many sweeps to average to create a single frame.
2. Define how many frames to store in total:
   a) Select [Trace] > "Spectrogram Configuration" > "History Depth".
   b) Enter the maximum number of frames to store.
3. Optionally, enable the "Time Stamp"option to replace the frame number by a time stamp.
4. If necessary, adapt the color mapping for the spectrogram to a different value range or color scheme as described in Section 4.8.1.5, "How to configure the color mapping", on page 302.

4.8.1.5 How to configure the color mapping

The color display is highly configurable so you can adapt the spectrogram to your needs.

To display the "Color Mapping" dialog box

► To display this dialog box, do one of the following:
- Select the color map in the window title bar of the "Spectrogram" result display.
- Select [Trace] > "Spectrogram Configuration" > "Color Mapping".

To select a color scheme

You can select which colors are assigned to the measured values.

► In the "Color Mapping" dialog box, select the color scheme to use.

Editing the value range of the color map

The "Color Mapping" dialog box shows a histogram with the distribution of the measured values. To cover the entire measurement value range, make sure the first and last bar of the histogram are included.

To ignore noise in a spectrogram, for example, exclude the lower power levels from the histogram.

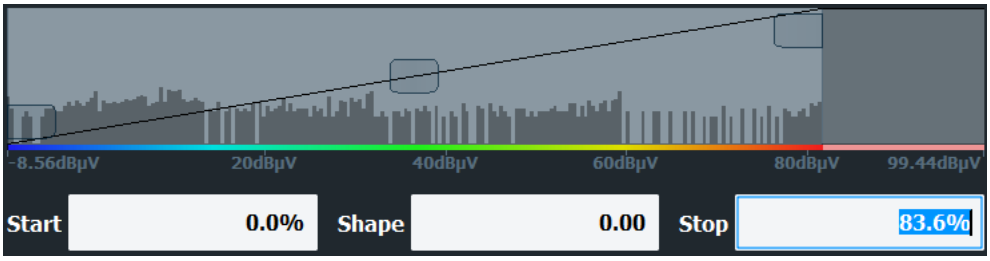


The value range of the color map must cover at least 10% of the value range on the horizontal axis of the diagram. Thus, the difference between the start and stop values must be at least 10%.

You can configure the value range of the color map numerically or graphically.

To set the value range graphically using the color range sliders

1. Select and drag the bottom color curve slider to the lowest value you want to include in the color mapping. The slider is indicated by a gray box at the left end of the color curve pane.
2. Select and drag the top color curve slider to the highest value you want to include in the color mapping. The slider is indicated by a gray box at the right end of the color curve pane.



To set the value range of the color map numerically

1. In the "Start" field, enter the percentage from the left border of the histogram that marks the beginning of the value range.
2. In the "Stop" field, enter the percentage from the right border of the histogram that marks the end of the value range.

Example:

The color map starts at -110 dBm and ends at -10 dBm (that is: a range of 100 dB). To suppress the noise, you only want the color map to start at -90 dBm. Thus, you enter *10%* in the "Start" field. The FSWX shifts the start point 10% to the right, to -90 dBm.

Adjusting the reference level and level range

The color map is based on percentages of the total value range. If you change the reference level or level range of the measurement, the power value range also changes. Thus, these changes also affect the color mapping in the spectrogram.

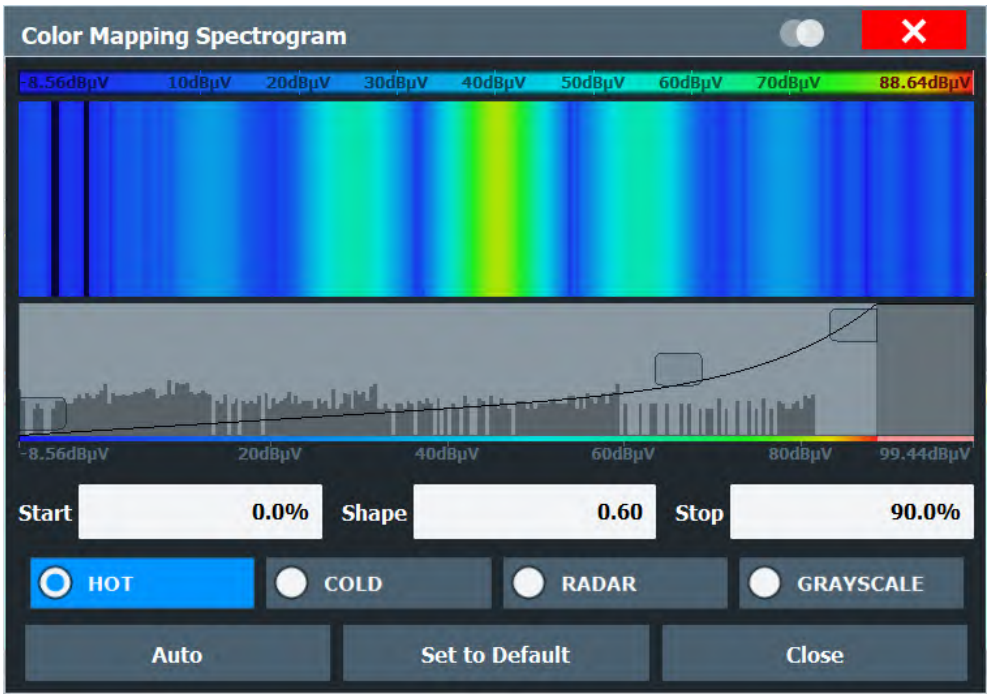
Editing the shape of the color curve

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear, i.e. the colors on the color map are distributed evenly. If you shift the curve to the left or right, the distribution becomes nonlinear. The slope of the color curve increases or decreases. One end of the color palette then covers many results, while the other end distributes several colors over a relatively small result range.

You can configure the color curve shape numerically or graphically.

To set the color curve shape graphically using the slider

► Select and drag the color curve shape slider (indicated by a gray box in the middle of the color curve) to the left or right. The value range under the flatter curve of the slider is focused, i.e. more colors are distributed there.



To set the color curve shape numerically

► In the "Shape" field, enter a value to change the shape of the curve:

- A negative value (-1 to <0) focuses the lower values.
- 0 defines a linear distribution.
- A positive value (>0 to 1) focuses the higher values.

4.8.2 Marker usage

Markers help you analyze your measurement results by determining particular values in the diagram. Thus, you can extract numeric values from a graphical display both in the time and frequency domain. In addition to basic markers, the FSWX provides sophisticated marker functions for special results such as noise or demodulation.

Markers in spectrogram displays

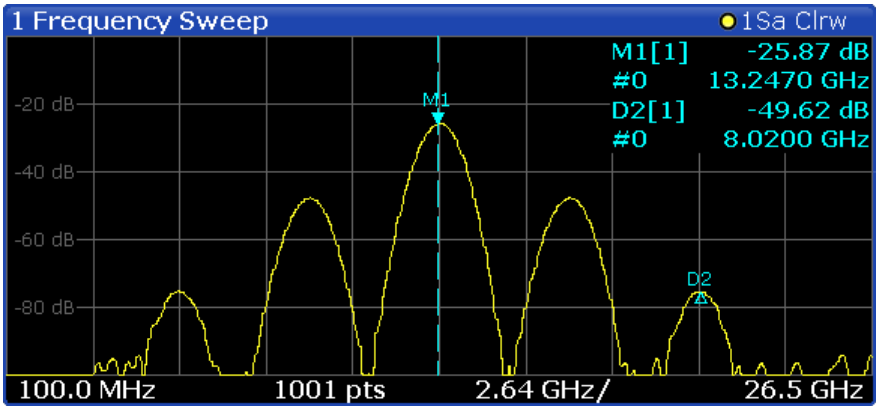
In the spectrogram result display, you can enable up to 16 markers or delta markers at the same time. You can assign each marker to a different (time) frame. Therefore, in addition to the frequency, you also define the frame number when activating a new marker. If you do not specify a frame number, the marker is positioned on the currently selected frame. You can see all markers that are positioned on a visible frame in the spectrogram.

- Markers for individual values 305
- How to work with markers 307
- Measurement example: measuring harmonics using marker functions 310

4.8.2.1 Markers for individual values

Markers are used to mark points on traces, to read out measurement results and to select a display section quickly. FSWX provides up to 17 markers per display window. In the Spectrum application, the same markers are displayed in all windows.

- To set individual markers quickly, use the softkeys in the "Marker" menu.
- To set up several markers at once, use the "Marker" dialog box.
- To position the selected marker to a special value, use the softkeys in the "Marker To" menu.
- The easiest way to work with markers is using a mouse. Simply drag the marker and drop it at the required position.
- When you select a marker in a diagram, a vertical line is displayed which indicates the marker's current x-value.



- As an alternative, change the position of the selected marker using the rotary knob. By default, the marker moves from one pixel to the next. If you need to position the marker more precisely, change the step size to move from one sweep point to the next (general marker setting).
- You can also set an active marker to a new position by defining its x-position numerically. When you select the softkey for a marker, an edit dialog box is displayed.
- The most commonly required marker settings and functions are also available as softkeys or via the context menu. Tap the marker on the touchscreen and hold

your finger for about 2 seconds until the context menu is opened, then select the required entry.

- Softkeys for active markers (displayed on the screen) are highlighted blue. The softkey for the currently selected marker (for which functions are performed) is highlighted orange.
- To determine more sophisticated marker results, use the special functions in the "Marker Function" dialog box.
  See Section 5.4.3, "Marker (measurement) functions", on page 1193.

- Marker types 306
- Activating markers 306
- Marker results 306

Marker types

You can define markers either as normal markers or delta markers. A normal marker indicates the absolute signal value at the defined position in the diagram. A delta marker indicates the value of the marker relative to the specified reference marker (by default, marker 1).

In addition, you can assign special functions to the individual markers. Which special marker functions are available depends on the type of measurement and whether the measurement is performed in the frequency or time domain

In addition to the markers and delta markers, the FSWX uses temporary markers to analyze the measurement results for special marker functions. They disappear when you disable the associated function.

Activating markers

The diagram and the marker table only display active markers.

Active markers are indicated by a checkmark in the marker selection lists. In addition, the softkeys for active markers are highlighted.

By default, normal marker 1 is active and positioned on the maximum value (peak) of trace 1. If several traces are displayed, the marker is set to the maximum value of the trace that has the lowest number and is not frozen ("View" mode). The next marker that you activate is set to the frequency of the next lower level (next peak) as a delta marker. The delta marker value is indicated as an offset to marker 1.

You can only activate a marker if at least one trace in the corresponding window is visible. If you disable a trace, the corresponding markers and marker functions are also disabled. If you enable the trace again, the markers and their functions are restored to their original positions, provided the markers are not already used on another trace.

Marker results

Normal markers point to a trace point on the x-axis and display the associated y-axis value for that trace point. Delta markers indicate an offset between the value at the delta marker position and the value at the position of the assigned reference marker.

Note that markers you place on the start and stop values of the x-axis indicate the y-values of the first and last trace point, respectively. For details see "X-value of the sweep point" on page 283.

The FSWX can display marker results directly within the diagram area or in a separate table. By default, the first two active markers are displayed in the diagram area. If you activate more markers, the FSWX displays the results in a marker table.

Marker information in diagram area

By default, the diagram area contains the results of the last two markers or delta markers that were activated.



The following information is displayed there:

- The marker type (M for normal, D for delta, or special function name)
- The marker number (1 to 16)
- The assigned trace number in square brackets [ ]
- The marker value on the y-axis, or the result of the marker function
- The marker position on the x-axis

For special marker functions, additional information is displayed.

Marker information in marker table

In addition to the marker information displayed within the diagram area, the FSWX can display a separate marker table beneath the diagram. This table provides the following information for all active markers:

Table 4-26: Marker information in marker table

"Type"	Marker type: N (normal), D (delta), T (temporary, internal) and number
"Ref"	Reference marker for delta markers
"Trc"	Trace to which the marker is assigned
"Frame"	Spectrogram frame the marker is positioned in. Displayed only when the Spectrogram is displayed.
"X-value"	X-value of the marker
"Y-value"	Y-value of the marker
"Function"	Activated marker or measurement function
"Function Result"	Result of the active marker or measurement function

4.8.2.2 How to work with markers

The following step-by-step instructions demonstrate in detail how to work with markers.

- How to analyze a signal point in detail....308
- How to use a fixed reference marker....308
- How to output the demodulated signal acoustically....309
- How to export a peak list....310

How to analyze a signal point in detail

Step-by-step instructions on working with markers are provided here. For details on individual functions and settings see Section 5.4.1, "Marker settings", on page 1182.

When you need to analyze a characteristic point in the signal in more detail, the following procedure can be helpful:

1. Perform a peak search to determine the characteristic point roughly by pressing the [Peak Search] key.
2. If the required signal point is not the maximum, continue the peak search to one of the subsequent maxima or minima:
   a) Press the [Marker To] key.
   b) Select "Next Peak" or "Next Min".
   c) If necessary, change the search settings by selecting "Marker Search".
3. Center the display around the determined signal point by setting the center frequency to the marker value. Select "Set Center Freq to Marker Freq".
4. Determine the precise frequency of the signal point:
   a) Select Marker Function.
   b) Select "Signal Count".
   c) Select "Signal Count Resolution".
   d) Select the resolution depending on how precise the result needs to be.

How to use a fixed reference marker

By default, delta markers refer to marker 1. However, they can also refer to a fixed reference marker.

How to define and move a fixed reference marker

1. To display a fixed reference marker, select Marker Function > "Reference Fixed".

   A vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is enabled and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value.
2. To move the fixed reference marker, do one of the following:
   - Change the "Level" and "Position" of the reference point in the "Marker Settings". By default, the reference point is set to the current peak value of trace 1.

- Set the fixed reference marker to the current peak value by selecting "Peak Search" in the "Marker Settings".
- Move the "FXD" display lines that define the position of the fixed reference marker by dragging them on the screen.

How to assign a fixed reference marker to delta markers

► In the "Marker Settings", for the active delta marker that is to refer to the fixed reference marker, select "Ref Marker": "FXD".

The delta marker indicates the offset of the current trace value at the marker position from the fixed reference value.

How to output the demodulated signal acoustically

For long sweep times, you can monitor a measurement acoustically rather than visually to determine when a certain signal level is reached.

1. Set marker 1 to the signal level that you want to monitor.
2. Select [Marker Function] > "Select Marker Function" > "Marker Demodulation".

   The marker function results are determined immediately according to the default settings.
3. Select "Marker Demodulation Configuration".
4. Define how long you want to hear the output signal when the marker value is reached.
   - Enter the duration as the "Marker Stop Time".
   - Set "Continuous Demodulation" to "On" to output the signal continuously, regardless of the marker value.
5. Select the modulation format (AM/FM/PM) of the signal.
6. To avoid listening to noise during continuous output, set "Squelch" to "On" and define the signal level below which the signal is ignored.
7. Set "Marker Demodulation" to "On".
8. Adjust the volume to a suitably low level.
9. **CAUTION!** Risk of hearing damage. To protect your hearing, make sure that the volume setting is not too high before putting on the headphones.

   Plug your headphones into the "Phones" connector on the front panel of the FSWX.

   During the next or currently running measurement, when the sweep reaches the marker position, the demodulated signal is output as an audio signal via the headphones for the given duration. Or, depending on the configuration, the demodulated signal is continuously output via the headphones, if the signal level exceeds the squelch level.

How to export a peak list

You can save the results of a "Marker Peak List" to an ASCII file.

1. Select [Marker Function].
2. Select "Configuration".
3. Configure the peak search and list settings as described in Section 5.4.3.1, "Marker peak list", on page 1195.
4. Set the marker peak list "State" to "On".
5. Select [Run Single] to perform a single measurement and create a marker peak list.
6. Select "Marker Peak List" to display the configuration dialog box again.
7. If necessary, change the decimal separator to use for the ASCII export file.
8. Select "Export Peak List".
9. In the file selection dialog box, select the storage location and filename for the export file.
10. Select "Save" to close the dialog box and export the peak list data to the file.

4.8.2.3 Measurement example: measuring harmonics using marker functions

This measurement example describes how to measure harmonics using the provided marker functions. Note that you can measure harmonics simpler using the "Harmonic Distortion" measurement.

For more information, see Section 5.3.9, "Harmonic distortion measurement", on page 1146.

Signal generator settings (e.g. R&S SMW):

Frequency:	128 MHz
Level:	+15 dBm

To measure harmonics

1. Preset the FSWX.
2. Set the center frequency to *128 MHz*.
3. Set the span to *100 kHz*.
4. Select "Auto Level".

   The FSWX displays the reference signal with a span of 100 kHz and a resolution bandwidth of 1 kHz.
5. Enable a marker by selecting [Marker].
   The marker is positioned on the trace maximum.

6. Set the measured signal frequency and the measured level as reference values:

   a) Select [Marker Function] > "Reference Fixed".

   The position of the marker becomes the reference point. The reference point level is indicated by a horizontal line, the reference point frequency with a vertical line. At the same time, the delta marker 2 is switched on.



Figure 4-44: Fundamental wave and the frequency and level reference point

7. Make the step size for the center frequency correspond to the signal frequency at the peak marker: in the "Frequency" configuration dialog box, select "Center Frequency Step Size" = "Set to Focused Marker".

   The step size for the center frequency is now equal to the marker frequency.

8. Move the center frequency to the second harmonic of the signal by selecting the arrow up (▲) key.

   The center frequency is set to the second harmonic (2x peak marker frequency).

9. Select "Auto Level" to ensure the FSWX measures the harmonics with a high sensitivity.

10. Place the delta marker on the second harmonic:
    Select [Marker To] > "Peak".

    The delta marker moves to the maximum of the second harmonic. The displayed level result is relative to the reference point level (= fundamental wave level).



Figure 4-45: Measuring the level difference between the fundamental wave (= reference point level) and the second harmonic

Measure the other harmonics by repeating steps step 8 to step 10. Increment or decrement the center frequency in steps of 128 MHz using the arrow up (▲) or arrow down (▼) keys.

4.8.3 Peak value search

Peak values, i.e. maximum or minimum measurement results, often indicate characteristic events in the signal. The FSWX provides various peak search functions and applications, including:

- Setting a marker to a peak value once (Peak Search)
- Searching for a peak value within a restricted search area ("Search Limits" on page 1190)
- Updating the marker position to the current peak value automatically after each sweep ("Auto Peak" on page 1189)
- Creating a "Marker Table" with all or a defined number of peak values for one sweep ("Marker Peak List")
- Creating a fixed reference marker at the current peak value of a trace (Section 5.4.3.5, "Defining a fixed reference", on page 1204)

Peak search limits

You can restrict the search results by limiting the search area. You define the search area by limit lines, which are also indicated in the diagram. In addition, you can define a minimum value (threshold) as a further search condition.

When is a peak a peak? - Peak excursion

If the signal is very flat or does not contain many peaks, the FSWX can detect peaks in noise values during a search. Therefore, you can define a relative threshold ("Peak Excursion"). The signal level must increase by the threshold value before falling again before a peak is detected. To avoid identifying noise peaks as maxima or minima, enter a peak excursion value that is higher than the difference between the highest and the lowest value measured for the displayed inherent noise.

Effect of peak excursion settings (example)

The following figure shows a trace to be analyzed.

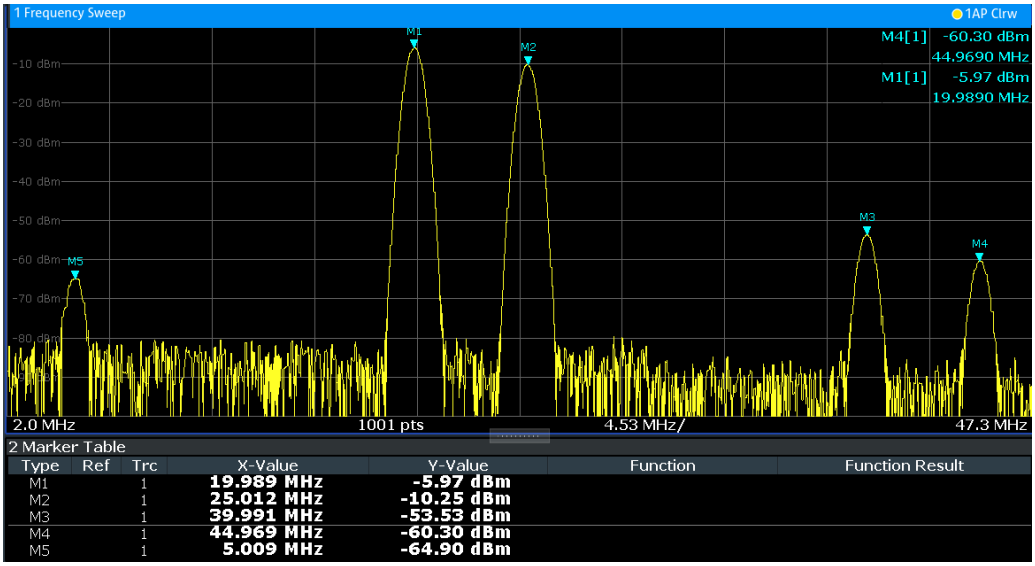


Figure 4-46: Trace example

The following table lists the peaks as indicated by the marker numbers in the diagram above, as well as the minimum decrease in amplitude to either side of the peak:

Marker #	Min. amplitude decrease to either side of the signal
1	80 dB
2	80 dB
3	55 dB
4	39 dB
5	32 dB

To eliminate the smaller peaks M3, M4 and M5 in the example above, a peak excursion of at least 60 dB is required. In this case, the amplitude must rise at least 60 dB before falling again before the FSWX detects a peak.

Marker peak list

The marker peak list determines the frequencies and levels of peaks in the spectrum. It is updated automatically after each sweep. You can define how many peaks are displayed, as well as the sort order. Optionally, the detected peaks can be indicated in the diagram. You can also export the peak list to a file for analysis in an external application.

Automatic peak search

The FSWX can repeat a peak search automatically after each sweep. Thus, you can keep the maximum value as the reference point for a phase noise measurement, for example. Automatic peak search is useful to track a drifting source. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore, the phase noise measurement leads to reliable results in a certain offset although the source is drifting.

Using a peak as a fixed reference marker

Some results are analyzed in relation to a peak value, for example a carrier frequency level. In this case, the FSWX can determine the maximum level by an initial peak search and then use the peak as a reference point for further measurement results.

4.8.4 Display lines for fixed values

Display lines help you analyze a measurement trace.

Display lines are not available for all measurements and all applications.

4.8.4.1 Basics on display lines

Display lines help you analyze a trace. Similar to a ruler, you can shift a display line on the trace to mark absolute values. Display lines merely visualize relevant frequencies or points in time (zero span), and constant level values. You cannot check whether the trace points are below or above the display line automatically. Use limit lines for that task (see Section 4.8.5.1, "Basics on limit lines", on page 318).

Display lines are not available for all measurements and all applications.

The FSWX provides two different types of display lines:

- Two horizontal lines: "Horizontal Line 1" and "Horizontal Line 2".

These lines are continuous horizontal lines across the entire width of a diagram. You can shift them up and down.

- Four vertical lines: "Vertical Line 1" to "Vertical Line 4"
  These lines are continuous vertical lines across the entire height of the diagram. You can shift them left and right.

Labels

Each line is identified by one of the following abbreviations in the diagrams:

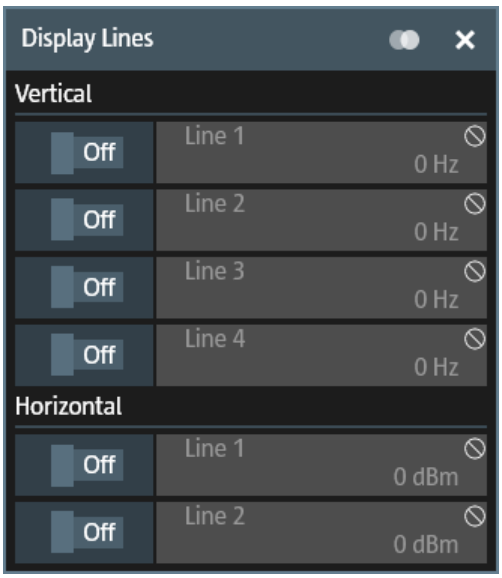
- H1: "Horizontal Line 1"
- H2: "Horizontal Line 2"
- V1: "Vertical Line 1"
- V2: "Vertical Line 2"
- V3: "Vertical Line 3"
- V4: "Vertical Line 4"

Display line settings

Access: [Lines] > "Display Lines Configuration"

You can define four vertical and two horizontal lines in a diagram.

In some applications, you can configure different lines for different result displays. In this case, the line settings are window-specific.



Vertical Line <x>.....315
Horizontal Line 1/ Horizontal Line 2.....316

Vertical Line <x>
Enables a vertical display line in the diagram at the specified point of the x-axis, depending on the scale of the axis.

Remote command:
CALCulate<n>:FLINe<dl> on page 759
CALCulate<n>:TLINe<dl> on page 760

Horizontal Line 1/ Horizontal Line 2
Enables a horizontal display line (H1 or H2) in the diagram at the specified point of the y-axis.

Remote command:
CALCulate<n>:DLINe<dl> on page 759
CALCulate<n>:TLINe<dl> on page 760

Defining display lines

1. Select [Lines].
2. To define a vertical line:
   a) Select "Vertical Line 1", 2, 3, or 4.
   b) Enter the position of the line on the x-axis.
3. To define a horizontal line:
   a) Select "Horizontal Line 1" or 2.
   b) Enter the position of the line on the y-axis.

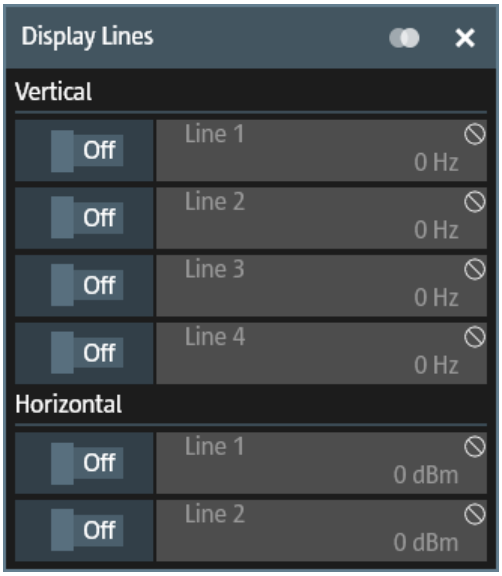
   The configured line is automatically enabled and displayed.

4.8.4.2 Display line settings

Access: [Lines] > "Display Lines Configuration"

You can define four vertical and two horizontal lines in a diagram.

In some applications, you can configure different lines for different result displays. In this case, the line settings are window-specific.



Vertical Line <x>.....317
Horizontal Line 1/ Horizontal Line 2.....317

Vertical Line <x>
Enables a vertical display line in the diagram at the specified point of the x-axis, depending on the scale of the axis.

Remote command:
`CALCulate<n>:FLINe<dl>` on page 759
`CALCulate<n>:TLINe<dl>` on page 760

Horizontal Line 1/ Horizontal Line 2
Enables a horizontal display line (H1 or H2) in the diagram at the specified point of the y-axis.

Remote command:
`CALCulate<n>:DLINe<dl>` on page 759
`CALCulate<n>:TLINe<dl>` on page 760

4.8.4.3 Defining display lines

1. Select [Lines].
2. To define a vertical line:
   a) Select "Vertical Line 1", 2, 3, or 4.
   b) Enter the position of the line on the x-axis.
3. To define a horizontal line:
   a) Select "Horizontal Line 1" or 2.

b) Enter the position of the line on the y-axis.

The configured line is automatically enabled and displayed.

4.8.5 Limit lines for value ranges

Limit lines allow you to check automatically whether the measured points are below or above specified values.

Limit lines are not available for all measurements and all applications.

- Basics on limit lines 318
- Limit line settings and functions 323
- How to define limit lines 329

4.8.5.1 Basics on limit lines

Limit lines are used to define amplitude curves or spectral distribution boundaries in the result diagram which must not be exceeded. For example, they can indicate the upper limits for interference radiation or spurious waves that a device under test (DUT) is allowed. When transmitting information in TDMA systems (e.g. GSM), the amplitude of the bursts in a timeslot must adhere to a curve that falls within a specified tolerance band. The lower and upper limits can each be specified by a limit line. Then, you can check the amplitude curve either visually or automatically for any violations of the upper or lower limits (Go/NoGo test).

The FSWX supports limit lines with a maximum of 200 data points. You can activate eight of the limit lines stored in the instrument simultaneously. The FSWX can store as many limit lines as the capacity of the used storage device allows.

You can also export limit line data to a file in ASCII (CSV) format for further evaluation in other applications. You can import limit lines stored in the specified ASCII (CSV) format to the FSWX for other measurements.

Compatibility

Limit lines are compatible with the current measurement settings, if the following applies:

- The x unit of the limit line is identical to the current setting.
- The y unit of the limit line is identical to the current setting, except for dB-based units. All dB-based units are compatible with each other.

Validity

You can only activate limit lines that fulfill the following conditions:

- Each limit line consists of a minimum of 2 and a maximum of 200 data points.

- The frequencies and times for each data point are defined in ascending order. However, for any single frequency or time, you can enter two data points (to define a vertical segment of a limit line).
- Gaps in frequency or time are not allowed. If you want gaps, define and enable two separate limit lines.
- The entered frequencies or times need not necessarily be selectable in FSWX. A limit line can also exceed the specified frequency or time range. The minimum frequency for a data point is -200 GHz, the maximum frequency is 200 GHz. For the time range, you can also define negative times. The allowed range is -1000 s to +1000 s.

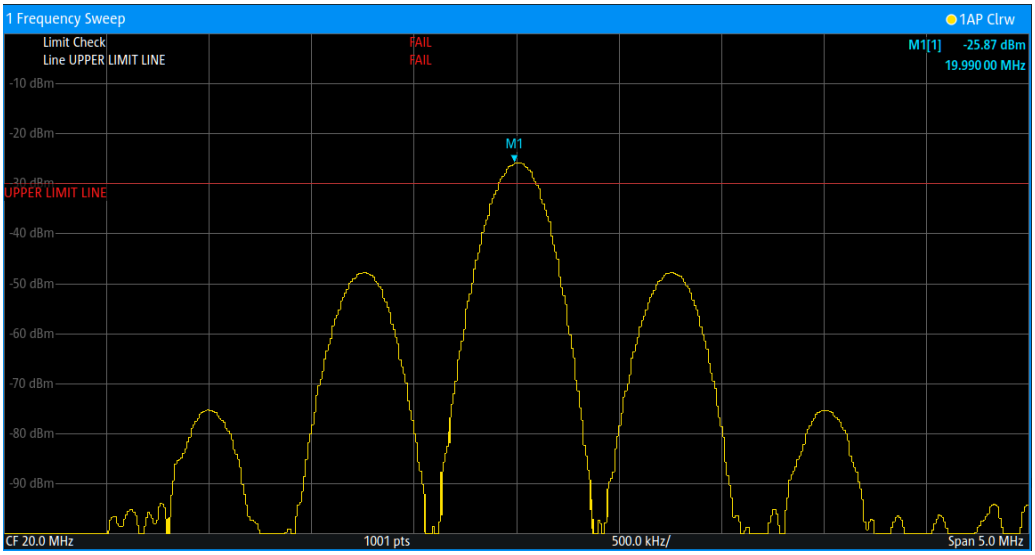


Figure 4-47: Example for an upper limit line

Limits and margins

Limit lines define strict values that the measured signal must not exceed. A **margin** is similar to a limit, but less strict and it still belongs to the valid data range. You can use a margin as a warning that the limit is almost reached. The margin is not indicated by a separate line in the display. However, if the signal violates a margin, a warning is displayed. You define margins as lines with a fixed distance to the limit line.

To check the signal for maximum levels, you define an **upper limit**. To check the signal for minimum levels, you define a **lower limit**.

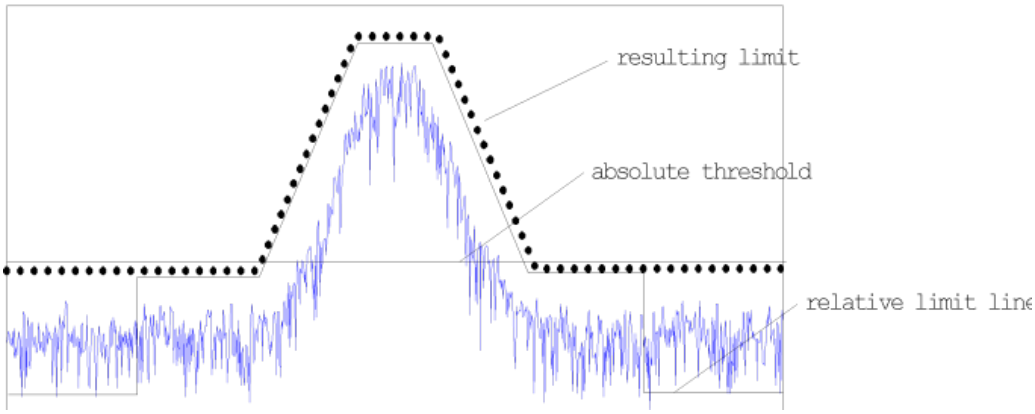
You can define limits:

- Relative to the reference level
- Relative to the beginning of the time scale
- Relative to the center frequency
- As absolute values

Relative scaling is suitable, for example, to define masks for bursts in zero span, or for masks for modulated signals in the frequency domain.

Thresholds

If the y-axis for the limit line data points uses relative scaling, you can define an additional absolute **threshold** for the limit check. In this case, a violation only occurs if the signal exceeds both the threshold value and the relative limit line.



Offsets and shifting

You can easily move a configured limit line vertically or horizontally. Two different methods to do so are available:

- An **offset** moves the entire line in the diagram without editing the configured values or positions of the individual data points. This option is only available if you use relative scaling.
  Thus, you can easily generate a new limit line based on an existing limit line which has been shifted horizontally or vertically.
- Defining a **shift** width for the values or position of the individual data points changes the line configuration, thus changing the position of the line in the diagram.

Limit check results

The FSWX automatically performs a limit check if you activate any of the limit lines ("State" setting). The FSWX compares only the specified traces to be checked with the active limit lines. The result of the limit check for each limit line is indicated in the diagram. If the signal violates a margin, the limit check status is set to "Marg". If the signal violates a limit, the status is set to "Fail".

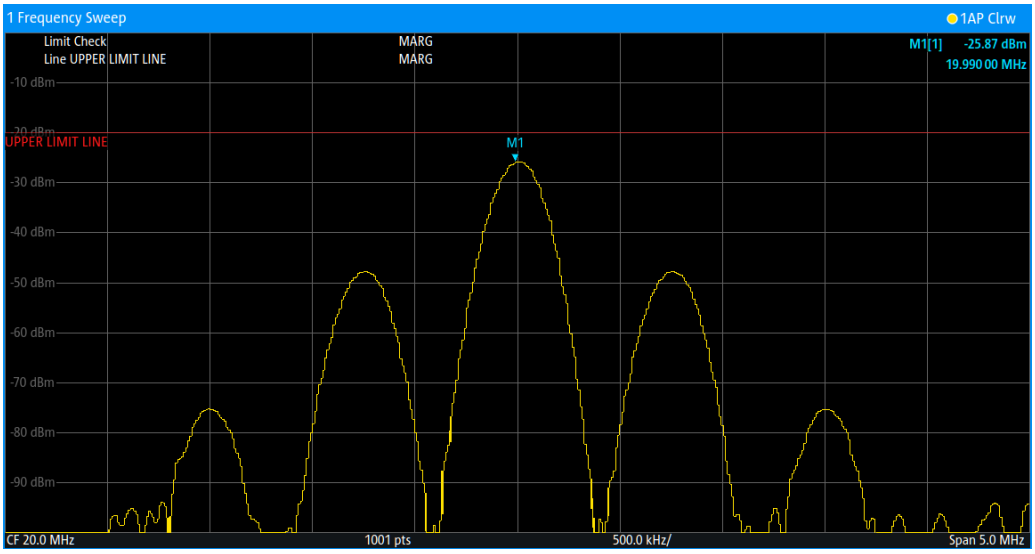


Figure 4-48: Margin violation for limit check

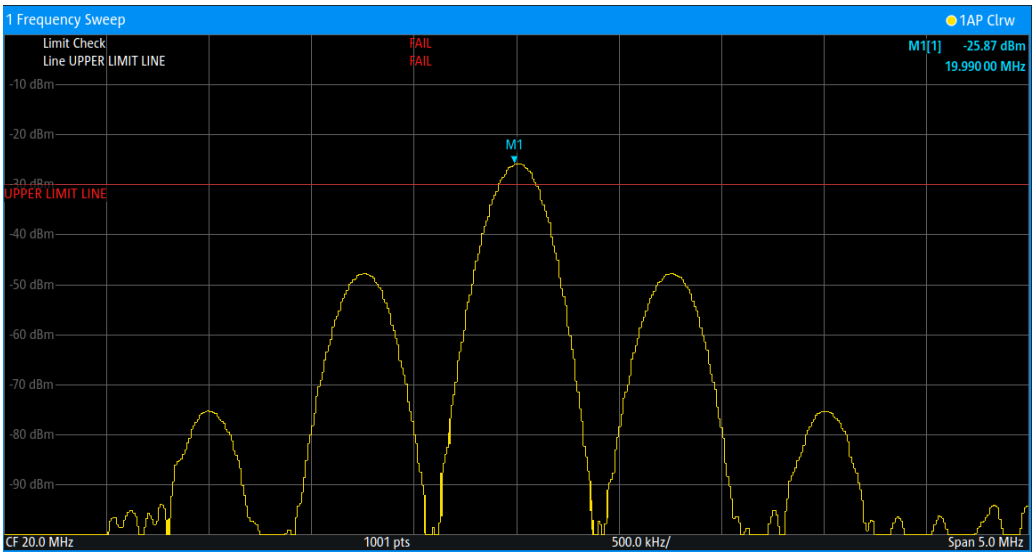


Figure 4-49: Limit violation for limit check

Storing and recalling limit lines

You can store limit lines with the configuration settings so you can recall them for other measurements later (see Section 4.10.3, "Storing and recalling instrument settings and measurement data", on page 358). Note, however, that you cannot restore any changes that were made to the limit lines *after* storing the configuration file. The stored values overwrite the changes when you recall the configuration file. Always remember to store the settings again after changing the limit line values.

After you recall measurement settings, the "Limit Lines" dialog can display other values than the limit line values that are currently applied to the measurement. See Section 4.10.3, "Storing and recalling instrument settings and measurement data", on page 358.

Reference: limit line file format

You can export limit lines to a file in ASCII (CSV) format for further evaluation in other applications. You can also import limit lines in the specified ASCII (CSV) format to the FSWX for other measurements (see "How to import a limit line" on page 333). This reference describes in detail the format of the export/import files for limit lines. Note that the **bold** data is **mandatory**, all other data is optional.

Depending on the regional or language settings, your evaluation program can require a different handling of the decimal point. Thus, you can define the decimal separator to be used (see "Decimal Separator" on page 370).

Table 4-27: ASCII file format for limit line files

File contents	Description
Header data	
sep=;	Separator for individual values (required by Microsoft Excel, for example)
Type;RS_LimitLineDefinition;	Type of data
FileFormatVersion;1.00;	File format version
Date;01.Oct 2006;	Date of data set storage
OptionID;SpectrumAnalyzer	Application the limit line was created for
Name;RELFREQ1	Limit line name
Comment;Defines the upper limit line	Description of limit line
Mode;UPPER	Type of limit line (upper, lower)
ThresholdUnit;LEVEL_DBM	Unit of threshold value
ThresholdValue;-200	Threshold value
MarginValue;0	Margin value
XAxisScaling;LINEAR	Scaling of x-axis linear (LIN) or logarithmic (LOG)
XAxisUnit;FREQ_HZ	Unit of x values
XAxisScaleMode;ABSOLUTE	Scaling of x-axis (absolute or relative)
YAxisUnit;LEVEL_DB	Unit of y values

File contents	Description
YAxisScaleMode;ABSOLUTE	Scaling of y-axis (absolute or relative)
NoOfPoints;5	Number of points the line is defined by
Data section for individual data points	
-4500000000;-50	**x- and y-values of each data point defining the line**
-2000000000;-30	
-1000000000;0	
0;-30	
2500000000;-50	

4.8.5.2 Limit line settings and functions

The FSWX can display up to 8 limit lines simultaneously. Many more can be stored on the instrument.

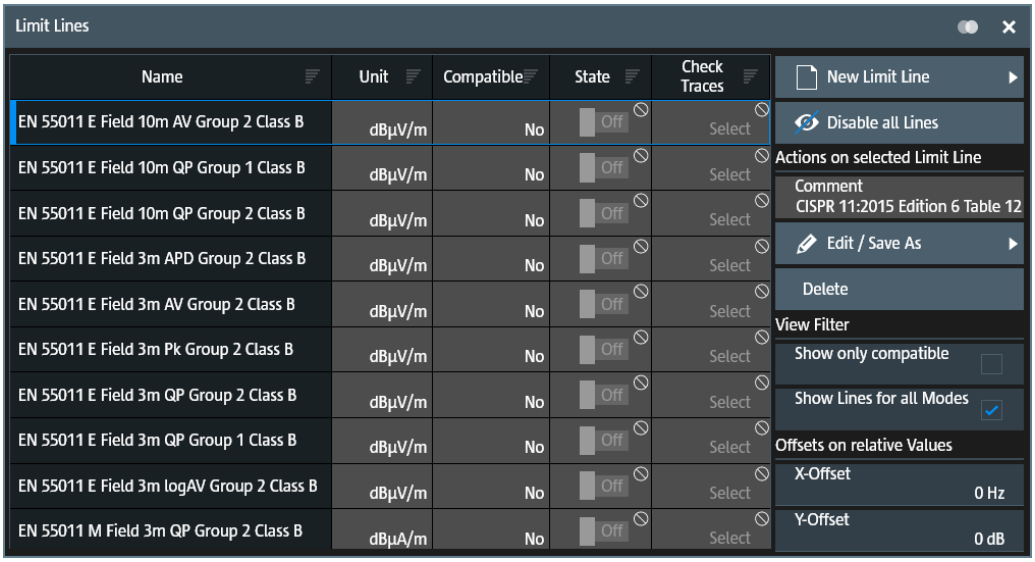
Stored limit line settings

When storing and recalling limit line settings, consider the information provided in "Saving and recalling transducer and limit line settings" on page 359.

- Limit line management....323
- Limit line details....325

Limit line management

Access: [Lines] > "Limit Lines Configuration"



For the limit line overview, the FSWX searches for all stored limit lines with the file extension `.lin` in

the home/instrument/.local/share/rohde-schwarz/esmain/fswx/limits folder. The overview allows you to determine which limit lines are available and can be used for the current measurement.

Name....324
Unit....324
Compatible....324
State....324
Check Traces....324
New Limit Line....324
Disable all Lines....324
Comment....325
Edit / Save As....325
Delete....325
Included lines in overview (View filter)....325
X-Offset on relative values....325
Y-Offset on relative values....325

Name
The name of the stored limit line.

Unit
The unit for the y-values of the limit line data points (read-only).

Compatible
Indicates whether the limit line definition is compatible with the current measurement settings.

State
Enables or disables the limit line in the diagram. The diagram can display and check up to 8 limit lines at the same time.

Remote command:
CALCulate<n>:LIMit<li>:LOWer:STATe on page 767
CALCulate<n>:LIMit<li>:UPPer:STATe on page 771
CALCulate<n>:LIMit<li>:ACTive? on page 772

Check Traces
Defines which traces the measurement automatically checks for conformance with the specified limit line. You can check several traces using the same limit line simultaneously. If any of the traces violate an active limit line, the diagram shows a message.

Remote command:
CALCulate<n>:LIMit<li>:TRACe<t>:CHECk on page 773

New Limit Line
Opens the "Limit Line Details" to create a limit line.

Disable all Lines
Disable all limit lines in one step.

Remote command:
CALCulate<n>:LIMit<li>:STATe on page 773

Comment
Optional description of the limit line.

Edit / Save As
Opens the "Limit Line Details" to edit or copy an existing limit line configuration.

Delete
Deletes the selected limit line configuration.

Remote command:
CALCulate<n>:LIMit<li>:DELete on page 773

Included lines in overview (View filter)
Defines which of the stored lines are included in the overview.

"Show only Compatible"
If enabled, only lines that are compatible to the current measurement settings are displayed.
The Compatible setting in the overview indicates whether a line is compatible or not.

"Show Lines for all Modes"
If enabled (default), limit lines from all applications are displayed.
If disabled, only lines that were created in the current application are displayed.
Note that limit lines from some applications can include additional properties that are lost when the limit lines are edited in another application. In this case, a warning is displayed when you try to store the limit line.

X-Offset on relative values
Shifts a limit line with a relative x-axis position horizontally.

This setting does not affect limit lines that are defined by an absolute x-axis position.

Remote command:
CALCulate<n>:LIMit<li>:CONTrol:OFFSet on page 763

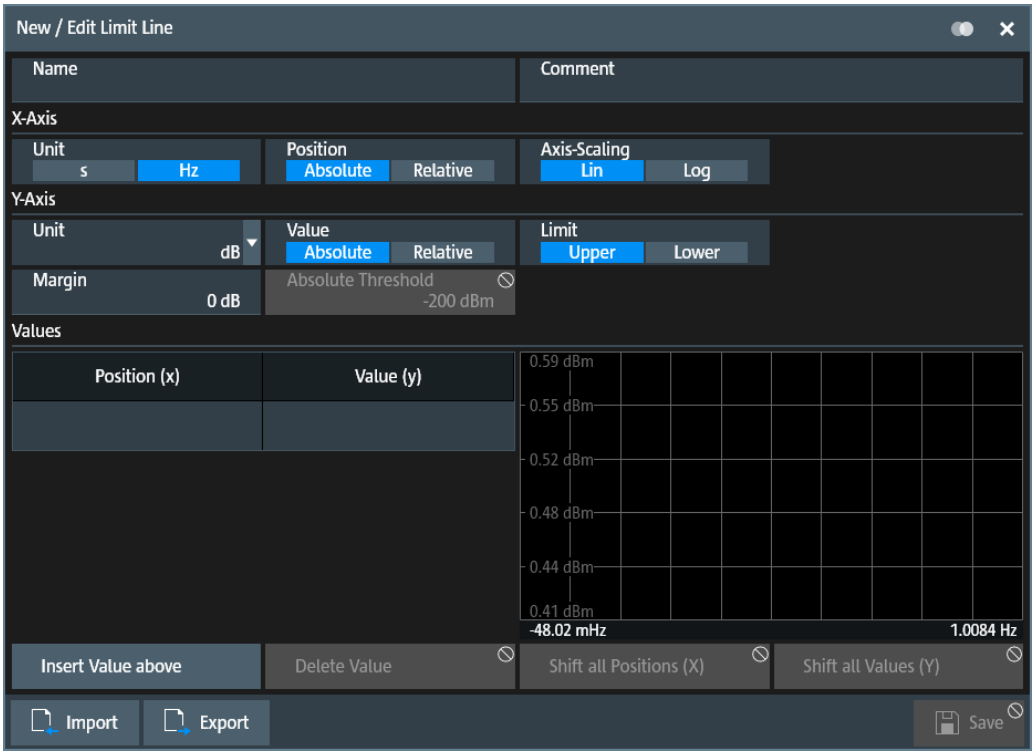
Y-Offset on relative values
Shifts a limit line with a relative y-axis position vertically.

This setting does not affect limit lines that are defined by an absolute y-axis position.

Remote command:
CALCulate<n>:LIMit<li>:LOWer:OFFSet on page 766
CALCulate<n>:LIMit<li>:UPPer:OFFSet on page 770

Limit line details

Access: [Lines] > "Limit Lines Configuration" > "New Limit Line" / "Edit / Save As"



Name....326
Comment....326
Unit....327
Position....327
Axis-Scaling....327
Unit....327
Value....327
Limit....327
Threshold....327
Margin....328
Data points (Position / Value)....328
Insert Value above....328
Delete Value....328
Shift all Positions (X)....328
Shift all Values (Y)....328
Save....328
Import....329
Export....329

Name
Defines the limit line name. The limit line data is stored under this name (with a `.lin` extension).

Remote command:
`CALCulate<n>:LIMit<li>:NAME` on page 767

Comment
Defines an optional comment for the limit line.

Remote command:
CALCulate<n>:LIMit<li>:COMMent on page 762

Unit
Unit of the x-axis values

- "Hz": for frequency domain
- "s": for time domain

Remote command:
CALCulate<n>:LIMit<li>:CONTrol:DOMain on page 762

Position
Scaling mode for the values: absolute or relative values

For relative values, the frequencies refer to the currently set center frequency. In the time domain, the left boundary of the diagram is used as the reference.

Remote command:
CALCulate<n>:LIMit<li>:CONTrol:MODE on page 763

Axis-Scaling
Scaling mode for the x-axis: linear or logarithmic

Remote command:
CALCulate<n>:LIMit<li>:CONTrol:SPACing on page 764

Unit
Level unit

Remote command:
CALCulate<n>:LIMit<li>:UNIT on page 768

Value
Scaling mode of the values: absolute or relative (dB/%) values

Relative limit values refer to the reference level.

Remote command:
CALCulate<n>:LIMit<li>:LOWer:MODE on page 765
CALCulate<n>:LIMit<li>:UPPer:MODE on page 769

Limit
Limit type: upper or lower limit

Values must stay above the lower limit and below the upper limit to pass the limit check.

Remote command:
CALCulate<n>:LIMit<li>:LOWer:SPACing on page 766
CALCulate<n>:LIMit<li>:UPPer:SPACing on page 770

Threshold
Defines an absolute threshold value (only for relative scaling of the y-axis).

For details on thresholds see "Thresholds" on page 320.

Remote command:
CALCulate<n>:LIMit<li>:LOWer:THReshold on page 767
CALCulate<n>:LIMit<li>:UPPer:THReshold on page 771

Margin
Defines a margin for the limit line. The default setting is 0 dB (no margin).

For details on margins see "Limits and margins" on page 319.

Remote command:
CALCulate<n>:LIMit<li>:LOWer:MARGin on page 765
CALCulate<n>:LIMit<li>:UPPer:MARGin on page 769

Data points (Position / Value)
Each limit line is defined by a minimum of 2 and a maximum of 200 data points. Each data point is defined by its position (x-axis) and value (y-axis). Data points must be defined in ascending order. The same position can have two different limit values.

Remote command:
CALCulate<n>:LIMit<li>:CONTrol[:DATA] on page 762
CALCulate<n>:LIMit<li>:LOWer[:DATA] on page 764
CALCulate<n>:LIMit<li>:UPPer[:DATA] on page 768

Insert Value above
Inserts a data point in the limit line above the selected one in the "Edit Limit Line" dialog.

Delete Value
Deletes the selected data point in the "Edit Limit Line" dialog.

Shift all Positions (X)
Shifts the x-value of each data point horizontally by the defined shift width.

To define an offset for the entire limit line, see "X-Offset on relative values" on page 325.

Remote command:
CALCulate<n>:LIMit<li>:CONTrol:SHIFt on page 764

Shift all Values (Y)
Shifts the y-value of each data point vertically by the defined shift width.

To define an offset for the entire limit line, see "Y-Offset on relative values" on page 325.

Remote command:
CALCulate<n>:LIMit<li>:LOWer:SHIFt on page 766
CALCulate<n>:LIMit<li>:UPPer:SHIFt on page 770

Save
Saves the currently edited limit line under the specified "Name".

Import
Opens a file selection dialog and loads the limit line from the selected file in `CSV` format.

Note that a valid import file must contain a minimum of required information for the FSWX.

For details on the file format see "Reference: limit line file format" on page 322.

Remote command:
`MMEMory:LOAD<n>:LIMit` on page 774

Export
Opens a file selection dialog and stores the currently displayed limit line to the defined file in `CSV` format.

For details on the file format see "Reference: limit line file format" on page 322.

You can import the limit line to the FSWX again later for use in other measurements.

Remote command:
`MMEMory:STORe<n>:LIMit` on page 774

4.8.5.3 How to define limit lines

Access: [Lines] > "Line Configuration" > "Limit Lines"

Limit lines for spurious and SEM measurements
Note that for "Spectrum Emission Mask" and "Spurious Emissions" measurements, you can define special limit lines for each frequency range. See "Limit lines in SEM measurements" on page 1032 and "Limit lines in spurious measurements" on page 1074. We strongly recommend that you define limits only via the "Sweep List" dialog for these measurements, not using the [Lines] menu.

The special limit lines are automatically overwritten when you change the sweep list settings.

- How to configure a new limit line....329
- How to find compatible limit lines....330
- How to enable and disable a limit check....331
- How to edit or copy existing limit lines....331
- How to delete an existing limit line....332
- How to move the limit line vertically or horizontally....332
- How to export a limit line....332
- How to import a limit line....333

How to configure a new limit line

1. In the "Limit Lines" dialog, select "New Limit Line".

   The "New / Edit Limit Line" dialog is displayed. The current line configuration is displayed in the preview area of the dialog. The preview is updated each time you change the configuration.

2. Define a "Name" for the new limit line.
3. Optionally, define a "Comment".
4. Define the x-axis configuration:
   - Time domain or frequency domain
   - Absolute or relative limits
   - Linear or logarithmic scaling
5. Define the y-axis configuration:
   - Level unit
   - Absolute or relative limits
   - Upper or lower limit line
6. Define the data points: minimum 2, maximum 200:
   a) Select "Insert Value".
   b) Define the x-value ("Position") and y-value ("Value") of the first data point.
   c) Repeat the steps to insert all other data points.
   To insert a data point before an existing one, select the data point and then "Insert Value above".
   To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value above".
   To delete a data point, select the entry and then "Delete Value".
7. Check the current line configuration in the preview area of the dialog. If necessary, correct individual data points or add or delete some.
8. If necessary, shift the entire line vertically or horizontally:
   a) Select "Shift all Positions (x)" or "Shift all Values (y)".
   b) Define the shift width.
9. Optionally, define a "Margin" at a fixed distance to the limit line.
   The margin must be within the valid value range and is not displayed in the diagram or preview area.
10. Optionally, if the y-axis uses relative scaling, define an "Absolute Threshold" as an additional criteria for a violation.
11. Save the new configuration.

    Note that the limit check is not enabled automatically, see "How to enable and disable a limit check" on page 331.

How to find compatible limit lines

By default, the "Limit Lines" overview displays all limit lines stored in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/limits` folder on the instrument. However, not all limit lines are compatible to all measurements and applications.

► In the "Limit Lines" dialog, enable the "View Filter" option: "Show only compatible".

The overview displays all stored limit lines with the file extension `.lin` that are compatible to the current measurement settings.

How to enable and disable a limit check

The FSWX automatically performs a limit check if any of the limit lines are enabled.

To enable a limit check

1. In the "Limit Lines" dialog, select the "Check Traces" setting for a limit line in the overview.
2. Define which traces the measurement automatically checks for conformance with the selected limit line. You can check several traces using the same limit line simultaneously.
3. Enable the "State" of the limit line.

   The measurement compares the results of each trace to the assigned and active limit lines. If any of the traces violate an active limit line, the diagram shows a message.

To disable a limit check

► In the "Limit Lines" dialog, disable the "State" of the limit line.
To disable all limit lines at once, select "Disable all Lines".

The measurement stops the limit checks for the disabled limit lines. The results are removed from the display.

How to edit or copy existing limit lines

You can edit existing limit line configurations.

Note that for "Spectrum Emission Mask" and "Spurious Emissions" measurements, you can define special limit lines for each frequency range. See "Limit lines in SEM measurements" on page 1032 and "Limit lines in spurious measurements" on page 1074. We strongly recommend that you define limits only via the "Sweep List" dialog for these measurements, not using the [Lines] menu.



Note that any changes you make here to the special limit lines for "Spectrum Emission Mask" and "Spurious Emissions" measurements are automatically overwritten when you change the sweep list settings.

1. In the "Limit Lines" dialog, select the limit line.
2. Select "Edit / Save As".
3. Edit the line configuration as described in "How to configure a new limit line" on page 329.
   To create a copy of the line, define a new "Name".

4. Save the new configuration.

   If the limit line is active, the edited limit line is displayed in the diagram.

How to delete an existing limit line

1. In the "Limit Lines" dialog, select the limit line.
2. Select "Delete".
3. Confirm the message.

   The limit line and the results of the limit check are deleted.

How to move the limit line vertically or horizontally

You can easily move a configured limit line vertically or horizontally. Thus, you can easily create a limit line based on an existing limit line that you shifted.

To shift the complete limit line

For limit lines based on relative values, you can define an additional fixed offset for the complete limit line.

1. In the "Limit Lines" dialog, select the limit line.
2. Select "X-Offset" (horizontal) or "Y-Offset" (vertical).
3. Enter an offset value.

   If enabled, the limit line is shifted in the diagram.

To shift the individual data points

You can shift the individual data points of a limit line by a fixed value, all at once.

1. In the "Limit Lines" dialog, select the limit line.
2. Select "Edit / Save As".
3. Select "X-Offset" (horizontal) or "Y-Offset" (vertical).
4. Enter an offset value.
5. Save the shifted data points.

   If enabled, the limit line is shifted in the diagram.

How to export a limit line

You can store limit lines to an ASCII file for use in other programs or to import them later for other measurements.

1. In the "Limit Lines" dialog, select the limit line.
2. Select "Edit / Save As".
3. Select "Export" to save the limit line to a file.

4. Select a filename and location for the limit line.
5. Select the decimal separator to use in the file.
6. Select "Save".

   The limit line is stored to a file with the specified name and the extension `.csv`. For details on the file format see "Reference: limit line file format" on page 322.

How to import a limit line

You can import limit lines from an ASCII file to the FSWX if they contain a minimum of required data.

For details on the required file format, see "Reference: limit line file format" on page 322.

1. In the "Limit Lines" dialog, select the limit line.
2. Select "Edit / Save As".
3. Select "Import" to load a limit line from a file.
4. Select the filename of the limit line.
5. Select the decimal separator used in the file.
6. Select "Select".

   The limit line is loaded from the specified file and displayed in the "Limit Lines" overview.
7. Enable the limit line as described in "How to enable and disable a limit check" on page 331.

4.8.6 Zoomed displays

You can zoom into the diagram to visualize the measurement results in greater detail. Using the touchscreen or a mouse pointer you can easily define the area to be enlarged.

- Graphical zoom vs measurement zoom....333
- Single zoom versus multiple zoom....334
- Zoom functions....335
- How to zoom into a diagram....337

4.8.6.1 Graphical zoom vs measurement zoom

Graphical zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points, the frequency range, or the reference level. Graphical zooming only changes the resolution of the displayed trace points temporarily. You must explicitly activate the graphical zoom function.

Graphical zoom and the number of sweep points

Note that (graphical) zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points.

Increase the number of sweep points before zooming. Otherwise, the resolution of the trace in the zoomed region is poor (see Section 4.3.3.8, "How much data is measured: sweep points and sweep count", on page 246).

When you change the display using touch gestures, however, the corresponding measurement settings are adapted. For example, dragging horizontally in a spectrum display changes the center frequency. Dragging vertically in a spectrum display changes the reference level (for absolute scaling). These changes are permanent for the measurement. This behavior is also referred to as *measurement zoom*, and is active by default in the new FSWX. However, you can also activate it manually for a display that has already been zoomed graphically. In this case, the temporary changes to the display are replaced by permanent changes to the measurement settings with the same effect.

Example:

Assume you have a spectrum display from a spurious emission measurement. You graphically zoom into the area around a detected spur. If you now activate a measurement zoom, the reference level, the center frequency, the frequency span, and the scaling settings are adapted. The results of the measurement then indicate only the formerly zoomed area around the detected spur.

4.8.6.2 Single zoom versus multiple zoom

The FSWX provides two different (graphical) zoom modes: single zoom and multiple zoom.

A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. You can use this function repetitively until the required details are visible.

In multiple zoom mode, you can enlarge up to four different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace. The zoomed trace areas are displayed in individual windows. You can move and resize the zoom areas at any time. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

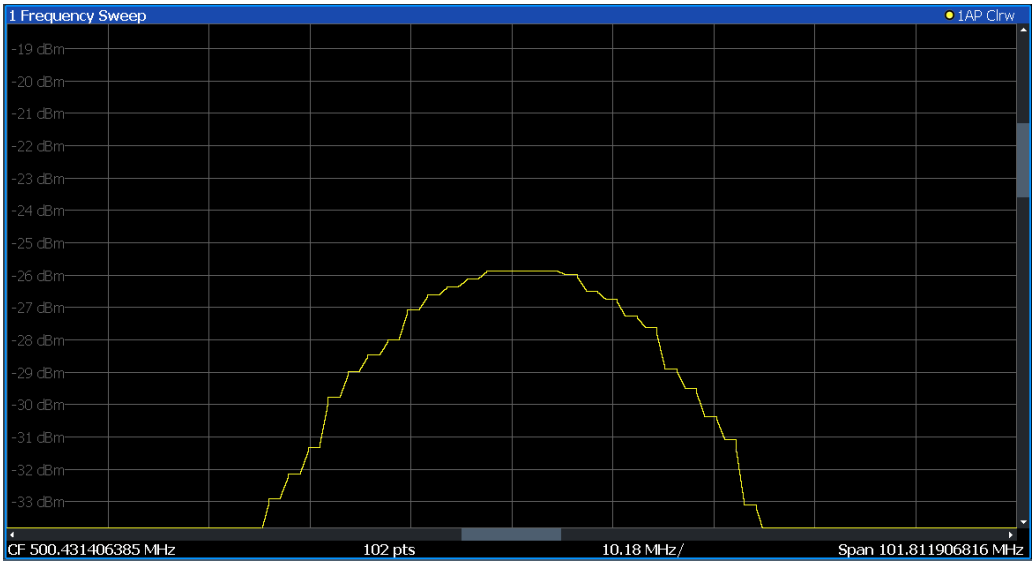


Figure 4-50: Single zoom

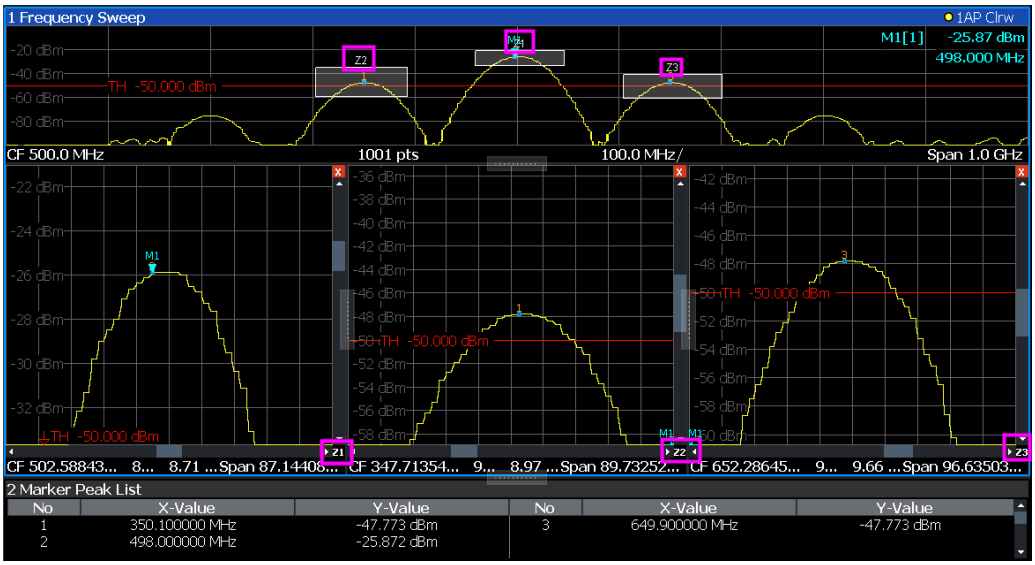


Figure 4-51: Multiple zoom

Using the zoom area to restrict a peak search

You can use the selected zoom area to restrict the search range for a peak search, but only in single zoom mode.

4.8.6.3 Zoom functions

Access: zoom icons in toolbar

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Multi-Zoom....336
Measurement Zoom....336
└ Level Lock....337
└ X-Lock....337
└ Y-Lock....337
└ Adapt Measurement to Zoom (selected diagram)....337
Zoom Off (Restore original display)....337



Single Zoom
A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. You can use this function repetitively until the required details are visible.

For details on zooming, see Section 4.8.6.2, "Single zoom versus multiple zoom", on page 334.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe]` on page 666
`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA` on page 665



Multi-Zoom
In multi-zoom mode, you can enlarge several different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace. The zoomed trace areas are displayed in individual windows.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe]`
on page 668
`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA`
on page 667



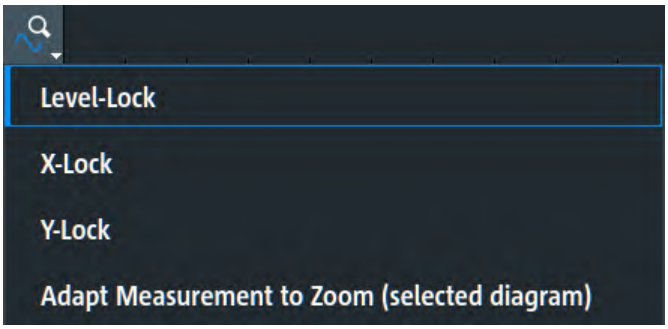
Measurement Zoom
The graphical zoom is merely a visual tool. The measurement zoom adapts the measurement settings such that the data you are interested in is displayed in the required detail. In measurement zoom mode, you can change the display using touch gestures. This is the default operating mode of the FSWX.

For details on touch gestures, see "Touch gestures in diagrams change measurement settings" on page 86.

Note: The measurement settings are adapted to practical values based on a suitable grid for the current settings. They are not adapted to impractical values that reflect precisely the pixel you happen to tap.
If the measurement zoom leads to undesirable results, you can easily return to the original measurement settings using the "Undo" function.

When you select the "Measurement Zoom" icon, then tap in a diagram, a dotted rectangle is displayed which you can drag to define the zoom area. Using the rectangle allows you to define the zoom area more precisely than by spreading two fingers in the display.

The measurement zoom function provides further options in a context-sensitive menu, which is displayed when you tap the icon for about a second (or right-click it). These options affect the behavior of the firmware for subsequent touch gestures on the screen. Note that these settings remain unchanged after an application instance preset.



Level Lock ← Measurement Zoom
If enabled (default), the reference level, and thus the attenuation, are locked. That means, they remain unchanged if you perform touch gestures on the screen.

X-Lock ← Measurement Zoom
If enabled, the x-axis of the diagram is not changed during subsequent touch gestures.

Y-Lock ← Measurement Zoom
If enabled, the y-axis of the diagram is not changed during subsequent touch gestures.

Adapt Measurement to Zoom (selected diagram) ← Measurement Zoom
If you already performed a graphical zoom using the "Single Zoom" on page 336 or "Multi-Zoom" on page 336 function, this function automatically adapts the measurement settings to maintain the currently zoomed display.

Zoom Off (Restore original display)
Restores the original display, that is, the originally calculated display for the entire capture buffer, and closes all zoom windows.

Note: This function only restores graphically zoomed displays. Measurement zooms, for which measurement settings were adapted, are recalculated based on the adapted measurement settings. In this case, the zoomed display is maintained.

Remote command:
Single zoom:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe]` on page 666
Multiple zoom:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe]`
on page 668 (for each multiple zoom window)

4.8.6.4 How to zoom into a diagram

The remote commands required to zoom into a display are described in Section 4.14.11.1, "Zooming into the display", on page 665.

For information on how to zoom into a diagram using touch gestures and change the display permanently, see "Touch gestures in diagrams change measurement settings" on page 86.

The following tasks are described here:

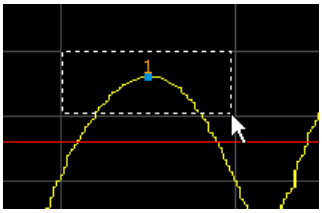
- To zoom into the diagram at one position 338
- To return to original display 339
- To zoom into multiple positions in the diagram 339
- To move or change zoom areas 339
- To maintain a zoomed display permanently 339
- To perform a measurement zoom 340

To zoom into the diagram at one position

1. Select "Single Zoom" in the toolbar.

   Zoom mode is enabled.

2. Tap and drag your finger in the diagram to select the area to enlarge. The selected area is indicated by a dotted rectangle.

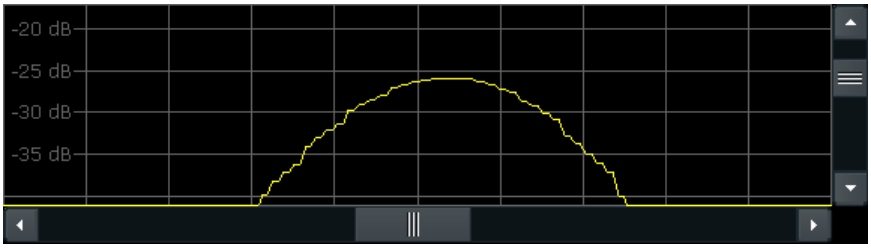
   

   When you leave the touchscreen, the diagram is replaced by the zoomed trace area.

3. Repeat these steps, if necessary, to enlarge the diagram further.

Scrolling in the zoomed display

You can scroll the diagram area to display the entire diagram using the scrollbars at the right and at the bottom of the diagram.



To return to original display



► Select "Zoom Off" in the toolbar.

The original trace display is restored.

To zoom into multiple positions in the diagram



1. Select "Multi-Zoom" icon in the toolbar.

   Multiple zoom mode is enabled.

2. Select the first area in the diagram to enlarge as described in "To zoom into the diagram at one position" on page 338. The selected area is indicated by a dotted rectangle.

   When you have completed your selection, the original trace is shown in an overview diagram. The selected area is indicated by a dotted rectangle. The zoomed trace area is displayed in a separate window (see Figure 4-51.



3. Select "Multi-Zoom" in the toolbar again.

4. In the overview diagram, select the next area to enlarge.

   The second zoom area is indicated in the overview diagram, and a second zoom window is displayed.

5. Repeat these steps, if necessary, to zoom into further trace areas (up to four).

To move or change zoom areas

In multiple zoom mode, you can change the size or position of the individual zoom areas easily at any time.

To resize a zoom area

1. Tap directly **on** the corresponding frame in the overview window.
2. Drag the line to change the size of the frame.

To move a zoom area

1. Tap **inside** the corresponding frame in the overview window.
2. Drag the frame to the new position.

   The contents of the zoom windows are adapted accordingly.

To maintain a zoomed display permanently

Graphical zooming only changes the resolution of the displayed trace points temporarily. To change the display permanently, you must change the corresponding measurement settings.

(Note: Performing a measurement zoom automatically adapts the measurement settings to reflect a graphically zoomed display, see "To perform a measurement zoom" on page 340).

1. Perform a graphical zoom as described in "To zoom into the diagram at one position" on page 338.



2. Select "Measurement Zoom" from the toolbar.
3. Select "Adapt Measurement to Zoom (selected diagram)".

   The measurement settings are adapted as required to obtain the zoomed result display.

To perform a measurement zoom

Performing a measurement zoom automatically adapts the measurement settings to reflect a graphically zoomed display.



1. Select "Measurement Zoom" from the toolbar.
2. Do one of the following to define the zoom area:
   - Stretch two fingers in the diagram to enlarge the area between them.
   - Tap and drag one finger in the diagram to select the area to enlarge. The selected area is indicated by a dotted rectangle.

   The measurement settings are adapted as required to obtain the zoomed result display.

4.9 Event-based actions

During a measurement, specific events require that you take a certain action. The FSWX allows you to automize such tasks.

Using the event-based actions feature, you can detect a particular state of the device under test. Then you can document it for further research or start a specific procedure. The mechanism triggers one or more actions at the end of a sweep, if a certain condition applies. Triggering conditions are referred to as *events*. Typical examples for events are exceeding or going below a limit value, the (non-) violation of a limit line, or reaching a marker value. The range of actions includes taking a screenshot, starting a separate program, or saving I/Q data. Also, continuous sweeping can be stopped to retain the data of a particular state of the system. The combinations of events and actions are called *rules*. Each application individually specifies its own set of rules.

General conditions for event-based actions

Some general conditions apply to event-based actions:

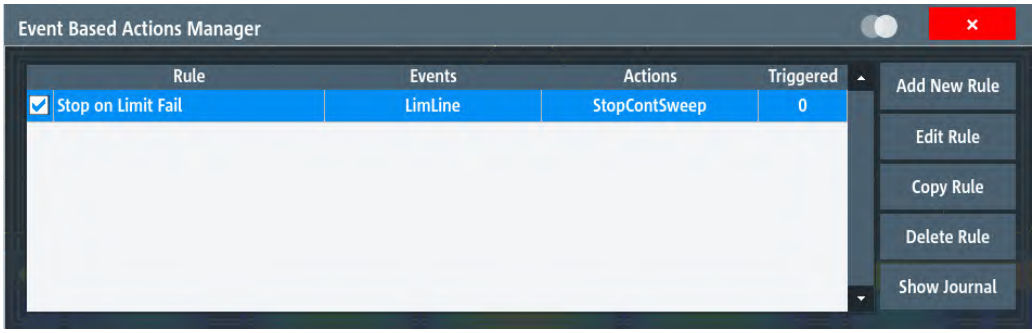
- You can define a maximum of 5 rules for each application.
- Rules defined in one application are visible in the other applications, but you cannot edit or enable them there. The same applies to different measurements within a single application (e.g. SEM and ACLR).
- Only the currently active application instance processes rules.
- The applications do not perform a validity check on the rules.
- When you save and then recall the instrument settings, the FSWX also stores and loads any rule definitions, including their state.
- When you preset or restart the instrument, the rules are maintained, but disabled. The trigger count for rules is cleared.

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- Defining rules....342
- Defining events....344
- Defining actions....346
- Debugging rules with the EBA-Journal....348
- Reference: overview of available result-events and state-events....350

4.9.1 Managing rules

Access: "Event Based Actions"

The event-based actions manager allows you to configure actions to perform when specific events occur in the measurement.



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Rule....342
Events....342
Actions....342
Triggered....342
New Rule....342
Edit Rule....342
Copy Rule....342
Delete Rule....342
Show Journal....342

Rule state
Enables/disables processing of the defined rule for the currently active application instance only.

Note that the application does not perform a validity check on the rules. For example, if you change or delete the required command file for a rule, the rule becomes invalid. However, the application still attempts to process the rule as far as possible. An easy way to detect such a situation is using the log information, see Section 4.9.5, "Debugging rules with the EBA-Journal", on page 348.

The base unit applications ("Spectrum", "I/Q Capture", "AM/FM/PM Analog Demod") are counted together. Rules defined in one application are visible in the other applications, but you cannot edit or enable them there.

Rule
Name of the rule

Events
Specified events that trigger the rule

Actions
Specified actions to be performed by the rule

Triggered
Number of trigger events for the rule that occurred since the last instrument preset or restart.

New Rule
Opens the "Event Based Actions: Add Rule" dialog box to define a new rule as described in Section 4.9.2, "Defining rules", on page 342.

Edit Rule
Opens the "Event Based Actions: Modify Rule" dialog box to edit the selected rule as described in Section 4.9.2, "Defining rules", on page 342.

Copy Rule
Creates a copy of the selected rule and opens the "Event Based Actions: Modify Rule" dialog box to edit it, as described in Section 4.9.2, "Defining rules", on page 342.

Delete Rule
Deletes the selected event-based action rule.

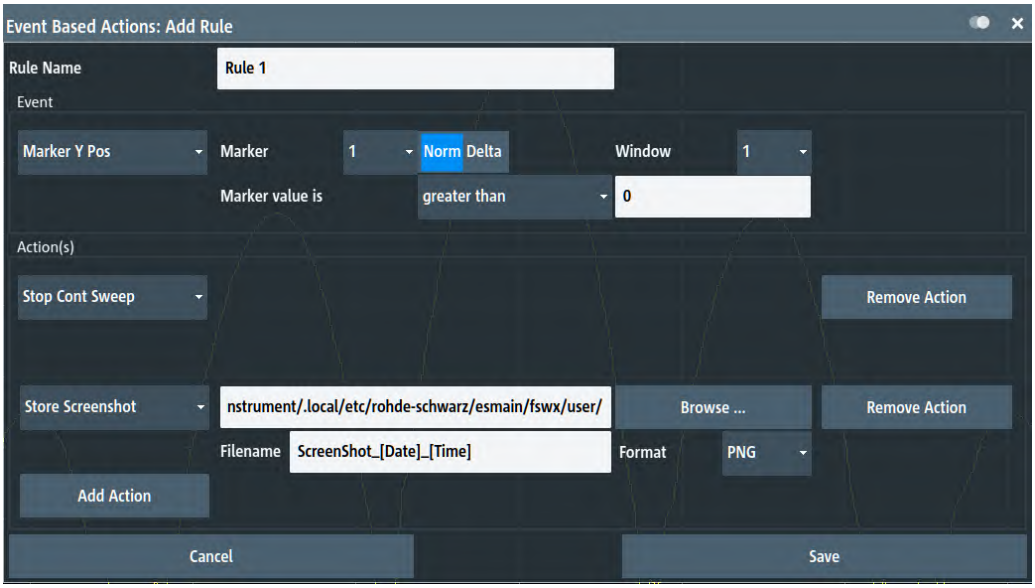
Show Journal
Shows the logging information for the rules defined in the EBA rule manager. This information is useful to debug rules when expected actions are not performed. For details, see Section 4.9.5, "Debugging rules with the EBA-Journal", on page 348.

4.9.2 Defining rules

Access: "Event Based Actions" > "New Rule" / "Edit Rule" / "Copy Rule"

You define rules individually for each application instance. You must activate each rule for each application individually. Only the currently active application instance processes the rules.

You can define a maximum of 5 rules for each application. Rules defined in one application are visible in the other applications, but you cannot edit or enable them there. The same applies to different measurements within a single application (e.g. SEM and ACLR).



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Add Action....343
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Rule Name
Defines the unique name for the actions to take under specific conditions.

Without a name, the rule cannot be stored.

Event
Defines the event that triggers the action. See Section 4.9.3, "Defining events", on page 344.

Action
Defines the actions to be taken when the specified events occur. See Section 4.9.4, "Defining actions", on page 346.

Add Action
Adds another action to be taken when the specified events occur. You can define up to 3 different actions. The order in which the actions are defined is irrelevant.

If several actions are scheduled due to one or more rules, the actions are performed in the following order (if specified):

- 1. Store Screenshot
- 2. Auto Level

Any other actions are performed in parallel.

Remove Action
Removes the corresponding action from the rule.

Save
Saves the rule definition. You can only save the rule if its definition is valid. Invalid parts of the definition are indicated by red font, for example if the specified command name, result, or limit line does not exist. Other validity checks are not performed.

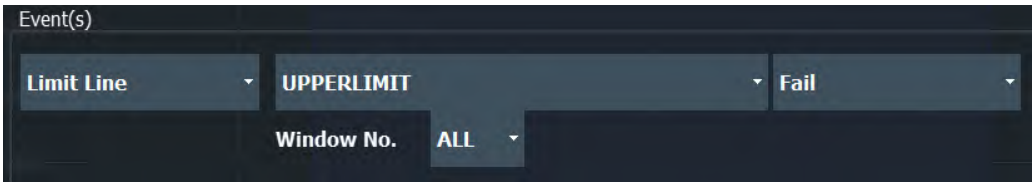
4.9.3 Defining events

Defines the event that triggers the action.

Depending on the selected event, further parameters are available.

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└ Limit Line....344
└ Condition....345
└ Window....345
Marker Y Pos....345
└ Marker....345
└ Window....345
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Result Value....345
└ Result....345
└ Trigger condition (Value is)....346
└ Value....346
State Value....346
└ Result....346
└ Trigger condition (Check for)....346

Limit Line
The result of a limit line check triggers the actions.



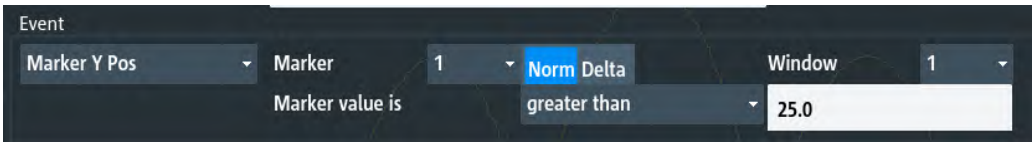
Limit Line ← Limit Line
The name of a limit line that is defined for the current application instance (see Section 4.8.5, "Limit lines for value ranges", on page 318).

The limit line must be active in the current application instance for the rule to be processed.

Condition ← Limit Line
The result of the limit check ("Pass" / "Fail" / "Margin") that triggers the actions.

Window ← Limit Line
Window in which the specified limit line is evaluated.

Marker Y Pos
The value of a specific marker triggers the actions. The marker must be active in the current application instance for the rule to be processed (see Section 4.8.2, "Marker usage", on page 304).



Marker ← Marker Y Pos
The marker whose value triggers the actions.

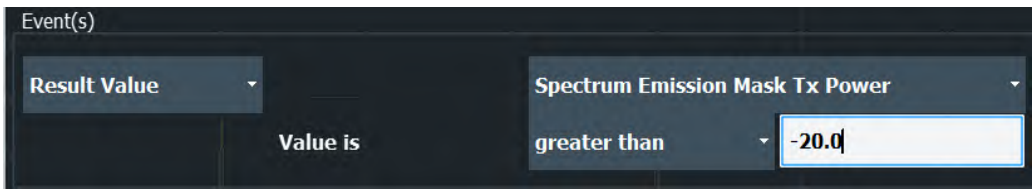
Only for marker 1: also the marker type ("Norm"/"Delta")

Window ← Marker Y Pos
Window in which the specified marker is evaluated.

Trigger condition (Marker value is) ← Marker Y Pos
The relation of the marker value to the specified value ("greater than" / "lower than") that triggers the actions.

Value ← Marker Y Pos
Value with which the marker value is compared.

Result Value
The value of a specific result triggers the actions. Depending on the currently selected measurement, different result values are available (see Section 5.3, "RF measurements", on page 985, Section 4.9.6, "Reference: overview of available result-events and state-events", on page 350).



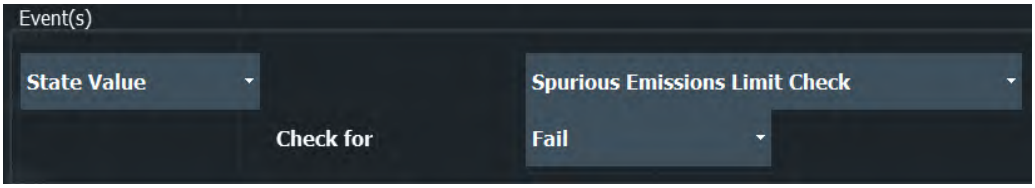
Result ← Result Value
The measurement result whose value is evaluated (see also Section 4.9.6, "Reference: overview of available result-events and state-events", on page 350).

Trigger condition (Value is) ← Result Value
The relation of the result value to the specified value ("greater than" / "lower than") that triggers the actions.

Value ← Result Value
Value with which the result value is compared.

State Value
The measurement result whose state ("Pass" / "Fail") is evaluated. Depending on the currently selected measurement, different state results are available (see Table 4-28).

For example, a limit check for a specific result triggers the actions.



Result ← State Value
The measurement result whose state is evaluated (see also Table 4-28).

Trigger condition (Check for) ← State Value
The state ("Pass" / "Fail") that triggers the actions.

4.9.4 Defining actions

Defines the actions to be taken when the specified events occur.

Depending on the selected action, further settings are available.

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I/Q Export 348

Store Screenshot
Creates and stores a screenshot of the current display to a file.



Storage location (Browse) ← Store Screenshot
Defines the storage location of the screenshots. Enter the path of the target directory directly, or browse in the file explorer and select the directory there.

Filename ← Store Screenshot
Define the path and (generic) filename. The default directory is `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user`. If necessary, a consecutive number is added to the specified file name to create unique file names. Insert placeholders in square brackets to create generic filenames. The placeholders are replaced by current values at the time the data is exported.

The following placeholders are supported:
- [Year]
- [Month]
- [Day]
- [Hour]
- [Minute]
- [Second]
- [Date] = `[Year]-[Month]-[Day]`
- [Time]: = `[Hour]-[Minute]-[Second]`

Example:

The definition `ScreenShot_[Date]_[Time]` creates file-names such as `ScreenShot_2024-12-14_12-49-51.PNG`, `ScreenShot_2024-12-14_12-50-01.PNG`.

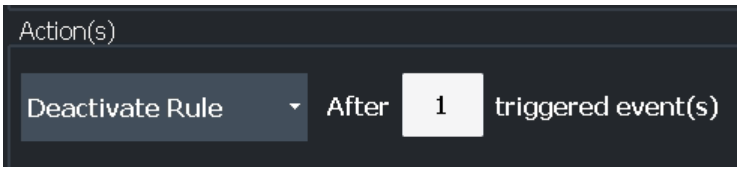
Format ← Store Screenshot
Defines the image file format.

Stop Cont Sweep
Stops a continuous sweep.

No further parameters required.

Deactivate Rule
Deactivates the rule after the specified number of trigger events occurred.

Useful to perform a single action only.



Auto Level
Automatically optimizes the level settings according to the current measurement.

Note: If several "Auto Level" actions are defined for the same rule or for multiple rules, only one "Auto Level" action is performed.
Combining an I/Q data export and the "Auto Level" function for the same event stops a continuous sweep.

Trace Export
Stores the current trace data to the specified file.

Note: Exporting trace data more than once for the same event is not possible (and not useful), even if the event is specified for multiple rules.

Define the path and (generic) filename. The default directory is `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user`. If necessary, a consecutive number is added to the specified file name to create unique file names. Insert placeholders in square brackets to create generic filenames. The placeholders are replaced by current values at the time the data is exported.

The following placeholders are supported:
- [Date] = `[Year]-[Month]-[Day]`
- [Time]: = `[Hour]-[Minute]-[Second]`

Browse ← Trace Export
Opens a file selection dialog box to select the directory for exported traces.

Mode ← Trace Export
Defines whether all traces or only user-defined traces are exported (as defined in "Trace Configuration" > "Export & Import" settings).

I/Q Export
Stores the current I/Q data to the specified file. Only available for I/Q-based applications. Not available for the "I/Q Capture" application.

Note: Exporting I/Q data more than once for the same event is not possible (and not useful), even if the event is specified for multiple rules.
Combining an I/Q data export and the "Auto Level" function for the same event stops a continuous sweep.

Define the path and (generic) filename. The default directory is `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user`. If necessary, a consecutive number is added to the specified file name to create unique file names. Insert placeholders in square brackets to create generic filenames. The placeholders are replaced by current values at the time the data is exported.

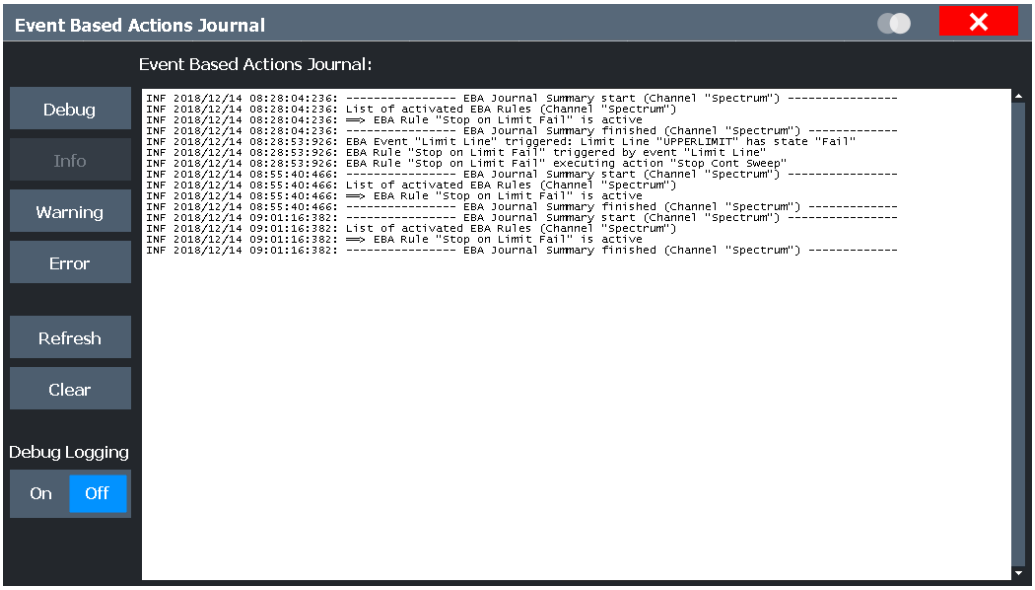
The following placeholders are supported:
- [Date] = `[Year]-[Month]-[Day]`
- [Time]: = `[Hour]-[Minute]-[Second]`

Select "Browse" to select the directory for exported data from a file selection dialog box.

4.9.5 Debugging rules with the EBA-Journal

Access: "Event Based Actions" > "Show Journal"

The event-based actions journal shows the logging information for the rules defined in the EBA manager. This information is useful to debug rules when actions are not performed as expected.



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Clear 349
Debug Logging 349

Debug / Info / Warning / Error
Determines which level of information the journal provides, depending on its importance. Each level displays information of the selected level or higher. The type of information is indicated in the log display.

"DBG"	Additional descriptions as debugging information (only if Debug Logging is enabled).
"INF"	Basic information on triggering events or executed actions defined by the active rules
"WNG"	Information on possibly unexpected results due to conflicting rule definitions, for example if an "Auto Level" action causes the EBA manager to pause execution of further actions.
"ERR"	Errors concerning failed rules, for example due to a missing action command or an invalid trigger event

Refresh
Updates the journal display to include the latest information (since the journal was opened or last updated).

Clear
Clears all currently stored information in the journal.

Debug Logging
If enabled, additional debug information is logged in the journal. Since this information requires large amounts of storage space and can slow down the performance of the firmware, use this mode carefully and only when necessary for troubleshooting. Debug mode is automatically disabled when you close the "EBA Journal" dialog.

4.9.6 Reference: overview of available result-events and state-events

Using the event-based actions, you can define actions to be performed depending on the values or states of specific results. The following overview shows you which results and states are available for which measurements.

Table 4-28: Available result and state events

Measurement	Results	States
"Channel power ACLR"	"Channel Power ACLR Tx Total"	"Channel Power ACLR"
	"Channel Power ACLR Tx<1-n>"	
	"Channel Power ACLR Adj Lower"	
	"Channel Power ACLR Adj Upper"	
	"Channel Power ACLR Alt<1-n> Lower"	
	"Channel Power ACLR Alt<1-n> Upper"	
"Carrier-to-Noise"	"C/N"	
	"C/N_0"	
"OBW"	"OBW Occ BW"	
	"OBW Occ BW Freq Offset"	
"Statistics"	"APD Crest (TRC <1-6>)"	
	"CCDF Crest (TRC <1-6>)"	
"Spectrum Emission Mask"	"Spectrum Emission Mask Tx Power"	"Spectrum Emission Mask Limit Check"
"Spurious Emissions"		"Spurious Emissions Limit Check"
"Time Domain Power"	"Time Domain Power Peak"	
	"Time Domain Power RMS"	
	"Time Domain Power Mean"	
	"Time Domain Power Std Dev"	
"Noise Power Ratio"	"NPR Channel Power Density"	
	"NPR Notch Power Density"	
GSM (R&S FSW3-K10)	"EVM RMS peak"	"Limit check - PvT"
	"EVM peak current"	"Limit check - ModSpectrum"
	"EVM peak peak"	"Limit check - TransSpectrum"
	"Mag error RMS current"	"Burst found"
	"Mag error RMS peak"	"Sync found"
	"Mag error peak current"	
	"Mag error peak peak"	
	"Phase error RMS current"	

Measurement	Results	States
	"Phase error RMS peak"	
	"Phase error peak current"	
	"Phase error peak peak"	
	"Frequency error current"	
	"Frequency error peak"	
	"Slot power current"	
	"Slot power peak"	
Vector Signal Analysis (R&S FSW3-K70)	"EVM RMS"	"Burst found"
	"EVM Peak"	"Waveform found"
	"Carrier Frequency Error"	"Signal within limits"

4.10 File and data management

The FSWX allows you to store and load instrument settings, and import and export measurement data for analysis later. Finally, you can store the measurement results displayed on the screen.

General storage and import/export functions are available via the toolbar. Some special storage functions are (also) available via softkeys or dialog boxes in the corresponding menus, for example trace data export.

For details on managing files on the instrument, see Section 4.12.6.1, "File Manager", on page 477 and "To exchange files with the FSWX" on page 488.

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- Restoring the default instrument configuration (preset)....357
- Storing and recalling instrument settings and measurement data....358
- Exporting and importing measurement results for evaluation....366
- I/Q data import and export....377
- Screenshots of current measurement results and settings....381

4.10.1 About the file system

Depending on their accessibility, this description distinguishes between system files and user files.

System files and the system directory are protected and not accessible by the user. They contain operating system and firmware files that are required for basic instrument operation.

User files contain user-defined configurations or data. Users can access and handle these files.

Firmware version dependent data vs. global data

Some data is provided by the firmware, e.g. predefined configuration sets. Users can access and overwrite this data, but it is overwritten by new firmware versions. To preserve a specific firmware state, including this data, you can create a snapshot. See Section 4.12.3.9, "System snapshot settings", on page 473. Firmware version specific data is stored in the directory: `var/lib/rohde-schwarz/esmain/fswx`.

Data created and stored by the user is not overwritten by firmware updates. It is available globally for all applications. Global user data is stored in the directory: `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user`.

In remote control, you can query this directory using `MMEMory:UDIRectory?` on page 783.

Persistent vs. volatile user data

Depending on the **data storage method**, user data can be:

- *Persistent*, i.e. user files that are recorded on the data storage.
  Data is preserved when the instrument is removed from power and can be accessed and modified subsequently.
- *Volatile*, i.e. temporary data that the instrument retains only while it is powered on.
  Volatile data is lost immediately when the FSWX is switched off.

Without any additional measures, the FSWX stores user files on the internal memory or, if connected, on a USB storage device.

You can store user-defined data **permanently**:

- In the unprotected `home/instrument/` directory (or any subdirectory) on the internal memory
- In the `run/media/instrument/usb/` directory (or any subdirectory) on the USB storage device

The (top-level) `tmp` directory is a TempFileSystem (tmpfs), meaning the content is stored in volatile memory, called RAM. The content is only stored **temporarily**, and deleted immediately when the FSWX is switched off. Thus, you can use this directory to protect sensitive information.



Limited storage space

Note that the available RAM on the instrument is limited. It is not only used to store volatile user data, but also for other temporary data required by internal processes. Thus, if you store large amounts of data in this directory, the performance of the firmware can decrease, or a "Memory full" error can occur.

Default storage location

By default, the FSWX stores user data in the directory `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user`.

In manual control, you access this directory via the "File Manager", see Section 4.12.6.1, "File Manager", on page 477.

To query and change the default directory used for mass storage, use the command `MMEMory:CDIRectory`.

File naming conventions

To enable files to be used in different file systems, consider the following file naming conventions:

- The filename can be of any length.
- The name is case-sensitive, i.e. uppercase and lowercase letters are considered to be different.
- All letters and numbers are permitted. However, do not begin a filename with a number.
- You can also use underscores, hyphens, periods. However, do not begin a filename with a hyphen.
- Do not use slashes "\" and "/". These symbols are used in file paths.
- Do not user special characters, such as ":", "*", "?", "$", "%" or brackets, which have special meanings in the operating system and can cause problems.
- Avoid using the following filenames: `CLOCK$`, `CON`, `COM1 to COM4`, `LPT1 to LPT3`, `NUL` or `PRN`
  They are reserved by the operating system.

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- Overview of default storage locations 355

4.10.1.1 Accessing, retrieving and handling data

Depending on their origin and content, this description distinguishes between the following data types:

- Operational data
- Non-operational data

Operational data (data for intended use)

Your instrument uses and creates this data because of its intended use and according to the settings and configuration you have made. Thus, this data makes up most of the data that the FSWX creates.

The following data types contain user data:

- Settings or configuration files, for example when you save the current instrument settings and load these settings on another instrument.
  See Section 4.10.3, "Storing and recalling instrument settings and measurement data", on page 358.
- Input signal files, containing stored I/Q data from previous measurements.
  See Section 4.10.5, "I/Q data import and export", on page 377.
- Measurement result export files.
  See Section 4.10.4, "Exporting and importing measurement results for evaluation", on page 366.

- Externally or internally generated user correction lists. You can load these list files on the instrument.
  See "How to export a transducer" on page 410 and "How to import a transducer factor" on page 411
- Screenshots of the instrument display
  See Section 4.10.6, "Screenshots of current measurement results and settings", on page 381.
- SCPI scripts that contain a series of commands. You can run the script to perform a task.
  See Section 4.13.4.4, "How to create and export SCPI scripts", on page 512.

Non-operational data (usage data)

The FSWX creates this data during and through its use. Such data is collected e.g. for troubleshooting, to help our customer support center find solutions quickly.

The FSWX generates the following data continuously and in real-time:

- User and authentication data
- Network and communication data
- Diagnostic and troubleshooting data
- Environmental conditions

On demand, this data is stored in a ZIP file containing files in TXT format. The file size typically amounts to about 10 MB. You can access and retrieve this data, and store the data on a remote server, for example via a network connection. See:

Section 7.7, "Collecting information for support", on page 1482

For additional information on the different memory types of your product and on how to protect sensitive data, see:

- "Protecting data using internal volatile memory" on page 470.
- Instrument Security Procedures document.
  See https://www.rohde-schwarz.com/manual/fswx-instrument-security-procedures_78701-1599717.html.

File access

To access files and the file system of the instrument or to use the general file management functions such as copying and moving data, use the standard "File Manager" dialog.

See Section 4.12.6.1, "File Manager", on page 477.

For remote access in a LAN, a file manager is available as a web application. See Section 4.13.2.7, "File manager", on page 489.

Note that in the file manager web application, only a limited part of the instrument file system is accessible. For example, operating system files are hidden. Only the following main directories are shown:

- `firmwaredata` - mapped from the instrument directory `var/lib/rohde-schwarz/esmain/fswx`

- `userdata` - mapped from the instrument directory `home/instrument/.local/share/rohde-schwarz/esmain/fswx`
- `usb` (optionally, if connected) - mapped from the instrument directory `run/media/instrument/usb/`

In the R&S Linux operating system, directories that start with a "." are hidden by default. If necessary, enable the "Show hidden files" option in your file manager.

File transfer

To transfer files from and to the instrument or to exchange files, use one of the following methods:

- Connect a memory stick to one of the USB interfaces.
  The instrument automatically recognizes a connected memory stick and assigns the `run/media/instrument/usb/` drive to it.
- Connect the instrument to a LAN and establish an SMB (samba) connection from a host device to the instrument. The instrument `home` directory is configured as a mapped network folder named "instrument". You can access it directly from any host device, also using a Windows operating system. On the host device, in a file explorer, enter `\\<instrument_name>`, where <instrument_name> is the computer name or IP address of the FSWX.

4.10.1.2 Overview of default storage locations

System files and the system directory are protected and not accessible. These files are stored in the `opt/rohde-schwarz/esmain/fswx` directory.

User data and predefined data that the user can edit is stored in the `home/instrument/` directory.

The FSWX uses the following default folders to store application and user-specific data.

Table 4-29: Protected folders

Data type	Default storage location
Program files, installation directory	`opt/rohde-schwarz/esmain/fswx`
Predefined ACP configuration files (fallback files for restoration)	`opt/rohde-schwarz/esmain/fswx/etc/acp_backup`
Predefined SEM files (fallback files for restoration)	`opt/rohde-schwarz/esmain/fswx/etc/sem_backup`
Predefined application data (fallback files for restoration)	`opt/rohde-schwarz/esmain/fswx/etc/predefined`
License server	`opt/rohde-schwarz/license-server/bin/`

Table 4-30: Firmware version specific data (firmwaredata)

Data type	Default storage location
var/lib/rohde-schwarz/esmain/fswx	
Self-alignment data	/devicedata/external_frontends
Conversion loss tables	/user/cvl
Frequency response files	/user/fresponse
Device footprint	/devicedata/xml
Predefined, configurable application data, e.g. demo signals	/user/predefined/<application>
Wave forms	user/waveform
I/Q data export	/user/<filename>
Trace export data	/user/<filename>
Test reports	/user/<filename>
Log files	var/log/esmain/fswx/runtime/

Table 4-31: Global data created by users (userdata)

Data type	Default storage location
home/instrument/.local/share/rohde-schwarz/esmain/fswx	
ACP standards (predefined and user-specific)	//acp_std
Event-based actions	/eba
Limit lines	/limits
SCPI recordings	/scpirecordings
SCPI log files	/scpilogging
SEM standards (predefined and user-specific)	/sem_std
Transducer files	/trd
Instrument settings	/user/quicksave
Screenshots	/user/<filename>
Device support information	/user/RS_Device_xxx.zip
External frontend configuration	/external_frontends

Table 4-32: Provided tools for connected devices with Windows operating system

Data type	Default storage location
home/instrument/win_inst	
Tool to execute remote commands directly on the instrument (IECWIN)	home/instrument/win_inst/iecwin.exe
VISA interface library to communicate with the instrument (RSVISA)	home/instrument/win_inst/rsvisa

4.10.2 Restoring the default instrument configuration (preset)

The FSWX is delivered with a default configuration. You can restore this defined initial state at any time as a known starting point for measurements ([Preset]). Presetting is often recommendable as a first step in troubleshooting when unusual measurement results arise.

Factory default configuration

The factory default configuration protects the RF input against overload, as long as the applied signal levels are in the allowed range for the instrument.

As an alternative to the factory default settings, you can define user-specific recall settings to be restored after a preset or reboot, see Section 4.10.3.2, "Configurable storage and recall", on page 360.

To restore the default instrument configuration for all application instances at once

► Select [Preset].

After you use the [Preset] function, the history of previous actions is deleted, i.e. you cannot undo or redo any actions performed previously using the [Undo]/[Redo] keys.

Remote command:

*RST or SYSTem:PRESet

To restore the default configuration for a single application instance

You can restore the default measurement settings for an individual application instance only, instead of resetting the entire instrument.

► In the "Overview", select "Preset Application".

The current application instance is reset to the factory default settings. Note that you cannot reset an application instance to a user-defined recall settings file.

Remote command:

SYSTem:PRESet:CHANnel[:EXEC] on page 791

4.10.3 Storing and recalling instrument settings and measurement data

Access: "Save"/ "Open"

Perhaps you want to restore or repeat a measurement you performed under specific conditions on the instrument. Or you want to evaluate imported data in another application on the FSWX using the same measurement settings. In these cases, you can store and recall instrument and measurement settings, and possibly other related measurement data.

Two different methods are available to manage instrument settings:

- "Quick Save"/"Quick Recall": a defined set of instrument settings or application settings are stored or recalled quickly in just one step.
- Configurable Save/Recall ("Save as File"): a user-defined set of instrument settings or application settings are stored to a definable storage location.

Restrictions when recalling measurement settings

When recalling a saved configuration file, the following restrictions apply:

- The FSWX must support the frequency range defined in the configuration file.
- Configuration files created on a FSWX with certain options in use do not work on an FSWX without these options.
- Files created with newer firmware versions may not work with a previous version.
- Files created on an instrument other than the FSWX do not work on the FSWX.

Saving and recalling transducer and limit line settings

When you store the "Current settings" while a transducer file is in use, the FSWX also stores the applied transducer factors. Thus, when you recall the settings, even if the transducer file has changed, the *originally stored* transducer values are applied to the measurement. However, the current transducer file is not overwritten. The "Edit transducer" dialog still displays the possibly changed transducer file values.

The same applies to limit line settings.

If you want to apply the changed transducer values after recalling the saveset, you must force the application to reload the transducer file. To do so, simply open the "Edit transducer" dialog and change a setting. For example, toggle the "X-axis" option from "Lin" to "Log" and back. Due to that change, the transducer file is automatically reloaded, and the changed transducer values are applied to the current measurement. Now you can create a new saveset with the updated transducer values.

Similarly, if you want to apply the changed limit values after recalling the saveset, you must force the application to reload the limit file. To do so, simply open the "Edit Limit Line" dialog and change a setting. For example, toggle the "Y-axis" unit. Due to that change, the limit line file is automatically reloaded, and the changed limit values are applied to the current measurement. Now you can create a new saveset with the updated limit values.

- Quick save/quick recall 359
- Configurable storage and recall 360
- Save settings 361
- Recall settings 363
- How to save and load instrument settings 364

4.10.3.1 Quick save/quick recall

The "Quick Save" and "Quick Recall" functions allow you to store instrument settings or application settings easily and quickly in one step. You can store or recall up to 10 different sets of settings from "savesets". Each saveset is identified by its storage date and type (instrument or specific application instance) in the display. The savesets are stored in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/quicksave` directory, in files named `QuickSave1.dfl` to `QuickSave10.dfl`. Only the current measurement settings are stored. Any additional data such as traces, limit line or transducer files are not stored (see "Stored data types" on page 360).

During recall, savesets that include instrument settings replace the settings of the entire instrument. All other savesets start a new application instance with the stored settings.

If you recall an application instance with the same name as an active instance, the name for the new application instance is extended by a consecutive number:



4.10.3.2 Configurable storage and recall

If you save the settings to a file, you can define which settings are stored, and where the settings file is stored to. You can select any settings file for recall.

- Stored data types....360
- Storage location and filename....360

Stored data types

You can store and load the following types of data from files on the FSWX:

Table 4-33: Items that can be stored to files

Item	Description
"Current Settings"	Current instrument and measurement settings.
"All Transducers"	All transducer factor *files*. (Note: Restoring a saveset overwrites transducer factor files on the hard disk that have the same name as files in the saveset. For more information, see "Saving and recalling transducer and limit line settings" on page 359.)
"All Traces"	All active traces.
"Spectrograms"	Spectrogram trace data (only available if a "Spectrogram" is active).
"All Limit Lines"	All limit line *files*.
EBA Rules	Event-based action rules See Section 4.9, "Event-based actions", on page 340

Storage location and filename

Quicksave settings are stored in the home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/quicksave directory. When you store settings to a file, you select the storage location and filename in a file selection dialog.

The default folder for settings files is `home/instrument/.local/share/rohde-schwarz/esmain/fswx/save`.

The default name of a settings file consists of:

- A base name
  The base name can contain characters, numbers and underscores.
- An underscore
- A 3-digit number
- The file extension `.dfl`

For example, for the base name `limit_lines`: `limit_lines_005.dfl`.

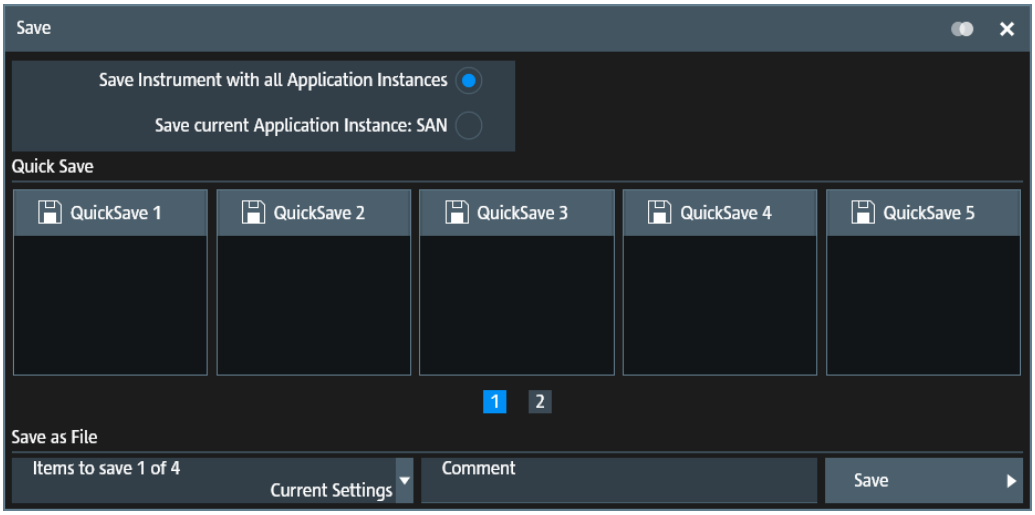
Filename restrictions

To enable files to be used in different file systems, consider the following file naming conventions:

- The filename can be of any length.
- The name is case-sensitive, i.e. uppercase and lowercase letters are considered to be different.
- All letters and numbers are permitted. However, do not begin a filename with a number.
- You can also use underscores, hyphens, periods. However, do not begin a filename with a hyphen.
- Do not use slashes "\" and "/". These symbols are used in file paths.
- Do not user special characters, such as ":", "*", "?", "$", "%" or brackets, which have special meanings in the operating system and can cause problems.
- Avoid using the following filenames: `CLOCK$`, `CON`, `COM1 to COM4`, `LPT1 to LPT3`, `NUL` or `PRN`
  They are reserved by the operating system.

4.10.3.3 Save settings

Access: "Save"



Saving instrument vs. application settings 362
QuickSave<x> 362
└ Rename 362
└ Write Protection 362
Items to save 362
Comment 363
File Name 363

Saving instrument vs. application settings
Defines whether the settings of a single application instance or the entire instrument are stored.

"Save Instrument with all Application Instances"
The instrument settings for all currently active application instances are stored.
When you recall these settings, the entire instrument configuration is replaced.

Remote command:
`MMEMory:SELect[:ITEM]...`

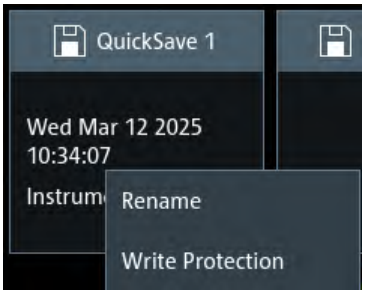
"Save current application instance"
Only the instrument settings for the currently selected application instance are stored.
When you recall these settings, only the current instance is replaced or a new application instance is created.

Remote command:
`MMEM:SELect:CHANnel[:ITEM]...`

Remote command:
Section 4.14.12.2, "Selecting the items to store", on page 784

QuickSave<x>
Selects one of the savesets to store the current settings in. At the time of storage, the "Quicksave <x>" placeholder is replaced by a label indicating the storage date and time and the storage type.

Right-click on one of the "QuickSave" buttons to display a context menu with additional functions for the saveset.



Rename ← QuickSave<x>
Displays an input field to rename the saveset, if write protection is disabled.

Write Protection ← QuickSave<x>
Enables or disables write protection for the saveset. If enabled, you cannot rename or overwrite the saveset.

Items to save
Defines which data and settings the FSWX stores. Depending on the selection Saving instrument vs. application settings, either application settings only, or global settings are available. Which items are available also depends on the installed options. See also "Stored data types" on page 360.

Remote command:
Section 4.14.12.2, "Selecting the items to store", on page 784

Comment
An optional description for the data file. A maximum of 60 characters can be displayed.

Remote command:
`MMEMory:COMMent` on page 781

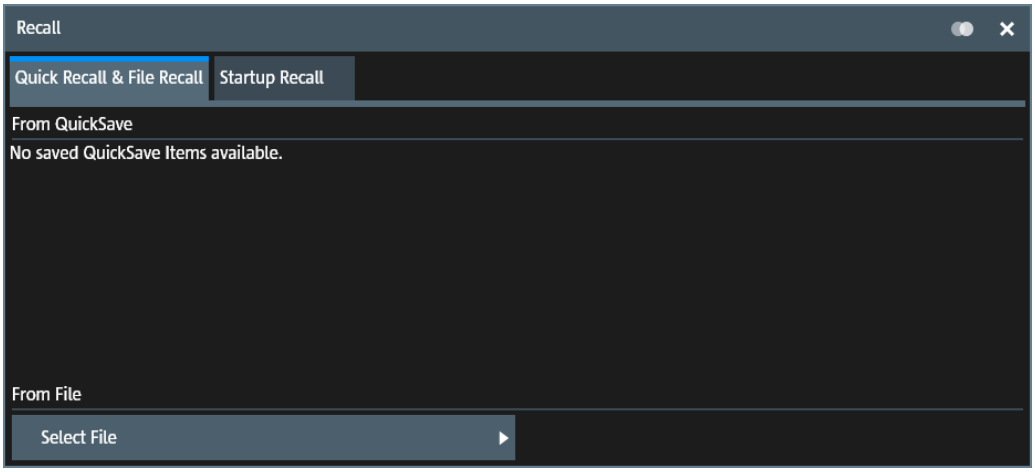
File Name
Contains the name of the data file without the path or extension.

For details on the filename and location, see "Storage location and filename" on page 360.

4.10.3.4 Recall settings

Access: "Open" > "Recall"

You can restore settings for an individual application instance or for the entire instrument.



After you use the "Recall" function, the history of previous actions is deleted, i.e. you cannot redo or undo any actions performed previously using the [Undo]/[Redo] functions.

When you recall instrument settings, the entire instrument configuration is replaced.

When you recall these settings, only the current instance is replaced or a new application instance is created. If you recall an application instance with the same name as an active instance, the name for the new application instance is extended by a consecutive number:



In remote commands, you must append this number to the application instance name, as well.

Recall From QuickSave 364
Recall From File 364
Recall File on Instrument Startup: Startup Recall 364

Recall From QuickSave
Restores the settings from the selected saveset.

Remote command:
`MMEMory:LOAD:STATe` on page 788

Recall From File
Restores the settings from the selected file.

Remote command:
`MMEMory:LOAD:STATe` on page 788

Recall File on Instrument Startup: Startup Recall
Enables or disables the startup recall function. If enabled, the FSWX loads the settings stored in the selected file each time you start or preset the instrument. If disabled, the FSWX loads the default settings.

Note that you can only select *instrument* settings files for the startup recall function, not application files.

If available, the file name and a comment for the selected file are indicated for reference.

Remote command:
`MMEMory:LOAD:AUTO` on page 787

4.10.3.5 How to save and load instrument settings

You can save instrument settings to a file and load them again later. Thus, you can repeat the measurement with the same settings. Optionally, the FSWX can automatically restore user-defined measurement settings each time you start or preset the instrument.

To save and recall instrument settings using the "Quick Save" function

1. Select "Save".
2. Select whether to store the instrument settings for **all** application instances, or only settings for the **current** application instance.
3. Select one of the savesets to save the settings to ("QuickSave<x>").

   The selected settings are stored to the file `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/quicksave/QuickSaveX.dfl`.

Note: If you change any settings *after* storing the configuration file, remember to save the settings again. Otherwise you cannot restore those settings and they are overwritten by the stored values when you recall the configuration file.

4. To recall the settings, select "Open".
5. Select the saveset that contains the settings ("QuickSave<x>").

   The selected settings overwrite the current instrument or application instance settings.

To save configurable instrument settings

1. Select "Save".
2. Select whether to store the instrument settings for **all** application instances, or only for the **current** application instance.
3. Select the items to save with the settings, such as lines or traces (see "Stored data types" on page 360).
4. Optionally, define a comment to describe the stored settings.
5. Select "Save".
6. In the file selection dialog, select a filename and storage location for the settings file.
7. Select "Save".

   A file with the defined name and path and the extension `.dfl` is created.

If you change any settings *after* storing the configuration file, remember to save the settings again. Otherwise you cannot restore those settings and they are overwritten by the stored values when you recall the configuration file.

To recall configurable instrument settings

1. Select "Open".
2. In the "Recall" dialog, select "Select File".
3. In the file selection dialog, select the filename and storage location of the settings file.

   Note: The "File Type" indicates whether the file contains instrument settings for **all** application instances, or only for a specific application instance.
4. If the saveset contains several items, select which items to recall.
5. Select "Recall".

   The settings and selected items from the saved measurement are restored and you can repeat the measurement with the same settings.
   Note that any changes made to the settings *after* storing the configuration file are overwritten by the stored values when you recall the configuration file.

To recall settings automatically after preset or reboot

You can define the settings to recall when you preset or reboot the instrument.

1. Configure the settings as required and save them as described in "To save configurable instrument settings" on page 365.
2. Select "Open" > "Startup Recall".
3. In the "Recall" dialog, select "Recall File on Instrument Startup": "Select File".
4. From the file selection dialog, select the recall settings file.
5. Select "Select File".
6. Set "Startup Recall" to "On".

   Now when you select [Preset] or reboot the instrument, the defined settings are restored.
7. To restore the factory preset settings, set "Startup Recall" to "Off".

4.10.4 Exporting and importing measurement results for evaluation

The FSWX provides various methods to evaluate the measurement results. However, possibly you want to evaluate the data with further, external applications. In this case, you can export the measurement data to a standard ASCII format file. You can also import existing trace data from a file, for example as a reference trace ("Spectrum" application only).

- Reference trace - importing trace data....366
- Trace and data export functions....368
- Trace import functions....370
- How to export trace data and numerical results....372
- How to import traces....372
- Formats for returned values: ASCII format and binary format....373
- Reference: ASCII file export format....374

4.10.4.1 Reference trace - importing trace data

You can import trace data that was stored during a previous measurement to the "Spectrum" application, for example as a reference trace.

The data in the import file must have a specified format (see Section 4.10.4.7, "Reference: ASCII file export format", on page 374. It can be stored in `CSV` or `DAT` format.

Trace mode

The trace mode for the imported traces is set to "View". Thus, the data is not overwritten immediately during the next sweep. Other trace settings remain unchanged. Therefore, **the displayed trace can differ from the displayed trace settings in the application info panel**.

Detector type and number of sweep points

In particular, the detector type and the number of sweep points remain unchanged.

If the detector type of the active trace requires two points per x-value ("Auto Peak"), but the file contains only one, each point is duplicated. If the detector type requires only one point per x-value, but the file contains two, each second point is ignored.

If the file contains more sweep points than the active trace requires, the superfluous points are ignored. If the file does not contain enough sweep points, the missing points are inserted as -200 dBm.

Units

If the unit of the y-axis values in the file does not correspond to the active result display, the imported values are converted. If no unit is defined in the file, it is assumed to be dBm.

Importing multiple traces in one file

If the import file contains more than one trace, you can import several traces at once, overwriting the existing trace data for any active trace in the result display with the same trace number. Data from the import file for currently not active traces is not imported.

Alternatively, you can import a single trace only, which is displayed for the trace number specified in "Import to Trace". This list contains all currently active traces in the result display. If a trace with the specified number exists in the import file, that trace is imported. Otherwise, the first trace in the file is imported (indicated by a message in the status bar).

Example:

The import file contains trace 1, trace 2, and trace 4. The current result display has 4 active traces.

"Import to Trace" = 2: trace 2 of the import file is displayed as trace 2 in the result display.

"Import to Trace" = 3: trace 3 is not available in the import file, thus trace 1 is imported and displayed as trace 3 in the result display

"Import all Traces" is enabled: Trace 1 is imported from the file and replaces trace 1 in the result display.

Trace 2 is imported from the file and replaces trace 2 in the result display.

Trace 4 is imported from the file and replaces trace 4 in the result display.

Trace 3 in the result display remains unchanged.

Importing spectrogram traces

You can also import trace data to an active "Spectrogram" result display.

Note the following differences that apply in this case:

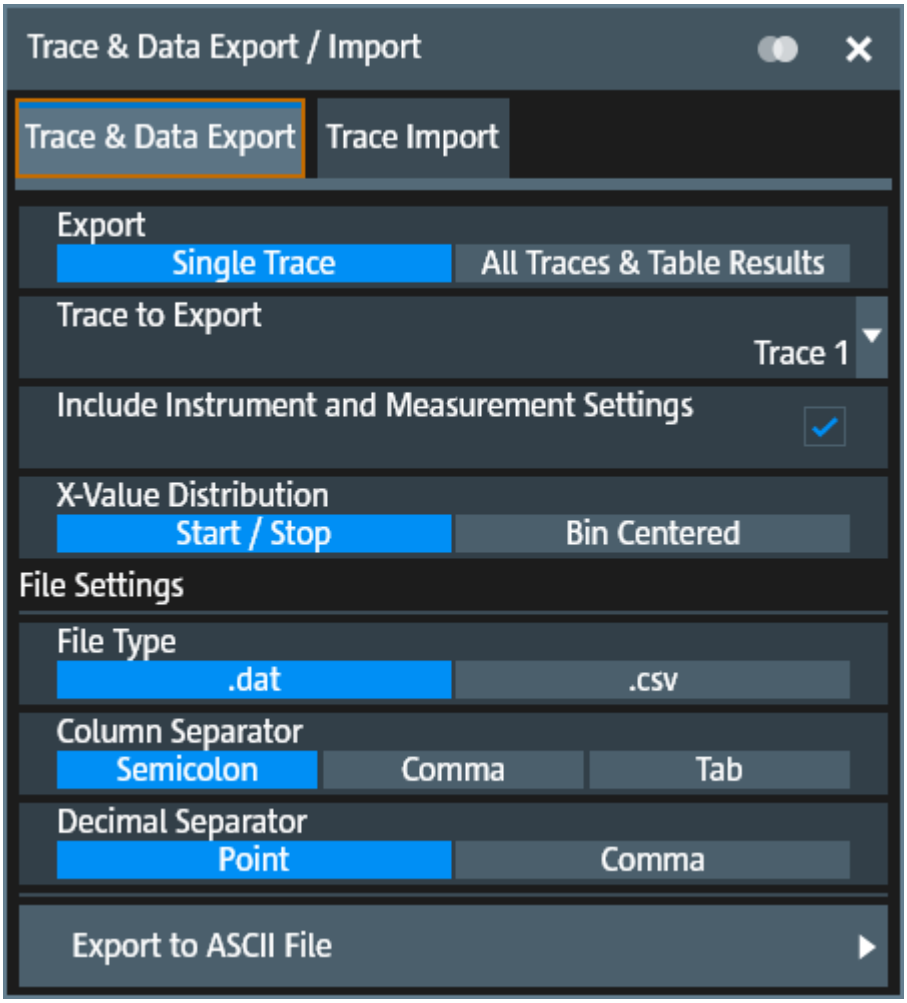
- You must stop the measurement before importing the trace.

- Only trace 1 is imported to the spectrogram. Any other traces can be imported to a "Spectrum" diagram, if available. However, they do not change the spectrogram display, which always refers to trace 1.
- A single spectrum is inserted as a new frame number 0.
- The trace mode is *not* changed to "View", as for "Spectrum" trace imports.

4.10.4.2 Trace and data export functions

Access: [Trace] > "Export & Import"

You can export the measurement data to a standard ASCII format file.



Export scope 369
Trace to Export 369
Include Instrument and Measurement Settings 369
X-Value Distribution 369
File Type 369
Column Separator 369
Decimal Separator 370
Export to ASCII File 370

Export scope
Determines which results are exported.

"Single Trace" Exports a single specific trace for export (see Include Instrument and Measurement Settings.

"All Traces & Table Results" Exports all displayed traces and result tables (e.g. "Result Summary", "Marker Table") in the current application to an ASCII file.
The results are stored in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Remote command:
`FORMat:DEXPort:TRACes` on page 691

Trace to Export
Defines an individual trace to be exported to a file.

This setting is not available if you select "Export All Traces & Table Results".

Include Instrument and Measurement Settings
If enabled, additional instrument and measurement settings are included in the header of the export file for result data.

See Section 4.10.4.7, "Reference: ASCII file export format", on page 374 for details.

Remote command:
`FORMat:DEXPort:HEADer` on page 802

X-Value Distribution
Defines how the x-values of the trace are determined in the frequency domain.

See "X-value of the sweep point" on page 283.

"Bin-Centered" The full measurement span is divided by the number of sweep points to obtain *bin*s. The x-value of the sweep point is defined as the x-value at the center of the bin (bin/2).

"Start/Stop" (Default): The x-value of the first sweep point corresponds to the starting point of the full measurement span. The x-value of the last sweep point corresponds to the endpoint of the full measurement span. All other sweep points are divided evenly between the first and last points.

Remote command:
`FORMat:DEXPort:XDIStrib` on page 691

File Type
Determines the format of the ASCII file to be exported.

Depending on the external program in which you evaluate the data file, you require a comma-separated list (`CSV`) or a plain data format (`DAT`) file.

Remote command:
`FORMat:DEXPort:FORMat` on page 691

Column Separator
Selects the character that separates columns in the exported ASCII file. The character can be either a semicolon, a comma or a tabulator (tab).

Example for semicolon:

```
Type;FSWX3026;Version;1.00;Date;01.Jan 3000;
```

Example for comma:

```
Type,FSWX3026,
Version,1.00,
Date,01.Jan 3000,
```

Example for tabulator (the tab after the last column is not visible):

```
Type    FSWX3026
Version    1.00
Date    01.Jan 3000
```

The selected column separator setting is maintained even after a preset.

Remote command:
FORMat:DEXPort:CSEParator on page 690

Decimal Separator
Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:
FORMat:DEXPort:DSEParator on page 779

Export to ASCII File
Saves the selected trace or all traces in the currently active result display to the specified file and directory in the selected ASCII format.

If the spectrogram display is selected when you perform this function, the entire histogram buffer with all frames is exported to a file. The data for a particular frame begins with information about the frame number and the time that frame was recorded. For large history buffers, the export operation can take some time.

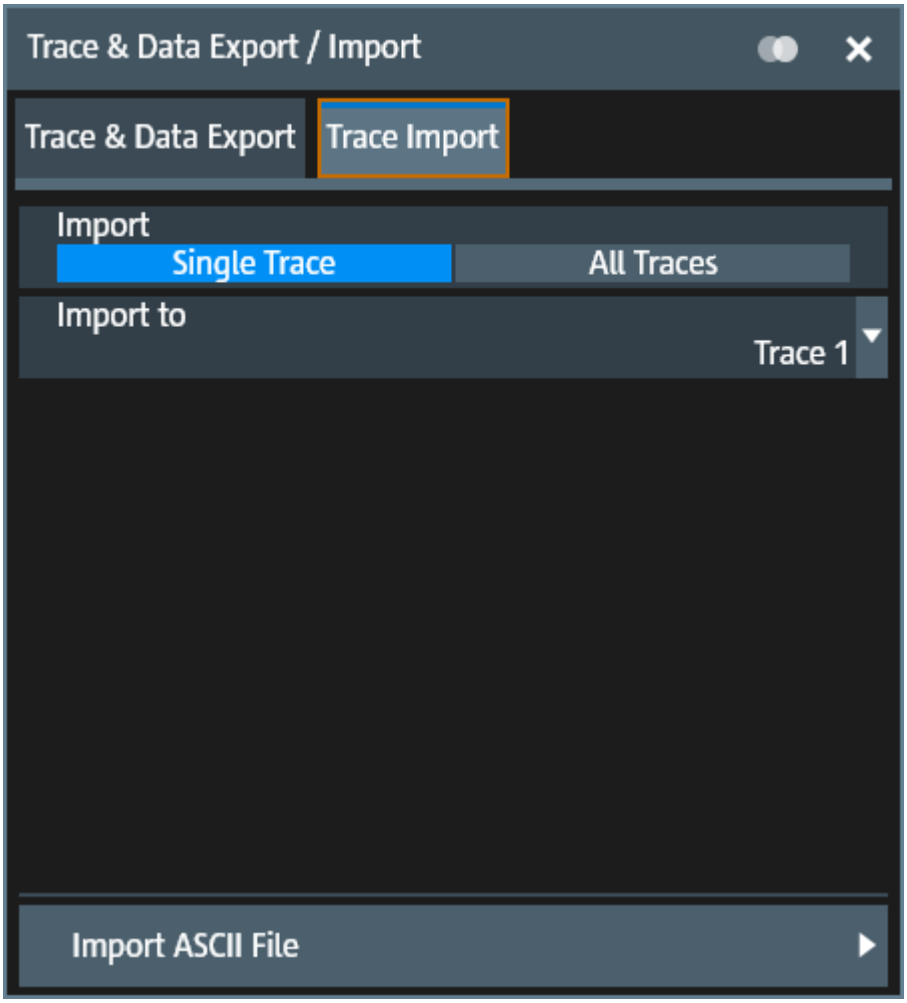
For details on the file format in the "Spectrum" application, see Section 4.10.4.7, "Reference: ASCII file export format", on page 374.

Remote command:
MMEMory:STORe<n>:TRACe on page 693
MMEMory:STORe<n>:SPECtrogram on page 803

4.10.4.3 Trace import functions

Access: [Trace] > "Export & Import" > "Trace Import"

You can import existing trace data from a file, for example as a reference trace ("Spectrum" application only).



Import scope 371
Import to Trace <x> 372
Import ASCII File 372

Import scope
You can import trace data that you stored during a previous measurement to the "Spectrum" application, for example as a reference trace. If the import file contains more than one trace, define which trace data you want to import.

"Single Trace" Import a single trace only, to the trace number specified in "Import to Trace <x>" on page 372. If the import file contains a trace with the specified number, that trace is imported. Otherwise, the first trace in the file is imported and a message is displayed in the status bar.

"All traces" All traces in the file are imported. If the result display already contains an active trace with the same trace number, the existing trace data is overwritten. Data from the import file for currently not active traces is not imported.

Remote command:
`FORMat:DIMPort:TRACes` on page 692

Import to Trace <x>
Defines an individual trace to which the data from a file is imported. The list contains all currently active traces in the result display.

This setting is not available if you select "Import All Traces".

Import ASCII File
Loads one trace or all traces from the selected file to the currently active result display.

Remote command:
`FORMat:DIMPort:TRACes` on page 692

4.10.4.4 How to export trace data and numerical results

You can export the measured trace data and numerical measurement results in tables to an ASCII file. For each sweep point, the measured trace position and value are stored.

The file is stored with a `.dat` or `.csv` extension. For details on the storage format, see Section 4.10.4.7, "Reference: ASCII file export format", on page 374.

For the results of a "Spectrum Emission Mask" (SEM) or "Spurious Emissions" measurement, special file export functions are available, see "How to save SEM result files" on page 1062(SEM) and "How to save the Result Summary" on page 1083 (Spurious).

To export trace data and table results

1. Select [Trace] > "Export & Import" > "Trace Export".
2. Select the scope of data to export:
   - "All Traces & Table Results" to export all available measurement result data for the current application
   - "Single Trace" and "Trace to Export" for a single trace
3. Optionally, select "Include Instrument Measurement Settings" to insert additional information in the export file header.
4. If necessary, change the decimal separator for the ASCII export file.
5. Select the data format of the ASCII file.
6. Select "Export Trace to ASCII File".
7. In the file selection dialog box, select the storage location and filename for the export file.
8. Select "Save" to close the dialog box and export the data to the file.

4.10.4.5 How to import traces

You can import existing trace data from a file to the "Spectrum" application, for example as a reference trace.

To import trace data

1. Select [Trace] > "Export & Import" > "Trace Import".
2. Select the scope of data to export:
   - "All Traces" to import traces for all the currently active traces
   - "Single Trace" and "Import to trace" to import a specific trace
3. Select "Import ASCII File to Trace".
4. Select the file that contains the trace data.
5. Select "Select" to close the dialog box and start the import.

4.10.4.6 Formats for returned values: ASCII format and binary format

When you retrieve trace data using the `TRAC:DATA` or `TRAC:IQ:DATA` command, the `FORM:DATA` command defines the format the data is returned in. The possible formats are described here.

- ASCII Format (FORMat ASCII):
  The data is stored as a list of comma-separated values (CSV) of the measured values in floating point format.
- Binary Format (FORMat REAL,16/32/64):
  The data is stored as binary data (definite length block data according to IEEE 488.2). Each measurement value is formatted in 16-bit/32-bit/64-bit IEEE 754 floating-point-format.
  The schema of the result string is as follows:
  `#<Length of length><Length of data><value1><value2>…<value n>`
  with:

<Length of length>	Number of digits of the following number of data bytes
<Length of data>	Number of following data bytes
<Value>	2-byte/4-byte/8-byte floating point value

Example: `#41024`<Data>... contains 1024 data bytes

Data blocks larger than 999,999,999 bytes

According to SCPI, the header of the block data format allows for a maximum of 9 characters to describe the data length. Thus, the maximum REAL 32 data that can be represented is 999,999,999 bytes. However, the FSWX is able to send larger data blocks. In this case, the length of the data block is placed in brackets, e.g. `#(1234567890)`<value1><value2>…



Reading out data in binary format is quicker than in ASCII format. Thus, binary format is recommended for large amounts of data.

4.10.4.7 Reference: ASCII file export format

You can export trace data to a file in ASCII format for further evaluation in other applications.

(For details see Section 4.10.4.4, "How to export trace data and numerical results", on page 372.)

This reference describes in detail the format of the export files for result data.

For a description of the file formats for "Spectrum Emission Mask" (SEM) measurement settings and results, see Section 5.3.3.8, "Reference: SEM file descriptions", on page 1064.

The file format for "Spurious Emissions" measurement results is described in Section 5.3.4.6, "Reference: ASCII export file format (spurious)", on page 1084.

The file consists of the header containing important scaling parameters and a data section containing the trace data. Optionally, you can exclude the header from the file (see "Include Instrument and Measurement Settings" on page 369).

The data of the file header consist of three columns, each separated by a semicolon:

- Parameter name
- Numeric value
- Basic unit

The data section starts with the keyword "`Trace <n>`" (<n> = number of stored trace). The measured data follows in one or several columns (depending on the measurement), which are also separated by a semicolon.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Generally, the format of this ASCII file can be processed by spreadsheet calculation programs, e.g. MS-Excel. Different language versions of evaluation programs can require a different handling of the decimal point. Thus, you can define the decimal separator to use (decimal point or comma, see "Decimal Separator" on page 370). In addition, you can configure a different column separator to use (see "Column Separator" on page 369).

If the spectrogram display is selected when you select "Export to ASCII File", the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Table 4-34: ASCII file format for trace export in the Spectrum application

File contents	Description
Header data	
Type;FSWX;	Instrument model
Version;1.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage

File contents	Description
Mode;ANALYZER;	Operating mode
Preamplifier;OFF	Preamplifier status
Transducer; OFF	Transducer status
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistic measurements
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Rf Att;20;dB	Input attenuation
El Att;2.0;dB	Electrical attenuation
RBW;100000;Hz	Resolution bandwidth
VBW;30000;Hz	Video bandwidth
SWT;0.005;s	Sweep time
Sweep Count;20;	Number of sweeps set
Data section for individual window	
Ref Position;75;%	Position of reference level referred to diagram limits (0 % = lower edge)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistic measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Window;1;Frequency Sweep	Window number and name
Trace 1;;	Selected trace
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
Detector;AUTOPEAK;	Selected detector
Values; 1001;	Number of measurement points

File contents	Description
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Data section for individual trace	
Trace 2;;	Next trace in same window
...	
Data section for individual window	
Window;2 ..;	Name of next window
Data section for individual trace	
Trace 1;;	First trace
...	

Table 4-35: ASCII file format for Spectrogram trace export

File contents	Description
Header	
Type;FSWX;	Instrument model
Version;5.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage
Mode;ANALYZER;**SPECTROGRAM**	Operating mode
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistic measurements
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Ref Position;75; %	Position of reference level referred to diagram limits (0 % = lower edge)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
Rf Att;20;dB	Input attenuation
RBW;100000;Hz	Resolution bandwidth

File contents	Description
VBW;30000;Hz	Video bandwidth
SWT;0.005;s	Sweep time
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAX-HOLD,MINHOLD
Detector;AUTOPEAK;	Selected detector
Sweep Count;20;	Number of sweeps set
Data section	
Trace 1:;;	Selected trace
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistic measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Values; 1001;	Number of measurement points
Frames;2;	**Number of exported frames**
Frame;0;	**Most recent frame number**
Timestamp;17.Mar 11;11:27:05.990	**Timestamp of this frame**
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values, identical to spectrum data: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Frame;-1;	**Next frame**
Timestamp;17.Mar 11;11:27:05.342	**Timestamp of this frame**
...	

4.10.5 I/Q data import and export

Baseband signals mostly occur as so-called complex baseband signals, i.e. a signal representation that consists of two channels; the in-phase (I) and the quadrature (Q) channel. Such signals are referred to as I/Q signals. The complete modulation information and even distortion that originates from the RF, IF or baseband domains can be analyzed in the I/Q baseband.

Importing and exporting I/Q signals is useful for various applications:

- Generating and saving I/Q signals in an RF or baseband signal generator or in external software tools to analyze them with the FSWX later.
- Capturing and saving I/Q signals with the FSWX to analyze them with the FSWX or an external software tool later.
  As opposed to storing trace data, which can be averaged or restricted to peak values, I/Q data is stored as it was captured, without further processing. Multichannel data is not supported.

The data is stored as complex values in 32-bit floating-point format.
The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.

For example, you can capture I/Q data using the "I/Q Capture" application and then perform analog demodulation on that data using the "AM/FM/PM Analog Demod" application, if available.

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

The import and export functions are available in the "Save"/"Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar.

4.10.5.1 I/Q import/export functions

Access: "Save"/"Open" > "Import" / "Export"

The FSWX provides various evaluation methods for the results of the performed measurements. However, perhaps you want to evaluate the data with further, external applications. In this case, you can export the measurement data to a standard format file. You can re-import some of the data stored in these files to the FSWX for further evaluation later, for example in other applications.

You can only import and export I/Q data in applications that process I/Q data, such as the "I/Q Capture" or the optional "I/Q Spectrum Analyzer" application.

See the corresponding user manuals for those applications for details.

These functions are only available if no measurement is running.

In particular, if a continuous sweep is active, the import/export functions are not available.

I/Q Import 378
I/Q Export 379
└ File Name 379
└ Comment 379
└ Input Stream 379

I/Q Import
Opens a file selection dialog box to select an import file that contains I/Q data.

Input from I/Q data files is imported as it was stored, including any correction factors, for example from transducers or SnP files. Any currently configured correction factors at the time of import, however, are not applied.

For details, see Section 4.10.5.1, "I/Q import/export functions", on page 378.

Remote command:
`MMEMory:LOAD:IQ:STATe` on page 804

I/Q Export
Opens a file selection dialog box to define an export file name to which the I/Q data is stored. This function is only available in single sweep mode, and only in applications that process I/Q data, such as the "I/Q Capture" or the optional "I/Q Spectrum Analyzer" application.

For details, see Section 4.10.5, "I/Q data import and export", on page 377.

Note: Storing large amounts of I/Q data (several Gigabytes) can exceed the available (internal) storage space on the FSWX. In this case, it can be necessary to use an external storage medium.

Remote command:
`MMEMory:STORe<n>:IQ:STATe` on page 805

File Name ← I/Q Export
Contains the name of the data file without the path or extension.

For details on the filename and location, see "Storage location and filename" on page 360.

Comment ← I/Q Export
An optional description for the data file. A maximum of 60 characters can be displayed.

Remote command:
`MMEMory:STORe<n>:IQ:COMMent` on page 805

Input Stream ← I/Q Export
For measurements with multiple input sources, select the input stream to export.

4.10.5.2 How to export and import I/Q data

Capturing and exporting I/Q data

I/Q data can only be exported in applications that process I/Q data, such as the "I/Q Spectrum Analyzer" or optional applications.

1. Select an application that supports I/Q data export.
2. Configure the data acquisition.
3. Select [Run Single] to perform a single sweep measurement.
4. Select "Save" on the toolbar.
5. Select "I/Q Export".
6. In the file selection dialog box, select a storage location and enter a filename.
7. Select "Save".

   The captured data is stored to a file.
   The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.

Importing I/Q data

I/Q data can only be imported to applications that process I/Q data, such as the "I/Q Spectrum Analyzer" or optional applications. The "I/Q Capture" application does not support I/Q data import.

1. Select an application that supports I/Q data.
2. If necessary, select [Run Single] to switch to single sweep mode.
3. Select "Open" on the toolbar.
4. Select "I/Q Import".
5. Select the storage location and the filename.
   The file extension determines the file type. If you do not provide a file extension, the application assumes the file type is `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.
6. Select "Open".

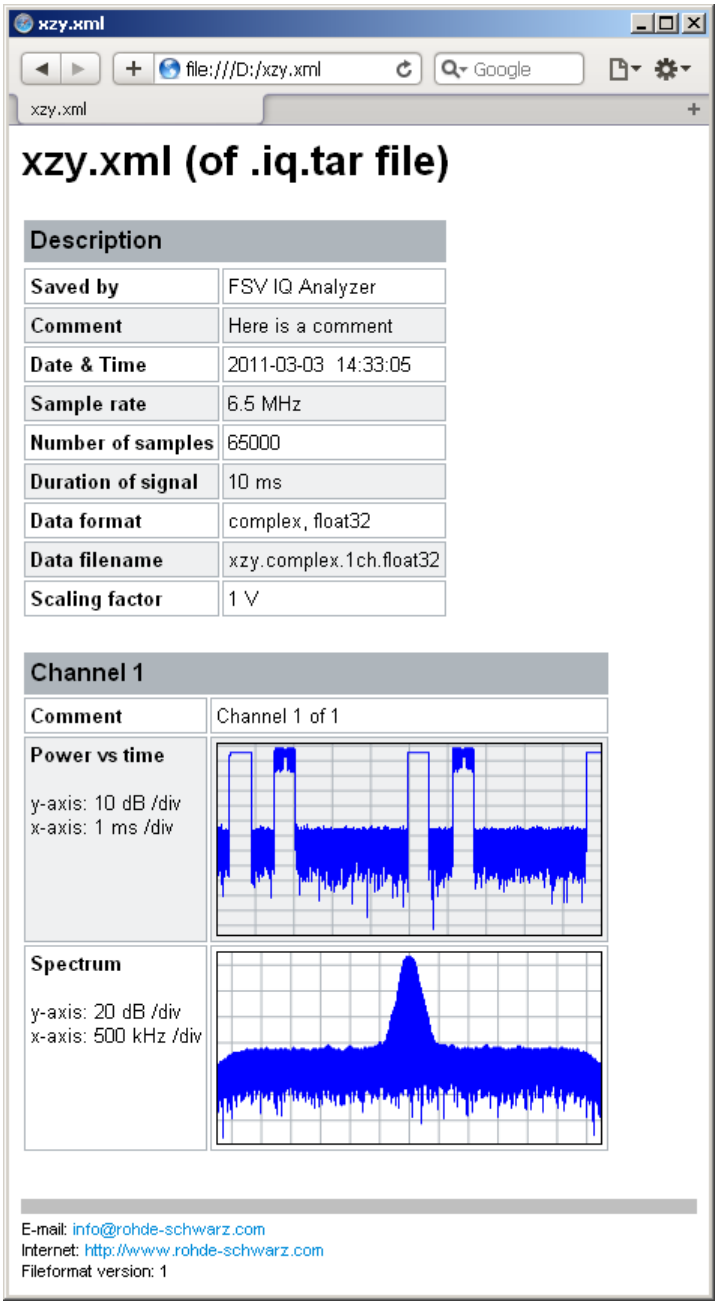
   The stored data is loaded from the file and displayed in the current application.

Previewing the I/Q data in a web browser

The `iq-tar` file format allows you to preview the I/Q data in a web browser.

1. Use an archive tool (e.g. PowerArchiver®) to unpack the `iq-tar` file into a folder.
2. Locate the folder in a file navigator.
3. Open your web browser.

4. Drag the I/Q parameter XML file, e.g. `example.xml`, into your web browser.



4.10.6 Screenshots of current measurement results and settings

To document the graphical results and the most important settings for the currently performed measurement, you can create a screenshot of the current display. You can store screenshots to a file.

The stored results include:

- Diagrams

- Traces
- Markers
- Marker lists
- Limit lines
- Application panel
- Status bar

Displayed items belonging to the software user interface (e.g. softkeys) are not included. The position and size of the elements in the screenshot is identical to the display.

- Screenshot configuration 382
- How to store screenshots of the display 392
- How to configure the colors for display and printing 394
- Example for storing multiple measurement results to a PDF file 395

4.10.6.1 Screenshot configuration

Access: "Screenshot"

Remote commands for these settings are described in Section 4.14.12.4, "Storing or printing screenshots", on page 791.

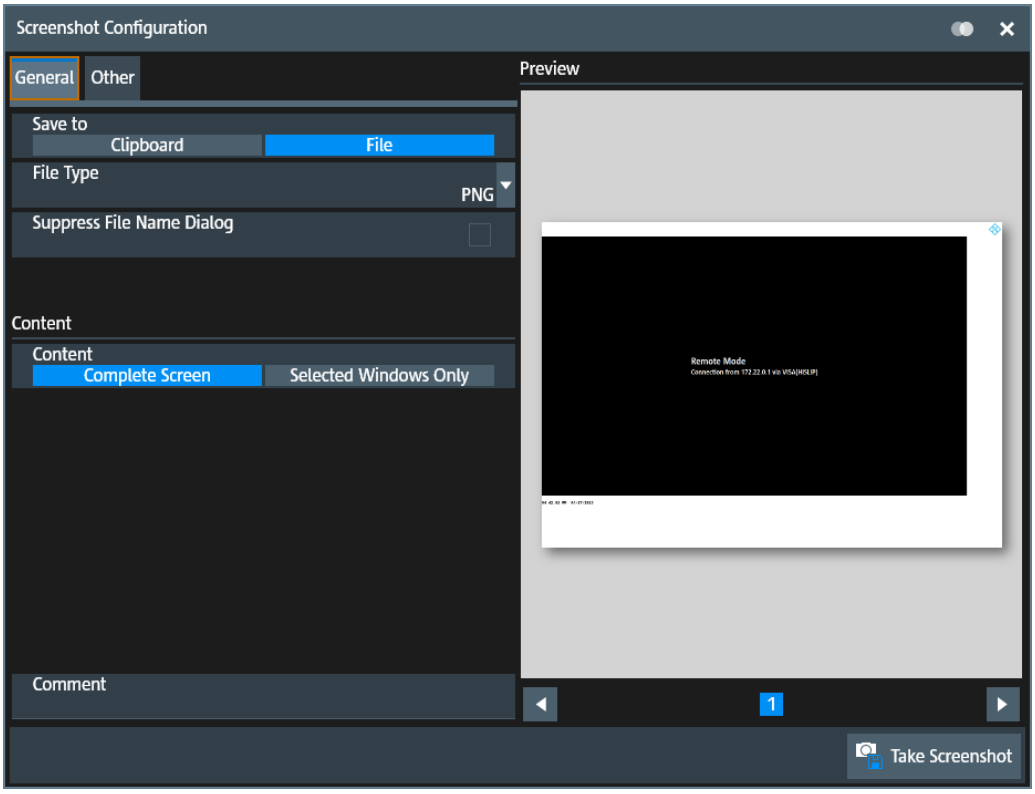
To take a screenshot of the current display with the current settings immediately, without switching to the "Screenshot" menu, select "Take Screenshot".

- General settings 382
- Specific (other) settings 385
- Preview functions 388
- Theme color settings 390

General settings

Access: "Screenshot" > "General"

The general screenshot settings determine the general behavior of screenshot creation.



Save To....383
File Type....384
Suppress File Name Dialog....384
Location....384
Content....384
Selected Windows....385
Comment....385

Save To

Determines whether the screenshot is stored to a file or to the system clipboard.

"Clipboard" Copies the screenshot to the clipboard. Since the clipboard can only contain single pages, you can only store the complete screen to the clipboard, not multiple windows. Thus, the content setting is automatically set to Content.

Remote command:
`HCOP:DEST1 'SYSTem:COMMunicate:CLIPboard'`

"File" Stores the screenshot to a file of the selected File Type. The filename is queried at the time of storage, or a default name is used (see "Suppress File Name Dialog" on page 384).
Multiple windows can only be stored to a file in PDF format. If you select an image file format, the content setting is automatically set to Content.

Remote command:
`HCOPy:DESTination<di> 'MMEM'`

File Type
The following file types are supported for screenshots:
- BMP
- JPEG
- PNG
- PDF
- SVG

Remote command:
`HCOPy:DEVice:LANGuage` on page 795

Suppress File Name Dialog
If enabled and you select Save To: "File", the file selection dialog is not displayed. Instead, the default storage location and filename are used.

(`home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/FSWX_ScreenShot_<date and time>`).

Location
Indicates where the screenshots are stored if the file name dialog is suppressed.

(`home/instrument/.local/share/rohde-schwarz/esmain/fswx/user`)

Content
Determines whether the screenshot includes the contents of the complete screen, or only selected windows.

"Complete Screen"
Selects all measurement results displayed on the screen for the current application instance (or "MultiView") for a screenshot on a single page.

The results include:
- Diagrams
- Traces
- Markers
- Marker lists
- Limit lines
- Application info panel
- Status bar

Items that belong to the software user interface (e.g. softkeys) are not included.
The position and size of the elements in the screenshot is identical to the display.

"Selected Windows Only"
Includes only the selected windows in the screenshot. You can select any of the currently active windows for the current application instance or the "MultiView". You can define how many windows are stored on a single page of the screenshot (see "Windows Per Page" on page 387).
This option is only available when storing to a PDF file (see "File Type" on page 384). If Save To: "Clipboard" is selected or File Type is currently set to an image file, the file type is automatically set to PDF.

Remote command:
HCOPy:CONTent on page 792

Selected Windows
For Content: "Selected Windows Only", select any of the currently active windows for the current application instance or the "MultiView".

Remote command:
HCOPy:PAGE:WINDow:STATe on page 799
HCOPy:PAGE:WINDow:CHANnel:STATe on page 798

Comment
Defines an optional comment to include in the screenshot of the display. A maximum of 120 characters are allowed. Up to 60 characters fit in one line. In the first line, you can force a manual line feed by entering "@".

The comment is included in the top-left corner of each screenshot page. If you do not want to include the comment, delete it.

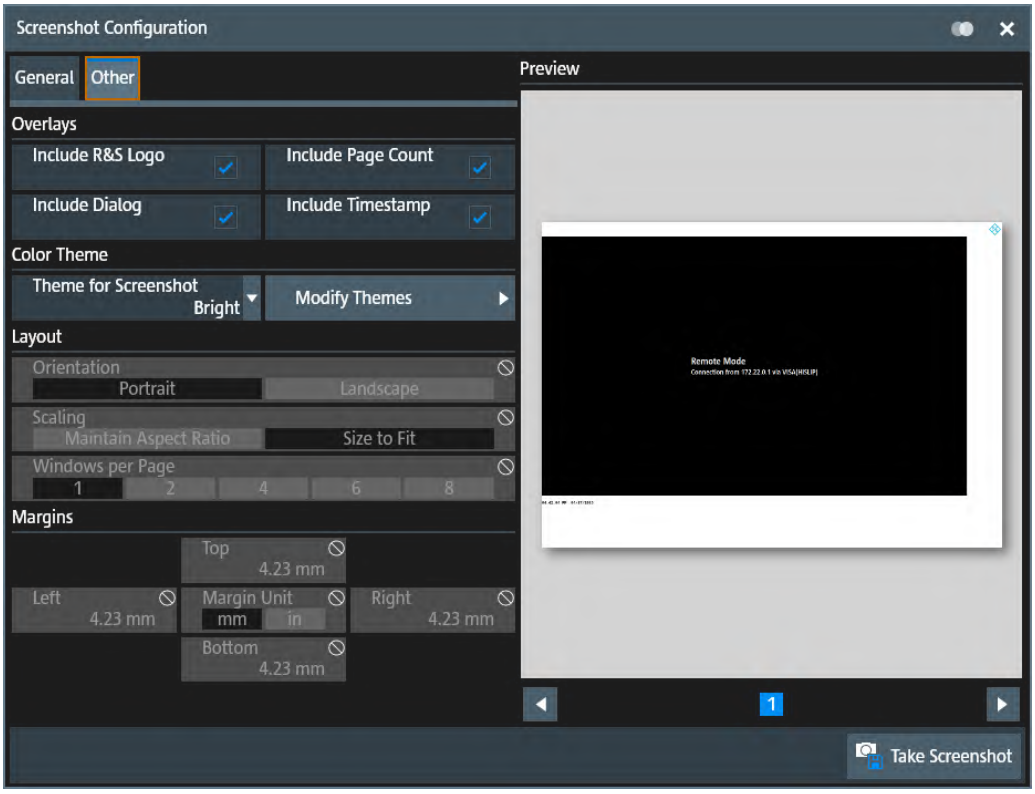
Tip: The current date and time can be inserted automatically, see "Include Timestamp" on page 387.

Remote command:
HCOPy:ITEM:WINDow:TEXT on page 796

Specific (other) settings

Access: "Screenshot" > "Other"

You can define the specific contents and layout for the screenshot.



Include R&S Logo..... 386
Include Page Count..... 386
Include Dialog..... 386
Include Timestamp..... 387
Theme for Screenshot..... 387
Modify Themes..... 387
Orientation..... 387
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Windows Per Page..... 387
Margins..... 387

Include R&S Logo
If enabled, includes the Rohde & Schwarz company logo in the upper right corner.

Remote command:
`DISPlay:LOGO` on page 792

Include Page Count
If enabled, includes the page number for screenshots consisting of multiple windows ("Selected Windows" on page 385).

Remote command:
`HCOPy:PAGE:COUNt:STATe` on page 796

Include Dialog
If enabled, includes any currently displayed dialog in the screenshot.

Include Timestamp
If enabled, includes the current date and time at the bottom of the screenshot.

Remote command:
HCOPy:TDSTamp:STATe on page 800

Theme for Screenshot
The theme defines the colors and style used to store screen objects.

"Dark" (Default:) Uses a dark background, as seen on the FSWX screen.

"Bright" Uses a white background, optimal for printing.

Remote command:
DISPlay:THEMe:CATalog? on page 849
HCOPy:THEMe:SELect on page 800

Modify Themes
Displays the "Theme Color Setup" dialog to configure the colors for the selected theme.

See "Theme color settings" on page 390.

Orientation
Selects the page orientation of the screenshot: portrait or landscape.

Remote command:
HCOPy:PAGE:ORIentation on page 798

Scaling
Determines the scaling of the windows in the screenshot if you select multiple windows (see "Selected Windows" on page 385).

If more than one window is stored on one page (see Windows Per Page), each window is equal in size.

"Maintain aspect ratio" Each window is stored as large as possible while maintaining the aspect ratio of the original display.

"Size to fit" Each window is scaled to fit the page size optimally, not regarding the aspect ratio of the original display.

Remote command:
HCOPy:PAGE:WINDow:SCALe on page 799

Windows Per Page
Defines how many windows are stored on a single page of the screenshot. This setting is only available for Save To: "File".

If more than one window is stored on one page, each window is equal in size.

Remote command:
HCOPy:PAGE:WINDow:COUNt on page 799

Margins
Defines margins for the screenshot page on which no elements are stored. The margins are defined according to the selected unit.

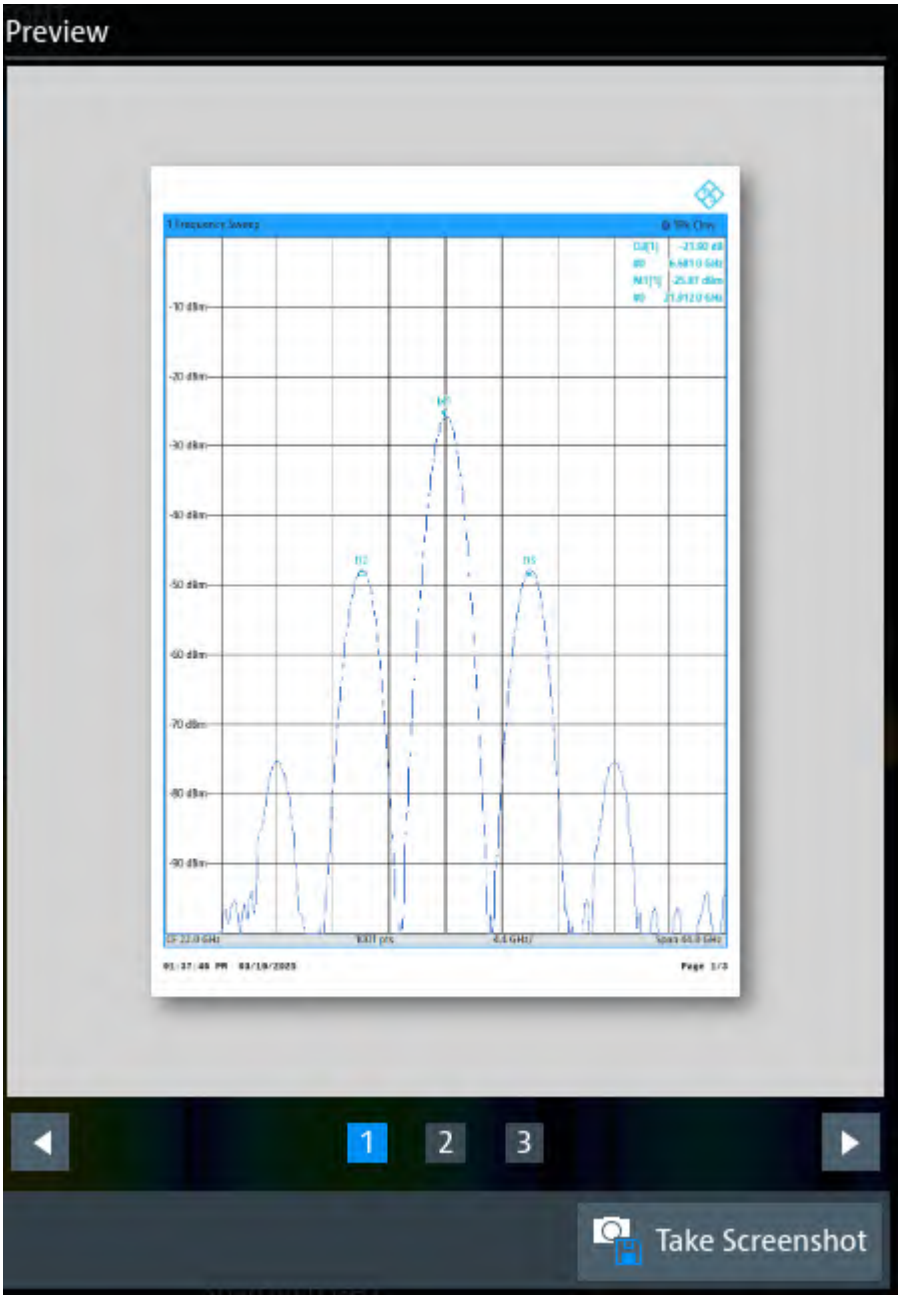
Margins are only available when storing to a PDF file (see "File Type" on page 384).

Remote command:
HCOPy:PAGE:MARGin:BOTTom on page 797
HCOPy:PAGE:MARGin:LEFT on page 797
HCOPy:PAGE:MARGin:RIGHt on page 797
HCOPy:PAGE:MARGin:TOP on page 797
HCOPy:PAGE:MARGin:UNIT on page 798

Preview functions

Access: "Screenshot" > "Preview"

The preview of the screenshot according to the current configuration is available in all "Screenshot Configuration" dialog tabs.



Previous Page / Next Page 389
Take Screenshot 389

Previous Page / Next Page
Depending on the selected contents (see "General settings" on page 382), the screenshot can consist of multiple pages. Use these functions to scroll within the preview to see the individual pages.

Take Screenshot
Stores the selected screen contents to a file (see "General settings" on page 382).

Whether the output is stored to a file or the clipboard depends on the selected destination settings (see "Save To" on page 383).

If the output is stored to a file, a file selection dialog is opened to select the filename and location. The default path is `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user`.

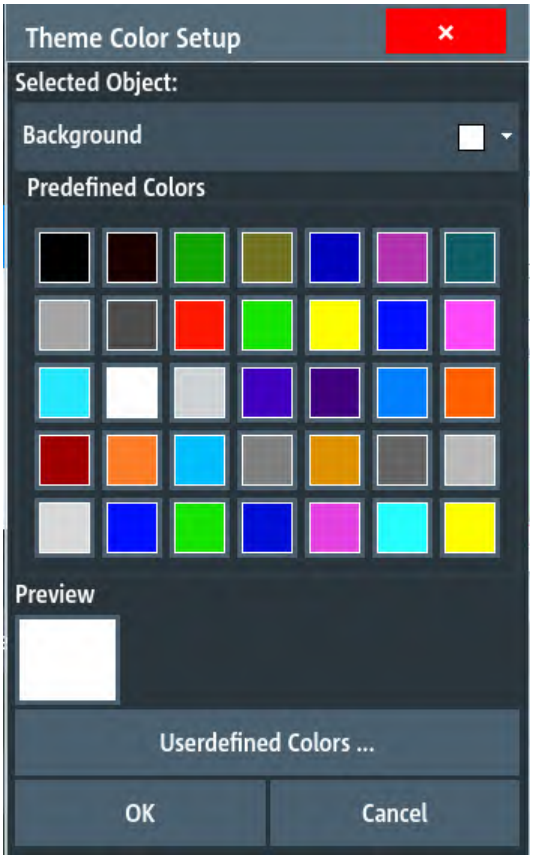
Remote command:
`HCOPy[:IMMediate]` on page 796
`HCOPy[:IMMediate]:NEXT` on page 796

Theme color settings

Access: "Screenshot" > "Other" > "Modify Themes""Color" > "Modify Selected Theme"

Or: **Access**: > "Display" > "General"

You can configure the colors used by the selected theme.



For step-by-step instructions, see Section 4.10.6.3, "How to configure the colors for display and printing", on page 394.

Selected Object 391
Predefined Colors 391
Preview 391
Userdefined Colors 391

Selected Object
Selects the object whose color you want to define. You can define colors for the following objects:

- Background
- Grid
- Individual traces
- Display lines
- Limit lines and check results
- Markers and marker information

Remote command:
Each object is assigned to a specific suffix of the CMAP commands, see "CMAP suffix assignment" on page 850.

Predefined Colors
Displays the available colors from the predefined color set that you can assign to the selected object.

Remote command:
`HCOPy:CMAP<it>:PDEFined` on page 794

Preview
Displays the currently selected color assigned to the selected object.

Userdefined Colors
In addition to the colors in the predefined color set, you can configure a user-specific color to assign to the selected object.

The set of predefined colors is replaced by a color palette and color configuration settings.



Select the color in the color palette directly, or define values for tint, saturation and brightness.

Remote command:
`HCOPy:CMAP<it>:HSL` on page 794

4.10.6.2 How to store screenshots of the display

You can store the measurement results displayed on the screen to a file easily.

For a programming example, see "Printing to a file" on page 808.

To take a screenshot

► If the FSWX is already set up according to your current requirements, simply select "Take Screenshot".

The current measurement display is stored to a file or the clipboard, as configured.

To configure screenshots

1. Select "Screenshot".

   The "Screenshot Configuration" dialog is displayed.

2. On the "General" tab, select where to store the screenshot ("Save to").
3. Select the file type to create.
4. Select "Complete Screen" to include all elements displayed on the screen in a single-page screenshot.
5. Optionally, add a comment to include at the top of the screenshot.
6. On the "Other" tab, define the elements of the screen and additional information to include in the screenshot.
   a) Optionally, include the date and time or the Rohde & Schwarz logo on the screenshot.
   b) Optionally, include dialogs that are currently displayed on the screen in the screenshot. This is useful, for example, to document the settings used for a particular result.
7. Configure the layout of the screenshot page.
   a) Select the page orientation.
   b) Define the page margins.
8. Define the colors to use for the screenshot.
   The default "Bright" theme improves the visibility of the colors on a printout. The background is stored in white and the grid in black.
   For a screenshot that reflects exactly what you see on the screen, select the "Dark" theme.
9. Check the "Preview" to make sure all relevant elements of the display are visible.
10. Select "Take Screenshot".

    The screenshot is stored to the file as configured.

11. To store another screenshot using the same configuration, simply select "Take Screenshot".

To store a screenshot containing multiple windows

Tip: Select the "MultiView" before configuring the screenshot to include windows from any active application instance.

1. Select "Screenshot".

   The "Screenshot Configuration" dialog is displayed.

2. On the "General" tab, select "Save to: File".
3. Select the file type to create.
4. By default, you define the filename individually for each screenshot. To avoid having the filename dialog being displayed for each screenshot, enable "Suppress

File Name Dialog". In this case, the previously used or default storage location and filename are used.
(`home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/FSWX3026_ScreenShot_<date and time>`).

5. Select "Selected Windows only" to include the selected windows in the screenshot, possibly on multiple pages.
6. Select the result displays in the currently selected application instance to include in the screenshot.
7. Optionally, add a comment to include at the top of the screenshot.
8. On the "Other" tab, define the elements of the screen and additional information to include in the screenshot.
9. Configure the layout of the screenshot page.
   a) Select the page orientation.
   b) Define the page margins.
10. Check the "Preview" to make sure all required result displays are included.
    Scroll through the individual pages of the screenshot using the ◀ and ▶ icons.
11. Select "Take Screenshot".
12. If you did not select the option to suppress the dialog, enter a filename in the file selection dialog.

    The selected data elements are stored to the file as configured.
13. To store another screenshot using the same configuration, simply select "Take Screenshot".

4.10.6.3 How to configure the colors for display and printing

You can configure the style and colors with which various screen objects are displayed or printed. The settings for theme colors are the same for print and display. However, you can select different themes to use for print and display.

To select a color set for a theme

1. - For print: Select "Screenshot" > "Other" > "Modify Themes".
   - For display: Select [Setup] > "Display" > "General" > "Modify Selected Theme".

   The "Theme Color Setup" dialog is displayed.
2. From the "Selected Object" list, select the object whose color you want to configure.
3. Do one of the following:
   - Select a predefined color to use.
   - Select "Userdefined colors" to configure the color yourself.

Continue with "To configure a user-defined color for a theme" on page 395.

4. Repeat these steps for other objects, as required.
5. Select "OK" to apply the theme color settings and close the dialog.

To configure a user-defined color for a theme

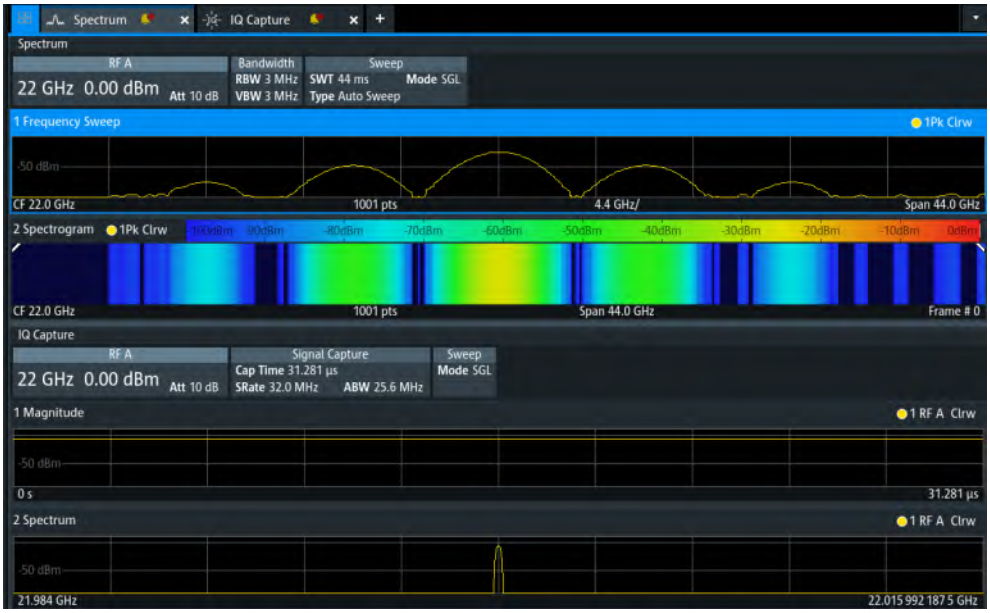
1. - For print: Select "Screenshot" > "Other" > "Modify Themes".
   - For display: Select [Setup] > "Display" > "General" > "Modify Selected Theme".

   The "Theme Color Setup" dialog is displayed.
2. From the "Selected Object" list, select the object whose color you want to configure.
3. Select "Userdefined colors".
4. To assign a user-specific color to the selected object, do one of the following:
   - Select the color directly in the palette.
   - Enter percentage values for the "Tint", "Saturation", and "Brightness".
     Note: In the continuous color spectrum ("Tint"), 0 % represents red and 100 % represents blue.
   - Enter an "ARGB" value in hexadecimal format.
5. Repeat these steps for other objects, as required.
6. Select "OK" to apply the theme color settings and close the dialog.

4.10.6.4 Example for storing multiple measurement results to a PDF file

The following example describes the procedure to store results from measurements in the "Spectrum" application and the "I/Q Capture" application to a single PDF file.

1. Configure and perform the measurements in the "Spectrum" and "I/Q Capture" applications as required. Configure at least the following result displays:
   - "Spectrum": "Frequency Sweep", "Spectrogram"
   - "I/Q Capture": "Magnitude", "Spectrum"
2. Switch to the "MultiView" tab to display an overview of the result displays in all active application instances.



3. Select "Screenshot".

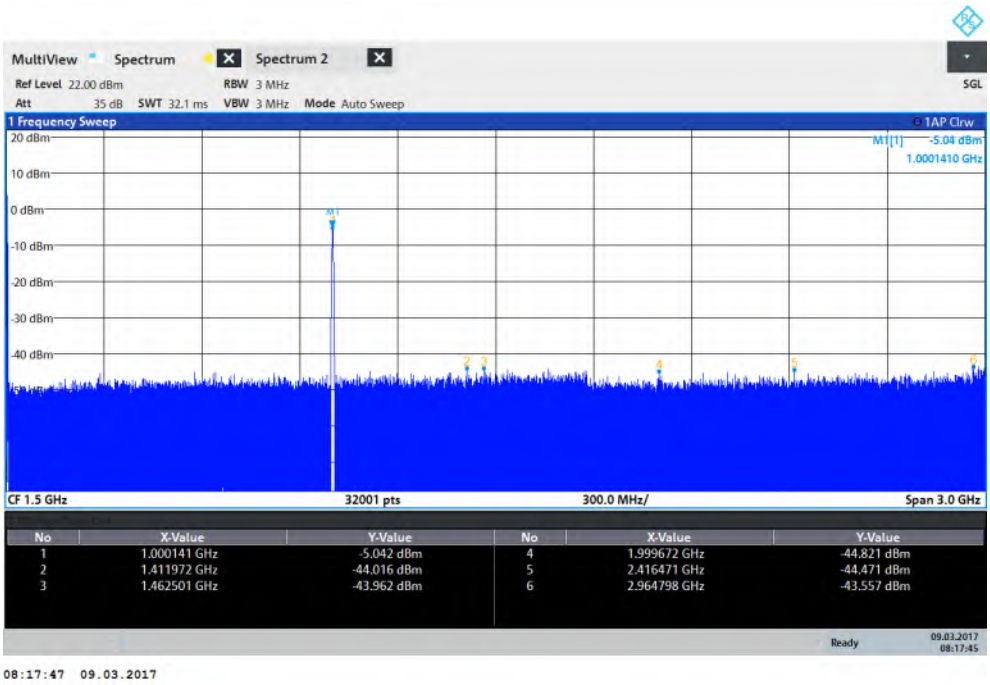
   The "Screenshot Configuration" dialog is displayed.

4. On the "General" tab, select "Save to: File".
5. Select "File Type": "PDF" from the file format selection list.
6. Select "Suppress File Name Dialog".

   The "Location" field indicates where the screenshots are stored.

7. Select "Selected Windows only".
8. Select the result displays listed in step 1.
9. Enter the comment *Measurement Test Report* to include at the top of each page.
10. On the "Other" tab, select "Orientation": "Landscape".
11. Select "Include Page Count" and "Include Timestamp".
12. Select "Windows per Page": *1* to store a single result display on each page.
13. Select the "Scaling" option "Size to Fit" to maximize the result display on each page.
14. Select "Theme": "Bright" for a screenshot that reflects the colors you see on the screen, but with a white background.
15. Check the "Preview" to make sure all required result displays are included. Scroll through the individual pages of the screenshot using the and icons.
16. Select "Take Screenshot".

    The selected data elements are stored to the file as configured.



4.11 General instrument setup

Access:

You can configure some basic instrument settings independently of the selected application. You configure most of these settings initially when you set up the instrument according to your personal preferences or requirements. Later you only adapt individual settings to special circumstances when necessary. Some special functions are provided for service and basic system configuration.

- Toolbar configuration....397
- Reference frequency signals....399
- Transducers....402
- User-defined frequency response correction....411
- Alignment....419
- Display configuration....425
- Synchronizing application configuration (parameter coupling)....434
- Instrument configuration....446
- Service and support....454

4.11.1 Toolbar configuration

You can configure which icons are displayed in the toolbar, and in which order.

Toolbar configuration is saved when you shut down or preset the FSWX. It is not included in savesets (see Section 4.10.3, "Storing and recalling instrument settings and measurement data", on page 358).

To configure the toolbar



1. From the toolbar, select "Edit Toolbar".
   The toolbar is highlighted red to indicate it is in edit mode.
2. Drag and drop the icons in the toolbar to the required position. A blue line indicates the selected position.

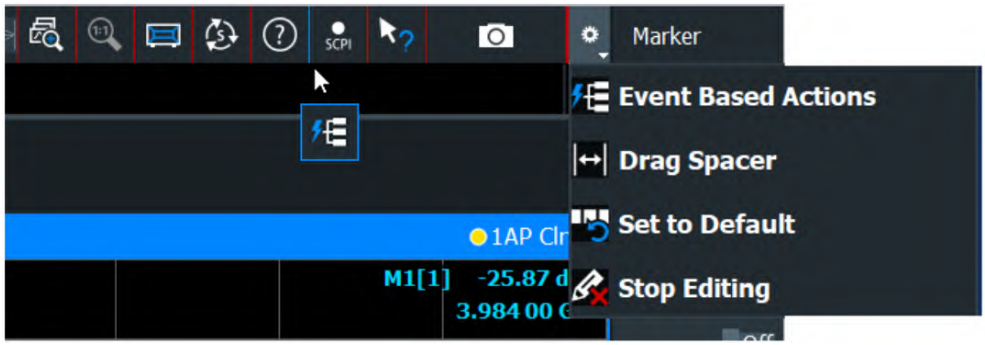


Figure 4-52: Inserting the Event Based Actions icon in the toolbar

3. To add an icon that is currently not visible:
   a) Select "Edit Toolbar".
   All hidden icons are displayed in a menu.
   b) Drag the icon from the menu to the toolbar.
   The added icon is displayed. If the toolbar contains too many icons to display, the icons from the right move to the menu.
4. To hide an icon from the toolbar, drag and drop it outside the toolbar.
   The icon is moved to the menu of hidden icons ("Edit Toolbar"). Empty spaces are indicated by a spacer, see Figure 4-53.



Figure 4-53: Spacer icon

5. To insert additional spaces between icons, for example to create groups of icons:
   a) Select "Edit Toolbar" > "Drag Spacer".
   b) Drag and drop the "Drag Spacer" at the required position in the toolbar. You can insert multiple spaces.
6. To restore the default FSWX toolbar, select "More icons" > "Set to Default".
7. To exit the toolbar edit mode, select "Edit Toolbar" > "Stop Editing".

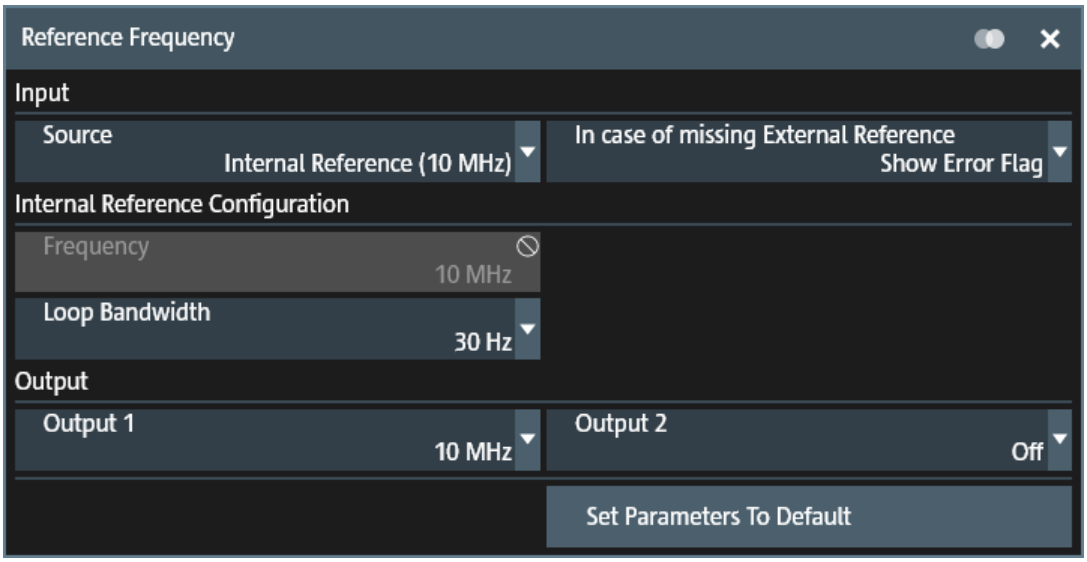
The red highlighting is removed. Selecting an icon performs the assigned function as usual.

4.11.2 Reference frequency signals

Access: > "Reference"

The FSWX requires a reference frequency for all internal oscillators. By default, the FSWX uses a 10 MHz crystal oscillator or the optional and more precise OCXO signal as an internal reference source.

As an alternative, all internal oscillators are synchronized to an external reference frequency provided to the FSWX.



The following reference inputs are available:

Table 4-36: Available reference frequency input

Source connector	Frequency	Tuning Range	Loop Bandwidth	Description
Internal (OCXO)	10 MHz	-	1 Hz to 100 Hz	Internal reference signal or optional OCXO
"Ref In 1"	10 MHz / 100 MHz / variable from 1 MHz to 250 MHz	For variable frequency only: +/-0.2 ppm +/-3 ppm	For fixed frequencies only: 5 Hz / 30 Hz / 100 Hz / 300 Hz	Fixed external frequency or variable external reference frequency in 1 Hz steps Good external phase noise suppression. Small tuning range.
"Ref In 2" (SMA)	640 MHz / 1 GHz / 8 GHz	3 ppm	5 Hz / 30 Hz / 100 Hz / 300 Hz / 100 kHz (for 8 GHz frequency only)	Fixed external reference frequency at specified frequencies Good phase noise performance **Tip**: For 8 GHz reference frequency, the loop bandwidth is automatically set to 100 kHz. If you switch to 640 MHz / 1 GHz frequency, the loop bandwidth is automatically set to the default 100 Hz.

Reference frequency input source 400
Behavior in case of missing external reference 401
Frequency Mode/Frequency 401
Loop Bandwidth 401
Tuning Range 401
Reference Frequency Output 1 402
Reference Frequency Output 2 402
Set Parameters to Default 402

Reference frequency input source

The FSWX requires a reference frequency for all internal oscillators. By default, the FSWX uses a 10 MHz crystal oscillator or the optional and more precise OCXO signal as an internal reference source.

As an alternative, all internal oscillators are synchronized to an external reference frequency provided to the FSWX. External references are connected to one of the REF INPUT connectors on the rear panel. When the FSWX uses an external reference, EXT REF is displayed in the status bar.

For details, see Table 4-36.

"Internal Reference (10 MHz)"
: The internal 10 MHz crystal oscillator or the optional and more precise OCXO signal is used.

"Ref In 1 (1..250 MHz)"
: The signal at the "Ref In 1" connector is used.
Define the used frequency in "Frequency Mode/Frequency" on page 401.

"Ref In 2 (640 MHz, 1 GHz, 8 GHz)"
: The signal at the "Ref In 2" connector is used.
Define the used frequency in "Frequency Mode/Frequency" on page 401.

Remote command:
[SENSe:]ROSCillator:SOURce on page 809

Behavior in case of missing external reference
If you select an external reference but none is available, there are different ways the instrument can react.

"Show Error Flag"
The error message "External reference missing" is displayed. Also, the flag "NO REF" is displayed to indicate that no synchronization was performed *for the last measurement*.

"Switch to internal reference"
The instrument automatically switches back to the internal reference. Note that you must re-enable the external reference if it becomes available again later.

Remote command:
[SENSe:]ROSCillator:EXTernal:FALLback on page 811

Frequency Mode/Frequency
Defines the external reference frequency to be used, depending on the selected source. Select "Manual" mode to define the frequency for variable connectors.

Remote command:
[SENSe:]ROSCillator:EXTernal:FREQuency on page 810
[SENSe:]ROSCillator:EXTernal:FREQuency:MODE on page 810

Loop Bandwidth
Defines the speed of internal synchronization with the reference frequency. The setting requires a compromise between performance and increasing phase noise.

For a variable external reference frequency, the loop bandwidth is fixed, depending on the Tuning Range, and cannot be changed.

Remote command:
[SENSe:]ROSCillator:LBWidth on page 812

Tuning Range
The tuning range is only available for the variable external reference frequency. It determines how far the frequency can deviate from the defined level in parts per million (10^{-6}).

"+/- 0.2 ppm" The smaller deviation uses a narrow fixed loop bandwidth of 0.1 Hz. The instrument can synchronize to an external reference signal with a precise frequency. Due to the narrow loop bandwidth, unwanted noise or spurious components on the external reference input signal are attenuated. Furthermore, the loop requires about 30 seconds to reach a locked state. During this locking process, "NO REF" is displayed in the status bar.

"+/- 3 ppm" The larger deviation allows the instrument to synchronize to less precise external reference input signals.

Remote command:
[SENSe:]ROSCillator:TRANge on page 812

Reference Frequency Output 1
The FSWX can provide a reference frequency to other connected devices. If enabled, the reference signal is output to the "Ref Out 1" connector.

"Off" No output is provided to the "Ref Out 1" connector.

"Output 10 MHz"
Outputs a 10 MHz reference signal to the "Ref Out 1" connector.

"Output 100 MHz"
Outputs a 100 MHz reference signal to the "Ref Out 1" connector.

"Ref In 1"
Outputs the external reference signal provided at the "Ref In 1" connector to the "Ref Out 1" connector.

Remote command:
`ROSC:OUTP1`, see `[SENSe:]ROSCillator:OUTPut<o>` on page 812

Reference Frequency Output 2
The FSWX can provide a reference frequency to other connected devices. If enabled, the reference signal is output to the "Ref Out 2" connector.

"Off" No output is provided to the "Ref Out 2" connector.

"Output 1 GHz"
Outputs a 1 MHz reference signal at the "Ref Out 2" connector.

"Output 8 GHz"
Outputs an 8 GHz reference signal at the "Ref Out 2" connector.

"Ref In 2"
Outputs the external reference signal provided at the "Ref In 2" connector to the "Ref Out 2" connector.

Remote command:
`ROSC:OUTP2`, see `[SENSe:]ROSCillator:OUTPut<o>` on page 812

Set Parameters to Default
The values for the "Tuning Range", "Frequency Mode", "Frequency" and "Loop Bandwidth" are stored for each reference input source.

When you switch the input source, the previously defined settings are restored. You can restore the default values for all input sources using the "Set Parameters to Default" function.

4.11.3 Transducers

4.11.3.1 Transducer settings

Access: ⚙ > "Transducer"

You can enable up to 8 transducers simultaneously on the FSWX. You can store many more.

You can also define transducers when using an optional external mixer.

Stored transducer settings

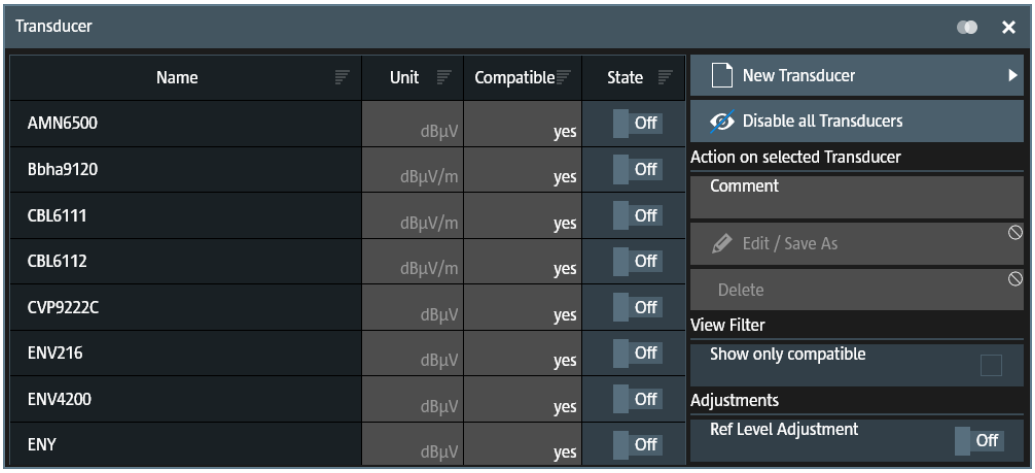
When storing and recalling transducer settings, consider the information provided in "Saving and recalling transducer and limit line settings" on page 359.

- Transducer management 403
- Transducer factors 405

Transducer management

Access: > "Transducer"

The settings required to manage all transducers on the instrument are described here.



For the transducer overview, the FSWX searches for all stored transducers with the file extension `.tdf` in the directory `home/instrument/.local/share/rohde-schwarz/esmain/fswx/trd`. The overview allows you to determine which transducers are available and can be used for the current measurement.

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Unit 403
Compatibile 404
State 404
New Transducer 404
Disable all Transducers 404
Comment 404
Edit / Save As 404
Delete 404
Included transducers in overview (View Filter) 405
Adjustments: Reference Level 405

Name
The name of the stored transducer.

Unit
The unit of the y-values of the transducer factors.

The following units are available:

- dB
- dBm
- dBmV
- dBµV
- dBµV/m
- dBµA
- dBµA/m
- dBpW
- dBpT

Compatibile
Indicates whether the transducer factors are compatible with the current measurement settings.

For more information on which conditions a transducer factor must fulfill to be compatible, see Section 4.1.6.1, "Fixed transducer factors for discrete trace points", on page 163.

State
Enables or disables the transducer. Up to 8 transducers can be active at the same time.

Remote command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 824
`[SENSe:]CORRection:TRANsducer[:STATe]` on page 825

New Transducer
Create a new transducer.

For instructions, see "How to configure a new transducer" on page 408.

Remote command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 824

Disable all Transducers
Disables all transducers in one step, without deleting the configuration.

Comment
An optional description of the selected transducer.

Remote command:
`[SENSe:]CORRection:TRANsducer:COMMent` on page 823

Edit / Save As
Edit an existing transducer configuration.

Delete
Delete the selected transducer.

Remote command:
`[SENSe:]CORRection:TRANsducer:DELete` on page 824

Included transducers in overview (View Filter)
Defines which of the stored transducers are included in the overview. The view can be restricted to compatible transducers only or include all transducers that are found. Whether a line is compatible or not is indicated in the Compatibile column.

Adjustments: Reference Level
The reference level can be adjusted to the selected transducer automatically.

"Auto" The reference level is automatically adjusted to the selected transducer. The original dynamic range is restored by shifting the reference level by the maximum transducer factor.

"Manual" Adjust the reference level via the "Amplitude" menu.

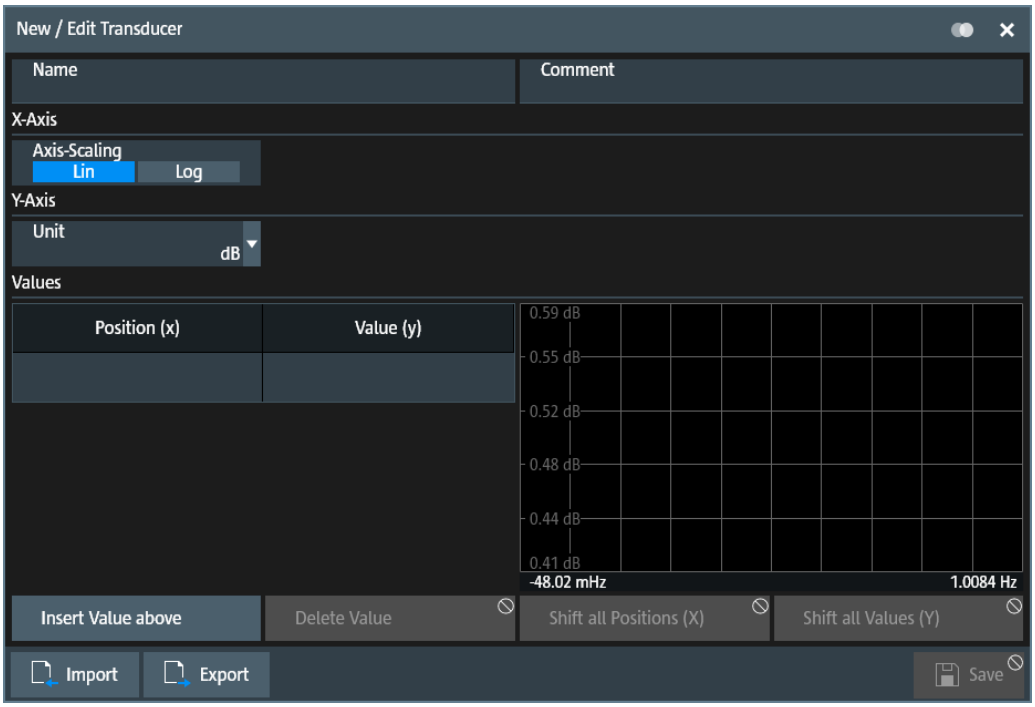
Remote command:
`[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe]` on page 822

Transducer factors

Access: > "Transducer" > "Edit / Save As" / "New Transducer"

The settings and functions available for individual transducers are described here.

For instructions on creating and editing transducers, see Section 4.11.3.2, "How to configure the transducer", on page 408.



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Comment....406
X-Axis scaling....406
Y-axis Unit....406
Transducer Factors (Position/Value)....406
Insert Value Above....407

Delete Value....407
Shift all Positions (x)....407
Shift all Values (y)....407
Import....407
└ File name....407
└ Decimal Separator....407
Export....407
Save....408

Name
Defines the transducer name. The transducer data is stored under this name (with a `.tdf` extension) in the directory `home/instrument/.local/share/rohde-schwarz/esmain/fswx/trd`.

Remote command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 824

Comment
Defines an optional comment for the transducer. The text can contain up to 40 characters.

Remote command:
`[SENSe:]CORRection:TRANsducer:COMMent` on page 823

X-Axis scaling
Defines whether the frequency values of the transducer factors are defined as linear or logarithmic values.

Remote command:
`[SENSe:]CORRection:TRANsducer:SCALing` on page 824

Y-axis Unit
The unit of the y-values of the transducer factors.

When you enable a transducer, the unit of the transducer is automatically used for all level settings and outputs of the measurement. You cannot change the unit in the "Amplitude" settings, unless you select dB.

Remote command:
`[SENSe:]CORRection:TRANsducer:UNIT` on page 825

Transducer Factors (Position/Value)
Each transducer is defined by a minimum of 2 and a maximum of 1001 transducer factors. Each transducer factor is defined by its position (x-axis) and value (y-value).

The transducer factors must comply with the following rules to ensure correct operation:

- Always define the frequencies for the transducer factors in ascending order. Otherwise the FSWX does not accept the entry and an error message is displayed.
- The frequencies of the transducer factors can exceed the valid frequency range of the FSWX. The minimum frequency of a transducer factor is 0 Hz, the maximum frequency is 200 GHz. Measurements only consider the relevant frequency range.
- The value range for the transducer factor is ±200 dB.

- Enter a gain as a negative value, and attenuation as a positive value.

Remote command:
[SENSe:]CORRection:TRANsducer:DATA on page 824

Insert Value Above
Inserts a transducer factor above the selected one.

Delete Value
Deletes the selected transducer factor.

Shift all Positions (x)
Shifts the x-value of each transducer factor horizontally by the defined shift width.

Shift all Values (y)
Shifts the y-value of each transducer factor vertically by the defined shift width.

Import
Opens a file selection dialog box and loads the transducer from the selected file in `.csv` format.

Note that a valid import file must contain a minimum of required information for the FSWX. For details on the file format, see Section 4.1.6.2, "Reference: transducer factor file format", on page 164.

Remote command:
MMEMory:LOAD<n>:TFACtor on page 826

File name ← Import
Contains the name of the data file without the path or extension.

For details on the filename and location, see "Storage location and filename" on page 360.

Decimal Separator ← Import
Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:
FORMat:DEXPort:DSEParator on page 779

Export
Opens a file selection dialog box and stores the currently displayed transducer factor to the defined file in `.csv` format.

For details on the file format, see Section 4.1.6.2, "Reference: transducer factor file format", on page 164.

You can import the transducer factor again later to the FSWX for use in other measurements.

Remote command:
MMEMory:STORe<n>:TFACtor on page 826

Save
Saves the currently edited transducer under the name defined in the "Name" field, with the extension `.tdf`.

Remote command:
`MMEMory:SELect[:ITEM]:TRANsducer:ALL` on page 786
`MMEMory:STORe<1|2>:STATe` on page 789

4.11.3.2 How to configure the transducer

You define transducer settings in the "Transducer" dialog box which is displayed when you select > "Transducer".

Stored transducer settings
When storing and recalling transducer settings, consider the information provided in "Saving and recalling transducer and limit line settings" on page 359.

The following tasks are described:

- "How to find compatible transducers" on page 408
- "How to enable and disable a transducer" on page 408
- "How to configure a new transducer" on page 408
- "How to edit or copy existing transducers" on page 409
- "How to move the transducer vertically or horizontally" on page 410
- "How to delete an existing transducer" on page 410
- "How to export a transducer" on page 410
- "How to import a transducer factor" on page 411

How to find compatible transducers

► In the "Transducer" dialog box, select the "View Filter" option: "Show only compatible".

All transducers stored on the instrument that are compatible to the current measurement settings are displayed in the overview.

How to enable and disable a transducer

1. To enable a transducer, in the "Transducer" dialog box, set its "State" to "On".

   The trace is automatically recalculated for the next sweep.

2. To disable a transducer, set its "State" to "Off".

   After the next sweep, the originally measured values are displayed.

How to configure a new transducer

1. In the "Transducer" dialog box, select "New Transducer".

The "Edit Transducer" dialog box is displayed. The current transducer configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.

2. Define a "Name" for the new transducer.
3. Optionally, define a "Comment", e.g. a description of its use.
4. Define the "Unit" for the y-axis.
5. Define the scaling for the "X-Axis": linear or logarithmic.
6. Define the transducer factors: minimum 2, maximum 1001:
   a) Select "Insert Value".
   b) Define the x-value ("Position") and y-value ("Value") of the first transducer factor.
   c) Select "Insert Value" again.
   d) Define the second transducer factor.
   e) Repeat the steps to insert all other transducer factors.
   To insert a transducer factor before an existing one, select the transducer factor and then "Insert Value".
   To insert a new transducer factor at the end of the list, select the row after the last entry, then "Insert Value".
   To delete a transducer factor, select the entry, then "Delete Value".
7. Check the current transducer configuration in the preview area of the dialog box. If necessary, correct individual transducer factors, or add or delete some.
   If necessary, shift the entire transducer vertically or horizontally by selecting "Shift x" or "Shift y" and defining the shift width.
8. Save the new configuration by selecting "Save".

   The new transducer is displayed in the overview and you can enable it.

How to edit or copy existing transducers

You can copy or edit existing transducer configurations.

1. In the "Transducer" dialog box, select the transducer.
2. Select "Edit/Save As".
3. Optionally, define a new "Name" to create a copy of the transducer.
4. Edit the line configuration as described in "How to configure a new transducer" on page 408.
5. Select "Save" to save the new configuration.

   The trace is automatically recalculated for the next sweep if the transducer is enabled.

To store the changes to the transducers in a settings file, select the "Save" icon in the toolbar.

See Section 4.10.3, "Storing and recalling instrument settings and measurement data", on page 358.

How to move the transducer vertically or horizontally

You can easily move a configured transducer vertically or horizontally. Thus, you can easily create a new transducer based on an existing transducer which has been shifted.

1. In the "Transducer" dialog box, select the transducer.
2. Select "Edit / Save As".
3. In the "Edit Transducer" dialog box, select "Shift all Positions (x)" or "Shift all Values (y)".
4. Define the shift width.
5. Optionally, define a new "Name" for the shifted transducer.
6. Save the shifted transducer by selecting "Save".

   If enabled, the trace is recalculated after the next sweep.

How to delete an existing transducer

1. In the "Transducer" dialog box, select the transducer.
2. Select "Delete".
3. Confirm the message.

   The transducer is deleted. After the next sweep, the originally measured values are displayed.

How to export a transducer

You can store a transducer to an ASCII file for evaluation in other programs, or to import it later for other measurements.

1. In the "Transducer" dialog box, select the transducer factor.
2. Select "Edit /Save As".
3. Define the transducer factor as described in "How to configure a new transducer" on page 408.
4. Select "Export" to save the configuration to a file.

   The FSWX asks you whether you want to save the configuration (`.tdf`) first.
5. Select a filename and location for the transducer.
6. Select the decimal separator to use in the file.

7. Select "Save".

   The transducer is stored to a file with the specified name and the extension `.csv`. For details on the file format see Section 4.1.6.2, "Reference: transducer factor file format", on page 164.

How to import a transducer factor

Transducer factor configurations that are stored in an ASCII file and contain a minimum of required data can be imported to the FSWX.

For details on the required file format, see Section 4.1.6.2, "Reference: transducer factor file format", on page 164.

1. In the "Edit Transducer" dialog box, select the transducer factor.
2. Select "New" or "Edit".
3. Select "Import" to load a transducer factor from a file.

   The FSWX asks you whether you want to save the configuration (`.tdf`) first.
4. Select the filename of the transducer factor (`.csv`).
5. Select the decimal separator that is used in the file.
6. Select "Select".

   The transducer factor is loaded from the specified file and displayed in the "Edit Transducer" dialog box.
7. Enable the transducer factor as described in "How to enable and disable a transducer" on page 408.

4.11.4 User-defined frequency response correction

Access: > "User Correction"

The FSWX supports user-defined frequency response correction using Touchstone (`.snp`) files or `.fres` files.

This function requires an additional option (User Defined Frequency Correction by SnP File (R&S FSW3-KR110)).

You can correct frequency response using one or more Touchstone files, one or more frequency response (`.fres`) files, or a combination of them. You can store a configuration of correction files to a file and load the file on the FSWX.



You can configure frequency response correction individually for each input source. The settings in the "User-defined Frequency Response Correction" dialog box apply to the currently selected input source. Be sure to select the appropriate input source *before* you define the correction data.

Apply to....413
Apply Correction....413
Reference Level Adjustment....413
S-Parameter (Touchstone Files) information....414
- ID....414
- Filename....414
- Active....414
- To - From....414
- Add File....414
- Remove file....415
- Move file up or down....415

Frequency Response file information....415
- ID....415
- Filename....415
- Magnitude....415
- Phase....415
- Add File....415
- Remove file....416

Preview....416
- Selected File....416
- I/Q Mode....417
- Spectrum Mode....418

Reload Files....418
Clear settings....418
Load settings....418
Save settings....419

Apply to
Determines which application instances the correction settings are applied to.

"All Instances" The frequency response correction settings are applied to **all** active measurement application instances with the same input source. A new filter is calculated for each measurement instance as soon as you switch to it, or when a measurement is performed (e.g. by the "Sequencer").

"Current Instance" The frequency response correction settings are applied to the currently selected application instance only.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:SCOPe` on page 835

Apply Correction
Enables or disables the general usage of user-defined frequency response correction settings. If enabled, the data in the active correction files is combined to create a filter. This filter is applied to the measurement results of subsequent sweeps.

TPIS correction is not supported if user frequency response correction is active. If you enable frequency response correction, TPIS correction is automatically disabled in all application instances.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:STATe` on page 842
Testing the validity of the correction setting:
`[SENSe:]CORRection:FRESponse<ip>:USER:VALid?` on page 843

Reference Level Adjustment
The FSWX can adjust the reference level to the active filter calculation automatically. The resulting offset is the mean of the filter calculation. The FSWX calculates the reference level offset individually for each application instance that the frequency response correction settings apply to (see "Apply to" on page 413).

Note the following prerequisites and restrictions concerning the automatic reference level adjustment:

- The reference level offset is only applied if frequency response correction is enabled (see "Apply Correction" on page 413). If you disable frequency response correction, "Adjust Ref Level" is automatically set to "Manual".
- The reference level offset is only applied if the center frequency is within the currently covered filter frequency range.
- The reference level offset is applied independently of a transducer reference level offset (see "Adjustments: Reference Level" on page 405).

"On" The original dynamic range of the reference level is automatically shifted by the filter calculation offset.

"Off" Adjust the reference level in the "Amplitude" settings (see "Reference Level" on page 181).

Remote command:
[SENSe:]CORRection:FRESponse<ip>:USER:ADJust:RLEVel:STATe
on page 829

S-Parameter (Touchstone Files) information
Provides information on loaded Touchstone files and the order in which they are applied.

If an external preamplifier is active, it is also included at the bottom of the list.

ID ← S-Parameter (Touchstone Files) information
Consecutive number which determines the order in which the correction files are applied to the measurement data. The maximum number of files per configuration is 15.

An LED-like symbol indicates whether the file is active and Touchstone files or the external preamplifier in general are switched on (symbol "lights up") or not (symbol is dark). A purple symbol represents a Touchstone file.

Filename ← S-Parameter (Touchstone Files) information
Name of a loaded Touchstone file.

Active ← S-Parameter (Touchstone Files) information
Enables or disables the selected file for the current configuration. Only active files are included in filter calculation.

Remote command:
[SENSe:]CORRection:FRESponse<ip>:USER:STATe on page 842

To - From ← S-Parameter (Touchstone Files) information
Touchstone files can be defined for a varying number of input and output ports.

Define the ports from the Touchstone file whose data is to be applied.

Remote command:
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:PORTs:TO
on page 839
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:PORTs:FROM
on page 838



Add File ← S-Parameter (Touchstone Files) information
Loads a new Touchstone file for the current configuration. The maximum number of files per configuration is 15. The new file is added below the currently selected file. To change the order of the files, use the Move file up or down icons.

The file extension of the Touchstone file must correspond to the number of ports included in the file. For example, a file containing 4 parameters for S11, S22, S12 and S21 must have the extension `.s2p`.

A minimum number of values is required to compensate for a group delay, see "Group delay compensation" on page 166.

The default directory for Touchstone files is
`var/lib/rohde-schwarz/esmain/fswx/user/fresponse`.

Remote command:
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:INSert
on page 837



Remove file ← S-Parameter (Touchstone Files) information
Removes the selected Touchstone file from the current configuration.

Remote command:
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:REMove
on page 839
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:CLEar on page 836



Move file up or down ← S-Parameter (Touchstone Files) information
Moves the selected Touchstone file one position up or down in the list of files, changing the order in which the correction data is applied.

Remote command:
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:MOVE on page 838

Frequency Response file information
Provides information on loaded frequency response files and the order in which they are applied.

ID ← Frequency Response file information
Consecutive number which determines the order in which the correction files are applied to the measurement data. The maximum number of files per configuration is 15.

An LED-like symbol indicates whether the file and frequency response in general is active (symbol "lights up") or not (symbol is dark). A green symbol represents a frequency response (`.fres`) file.

Filename ← Frequency Response file information
Name of a loaded Touchstone file.

Magnitude ← Frequency Response file information
Enables or disables the use of the correction data in the selected file for magnitude results.

Remote command:
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:MAGNitude[:STATe] on page 831

Phase ← Frequency Response file information
Enables or disables the use of the correction data in the selected file for phase results.

Remote command:
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:PHASe[:STATe]
on page 831



Add File ← Frequency Response file information
Loads a frequency response (`.fres`) file to the current configuration. The maximum number of files per configuration is 15.

A minimum number of values is required to compensate for a group delay, see "Group delay compensation" on page 166.

The default directory for `.fres` files is `var/lib/rohde-schwarz/esmain/fswx/user/fresponse`.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:INSert` on page 830

Remove file ← Frequency Response file information
Removes the selected frequency response (`.fres`) file from the current configuration.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:REMove` on page 832
`[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:CLEar` on page 830

Preview
The preview of the (combined) user correction files shows the correction values.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:PSTate` on page 840
`[SENSe:]CORRection:FRESponse<ip>:USER:SCOVered?` on page 835

Selected File ← Preview
The preview of the selected user correction file shows the correction values for the specified frequency range. You can enable or disable the values for individual ports.



Figure 4-54: Preview of selected user correction file

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:FREQuency?` on page 830
`[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:MAGNitude?` on page 830
`[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:PHASe?` on page 830
`[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:FREQuency<spi>?` on page 836

[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:MAGNitude<spi>? on page 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:PHASe<spi>? on page 836

I/Q Mode ← Preview

The preview in "I/Q Mode" indicates the frequencies that are covered by the individual correction files. The blue bar indicates the valid frequency range for which all files contain values.

An LED-like symbol indicates whether each file is active and user correction in general is switched on (symbol "lights up") or not (symbol is dark). A purple symbol represents a Touchstone file. A green symbol represents a frequency response (`.fres`) file.

The lower part shows the combined correction values for the valid frequency range.

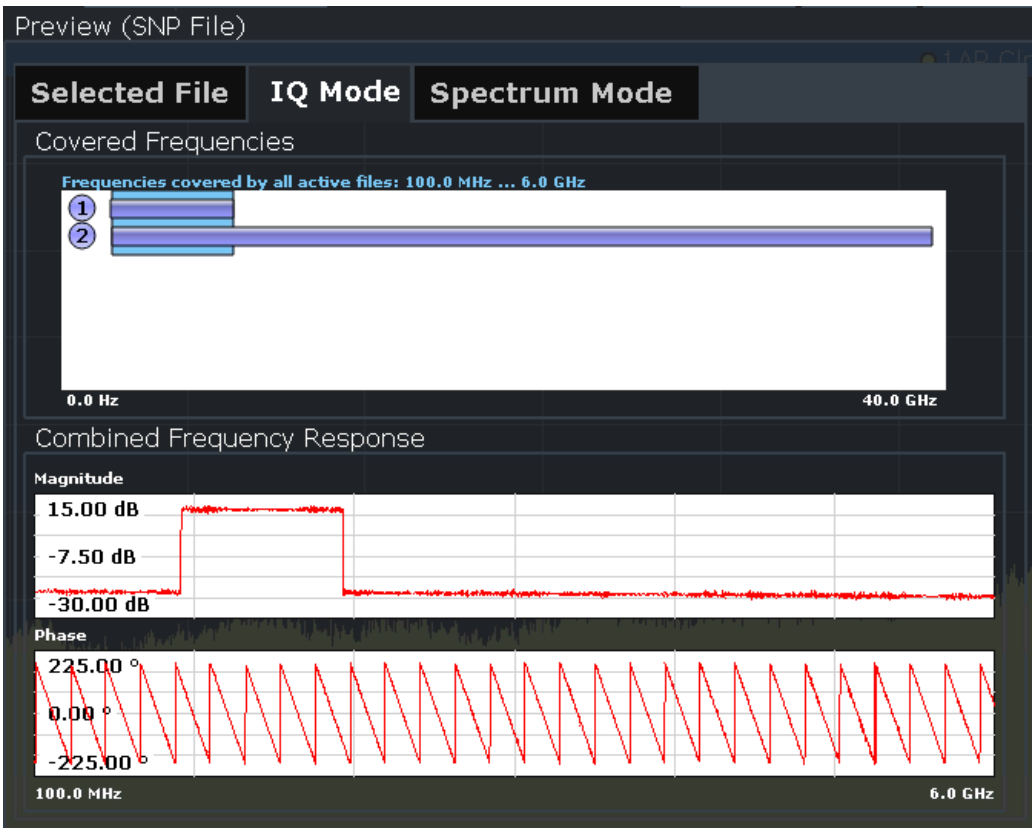


Figure 4-55: I/Q Mode preview of user correction files

Remote command:
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:FREQuency? on page 834
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:MAGNitude? on page 834
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:PHASe? on page 834

Spectrum Mode ← Preview
The preview in "Spectrum Mode" indicates the frequency ranges covered by the individual correction files. The blue bar indicates the valid frequency range for which at least one file contains values.

An LED-like symbol indicates whether each file is active and user correction in general is switched on (symbol "lights up") or not (symbol is dark). A purple symbol represents a Touchstone file. A green symbol represents a frequency response (`.fres`) file.

The lower part shows the combined correction values for the valid frequency range.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:FREQuency?` on page 842
`[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:MAGNitude?` on page 842
`[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:PHASe?` on page 842

Reload Files
Retrieves the specified files again and creates a new combined filter. If enabled, the correction filter is applied immediately.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:INPut:USER:REFResh` on page 834

Clear settings
Clears all current user-defined frequency response correction settings. The settings are cleared either for the currently selected application instance only, or for all application instances, depending on the Apply to setting.

Only files specific to the FSWX itself remain in the list of Touchstone files.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:PRESet` on page 834

Load settings
Loads a stored saveset for a user-defined frequency response correction scenario. Existing settings in the dialog box are overwritten. The settings apply to the currently selected application instance or all application instances, depending on the Apply to setting.

You can only load `.dfl` files.

The default storage directory for correction files is `var/lib/rohde-schwarz/esmain/fswx/user/fresponse`.

For details on savesets and loading settings, see Section 4.10.3, "Storing and recalling instrument settings and measurement data", on page 358.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:LOAD` on page 834

Save settings
Stores a saveset for a user-defined frequency response correction scenario. As for all instrument settings, a `.dfl` file is created. Note that only the settings defined in this dialog box are stored, not the contents of any loaded files.

For details on savesets and saving settings, see Section 4.10.3, "Storing and recalling instrument settings and measurement data", on page 358.

The settings are stored for the currently selected application instance only or for all application instances, depending on the Apply to setting.

The default storage directory for correction files is `var/lib/rohde-schwarz/esmain/fswx/user/fresponse`.

Remote command:
`[SENSe:]CORRection:FRESponse<ip>:USER:STORe` on page 843

4.11.5 Alignment

4.11.5.1 Basics on alignment

When you put the instrument into operation for the first time or when strong temperature changes occur, align the data to a reference source (see "Temperature check" on page 420).

The firmware determines the correction data and characteristics required for the alignment. It compares the results at different settings with the known characteristics of the high-precision calibration signal source at 64 MHz.

Basic operation of the FSWX can be affected before or after a self-alignment in the following ways:

- Depending on the installation settings, an automatic self-alignment is performed directly after installation. A dialog is displayed indicating how much warm-up time is still required before self-alignment can be performed.
- During instrument start, the firmware checks whether the installed hardware is supported. If not, an error message is displayed ("Wrong firmware version"") and you are asked to update the firmware. Until the firmware version is updated, self-alignment fails.
- When you start self-alignment, a self-test is automatically performed first.
  For details on the self-test, see Section 4.11.9.2, "Self-test settings and results", on page 456.
- By default, a reminder is shown in the status bar of the instrument 30 days after the last self-alignment took place. You can enable or disable the reminder, and change the timing for it.
  Tip: To check for a self-alignment reminder message in the status history, use the `SYStem:ERRor:EXTended?` command and search for messages that start with `Self alignment older than`.
- If you start a self-alignment remotely and then select "Local" while the alignment is still running, the instrument only returns to the manual operation state after the alignment is completed.

- During self-alignment, do not connect a signal to any of the RF input connectors. Running a self-alignment with a signal connected to the RF input can lead to false measurement results.

Temperature check

During self-alignment, the instrument's frontend temperature is measured (if enabled, only after the instrument has warmed up completely, see "Await Warm-Up before Self-Alignment" on page 422). This temperature is used as a reference for a continuous temperature check during operation. If the current temperature deviates from the stored self-alignment temperature by a certain degree, a warning is displayed in the status bar. The warning indicates the resulting deviation in the measured power levels. A status bit in the `STATUs:QUEStionable:TEMPerature` register indicates a possible deviation. You can query the current temperature of the frontend using a remote command (see `SOURce<si>:TEMPerature:FRONtend` on page 822).

4.11.5.2 Alignment results

The alignment results are displayed and contain the following information:

- Date and time of last correction data record
- Overall results of correction data record
- List of performed alignment steps

The results are classified as follows:

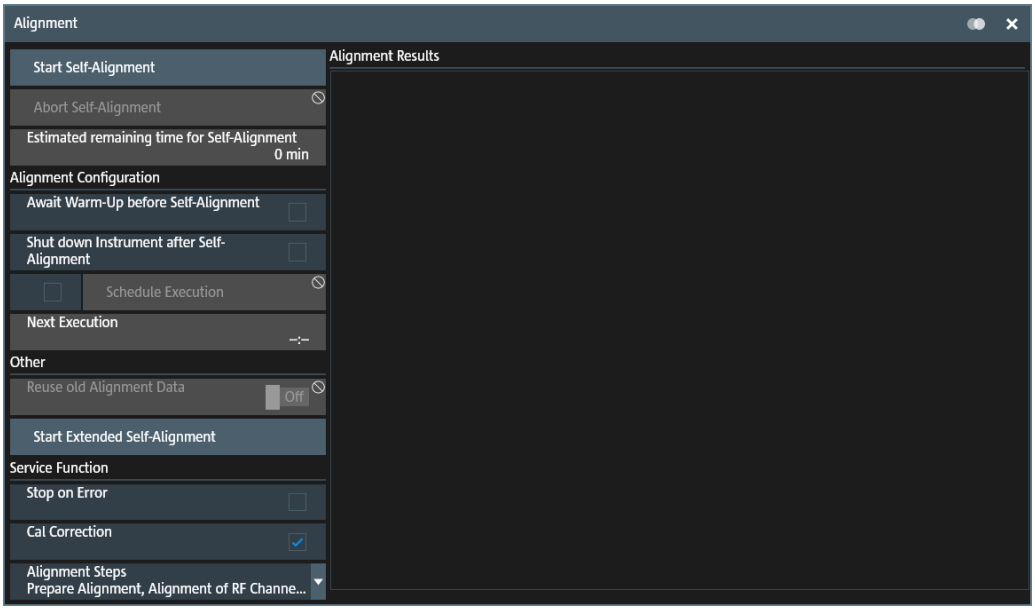
PASSED	Calibration successful without any restrictions
CHECK	Deviation of correction value larger than expected, correction could still be performed
FAILED	Deviations of correction value too large, no correction was possible. The determined correction data is not applicable.

The results are available until you start the next self-alignment process or switch off the instrument.

4.11.5.3 Alignment settings

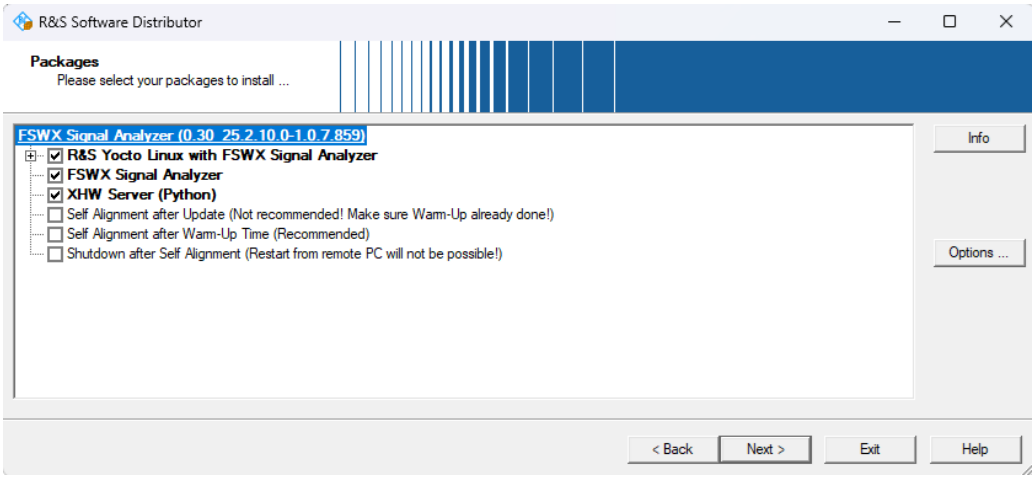
Access: > "Alignment"

You can align the instrument when necessary (see Section 4.11.5.1, "Basics on alignment", on page 419).



Automatic self-alignment

During installation of the FSWX firmware, you can configure an automatic self-alignment to be performed directly after installation. In addition, you can enable a preceding warm-up time before self-alignment, which is strongly recommended. If you do not enable this option, make sure that the instrument has reached its operating temperature before installing the firmware. Furthermore, you can force the instrument to shut down after self-alignment. Note, however, that you cannot switch on the instrument remotely afterwards.



You can also enable or disable the additional settings for self-alignment during operation in the "Alignment" settings dialog (see "Await Warm-Up before Self-Alignment" on page 422 and "Shut down Instrument after Self-Alignment" on page 422.)

Start Self Alignment 422
Abort Self Alignment 422
Estimated remaining time for Self-Alignment 422

Await Warm-Up before Self-Alignment....422
Shut down Instrument after Self-Alignment....422
Schedule Execution.... 422
Reuse Old Alignment Data....423
Start Extended Self-Alignment....423
Alignment Results.... 423

Start Self Alignment
Starts recording correction data for the instrument. If the correction data acquisition fails or if the correction values are disabled, a corresponding message is displayed in the status field.

For details, see Section 4.11.5.1, "Basics on alignment", on page 419.

Note: A running "Sequencer" operation is aborted when you start a self-alignment. During self-alignment, do not connect a signal to any of the RF input connectors. Running a self-alignment with a signal connected to the RF input can lead to false measurement results.

Remote command:
`*CAL?` on page 536, see also `CALibration[:ALL]?` on page 814

Abort Self Alignment
As long as the self-alignment data is being collected, you can cancel the procedure.

Note: If you start a self-alignment remotely, then select "Local" while the alignment is still running, the instrument only returns to the manual operation state after the alignment is completed. In this case, you cannot abort a self-alignment manually.

Estimated remaining time for Self-Alignment
Indicates the estimated remaining time to complete the self-alignment.

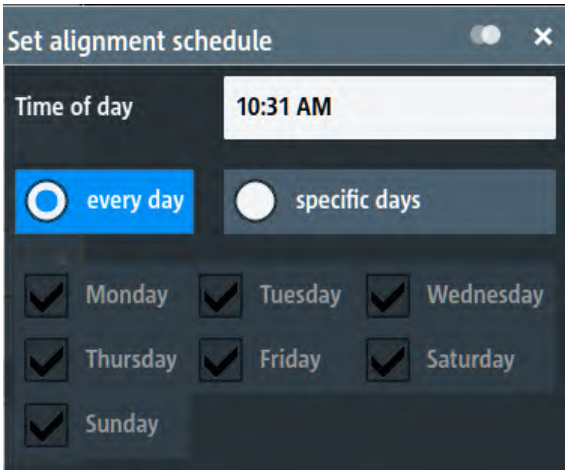
Await Warm-Up before Self-Alignment
Displays a message indicating the remaining warm-up time required before self-alignment is performed. After the warm-up operation has completed, self-alignment is started automatically.

Remote command:
`CALibration:DUE:WARMup` on page 817

Shut down Instrument after Self-Alignment
If enabled, the FSWX is automatically shut down after self-alignment is completed. Note that the instrument cannot be restarted via remote control.

Remote command:
`CALibration:DUE:SHUTdown` on page 816

Schedule Execution
If enabled, a self-alignment is performed regularly at specific days and time. The next scheduled execution is indicated.



Remote command:
CALibration:DUE:SCHedule on page 816
CALibration:DUE:DAYS on page 815
CALibration:DUE:TIME on page 817

Reuse Old Alignment Data
If data from a previous self-alignment is available on the instrument, it can be reused even though the instrument claims the instrument is uncalibrated. This is useful, for example, after activating a software option or updating the firmware to a beta version. After rebooting the instrument, you must re-enable this function if you still want to reuse the old alignment data.

Note, however, that **re-using old alignment data can lead to inaccurate measurement results, or even cause the FSWX firmware to fail altogether**. For measurements using old alignment data, an "OLD CAL" message is indicated in the status bar (instead of "UNCAL", which indicates that a new self-alignment is actually required.)

To measure with the accuracy specified in the specifications document, always perform a self-alignment when the instrument calls for it.

Start Extended Self-Alignment
Performs an extended self-alignment as performed in the factory. Any previous self-alignment results are deleted.

Note that this process takes longer than the common self-alignment.

Remote command:
CALibration[:ALL] ACLear

Alignment Results
Information on whether the alignment was performed successfully and on the applied correction data. The results are available until the next self-alignment process is started or the instrument is switched off.

Remote command:
CALibration:RESult? on page 818

4.11.5.4 How to perform a self-test

You do not have to repeat the self-test every time you switch on the instrument. It is only necessary when you suspect the instrument is malfunctioning.

Operating temperature
Before performing this alignment, make sure that the instrument has reached its operating temperature.
For details, refer to the specifications document.

1. Select .
2. Select "Service & Support".
3. Select "Selftest".

   Once the instrument modules have been checked successfully, a message is displayed.

4.11.5.5 How to align the instrument

Operating temperature
Before performing this alignment, make sure that the instrument has reached its operating temperature.
For details, refer to the specifications document.

To perform a self-alignment

Make sure that no signal is connected to any of the RF input connectors. Running a self-alignment with a signal connected to the RF input can lead to false measurement results.

1. Select .
2. Select "Alignment".
3. Select "Start Self Alignment".
4. To abort the self-alignment process, select "Abort Self Alignment".

   Once the system correction values have been calculated successfully, a message is displayed.

To display the alignment results again later

► Select > "Alignment".

4.11.6 Display configuration

4.11.6.1 Display settings

Access: ⚙ > "Display"

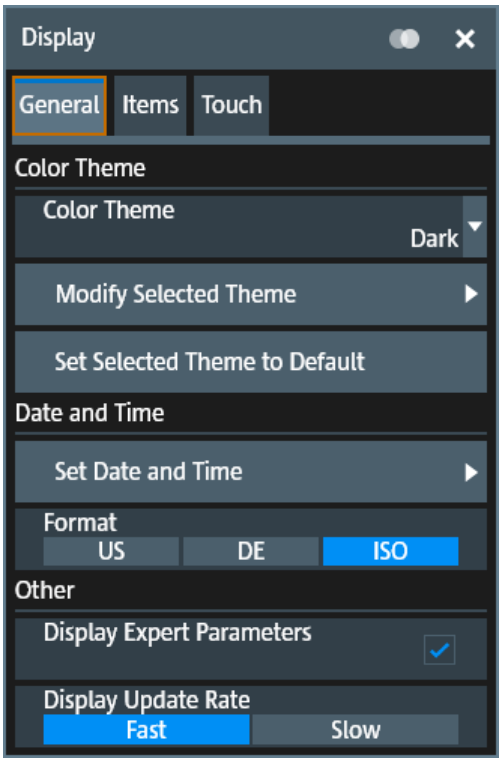
Some general display settings are available for all applications. For information on optimizing your display for measurement results, see Section 4.7, "Laying out the result display", on page 277.

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- Touch(screen) settings 430

General display settings

Access: ⚙ > "Display" > "General"

This section includes general screen display behavior and date and time display.



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Date and Time Format 426
Display Expert Parameters 426
Display Update Rate 427

Color Theme
The theme defines the colors and style used to display softkeys and other screen objects.

The available color settings are identical for print and screen display, see "Theme color settings" on page 390. However, you can select different themes for screenshots and display.

"Dark" (Default:) Uses a dark background.

"Light" Uses a white background.

Remote command:
`DISPlay:THEMe:CATalog?` on page 849
`DISPlay:THEMe:SELect` on page 849

Set Selected Theme to Default
Restores the predefined settings for the selected theme.

Set Date and Time
Sets the current date and time for the internal real-time clock on the instrument. This function uses the standard operating system "Date and Time Settings" dialog box. Setting the clock requires administrator rights.

See Section 4.12.3.1, "Date and time", on page 463.

Date and Time Format
Switches the time and date display on the screen between US, ISO and German (DE) format.

"DE" dd.mm.yyyy hh:mm:ss
24-hour format.

"US" mm/dd/yyyy hh:mm:ss
12-hour format.

"ISO" yyyy-mm-dd hh:mm:ss
24-hour format.

Remote command:
`DISPlay[:WINDow<n>]:TIME:FORMat` on page 847

Display Expert Parameters
If enabled, expert parameters are automatically displayed in dialog boxes when available.

If disabled, you can display the additional parameters by selecting "Display Expert Parameters" in the title bar of the dialog. See also Section 3.6.5.3, "Dialogs", on page 91.

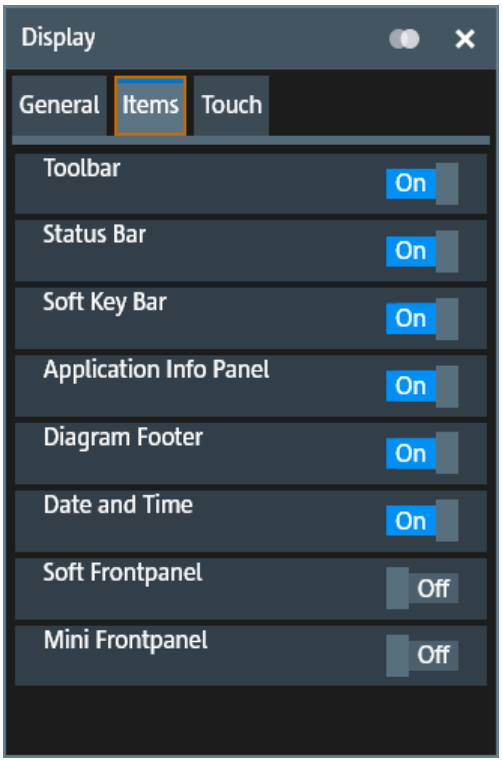


Display Update Rate
By default, a fast update rate ensures the most recent measurement results on the display. However, when performance is poor due to slow data transfer (for example during remote control), it can be helpful to decrease the frequency with which the screen display is updated.

Displayed items

Access: > "Display" > "Displayed items"

You can hide or show several elements on the screen display as required, for example to enlarge the display area for the measurement results.



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Status Bar 428
Soft Key Bar 428
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Date and Time 428
Soft Frontpanel 429
Mini Frontpanel 429

Toolbar
The toolbar provides access to frequently used functions via icons. Some functions, such as zooming, finding help, printing screenshots or storing and loading files are not accessible at all without the toolbar.

Remote command:
`DISPlay:TBAR[:STATe]` on page 846

Status Bar
The status bar indicates the global instrument settings, the instrument status and any irregularities during measurement or display.

Some of the information displayed in the status bar can be queried from the status registry via remote commands, see Section 4.14.14, "Using the status register", on page 883.

We recommend displaying the status bar at all times. If you hide the status bar, you can miss important error messages.

Remote command:
`DISPlay:SBAR[:STATe]` on page 845

Soft Key Bar
Softkeys are virtual keys provided by the software. Thus, the application can provide more functions than you can access directly via the function keys on the instrument.

The functions provided by the softkeys are often also available via dialog boxes. However, some functions are not accessible at all without the softkey bar.

Note: The softkey bar is hidden while the "Display Configuration" is displayed. The bar is restored automatically when you close the "Display Configuration".

Remote command:
`DISPlay:SKEYs[:STATe]` on page 846

Application Info Panel
The application info panel provides information on instrument and measurement settings for a specific application.

Remote command:
`DISPlay:ANNotation:CBAR` on page 845

Diagram Footer
The diagram footer beneath the diagram contains information on the x-axis of the diagram display, such as:

- The current center frequency and span settings
- The displayed span per division
- The number of sweep points

Remote command:
`DISPlay:ANNotation:FREQuency` on page 845

Date and Time
You can switch off the date and time display independently of the status bar.

Tip: You can set the current date and time and configure the display format in the "Date and Time Settings" dialog box. Setting the clock requires administrator rights. See Section 4.12.3.1, "Date and time", on page 463.

Remote command:
`DISPlay[:WINDow<n>]:TIME` on page 846

Soft Frontpanel

The "Front Panel" display simulates the entire front panel of the instrument (except for the external connectors) on the screen. Thus, you can interact with the FSWX without the keypad and keys on the front panel of the instrument. That is useful, for example, when working with an external monitor or operating via remote control from a computer.



To hide or show the front panel temporarily, press [F6] on the external keyboard (if available) or the remote computer.

For more information, see Section 4.11.6.2, "How to work with the soft front panels", on page 432.

Remote command:
`SYSTem:DISPlay:FPANel[:STATe]` on page 847

Mini Frontpanel

If you require a front panel display, but do not want to lose too much space for results in the display area, you can use the mini front panel. The mini version displays only the main function keys in a separate window in the display area.



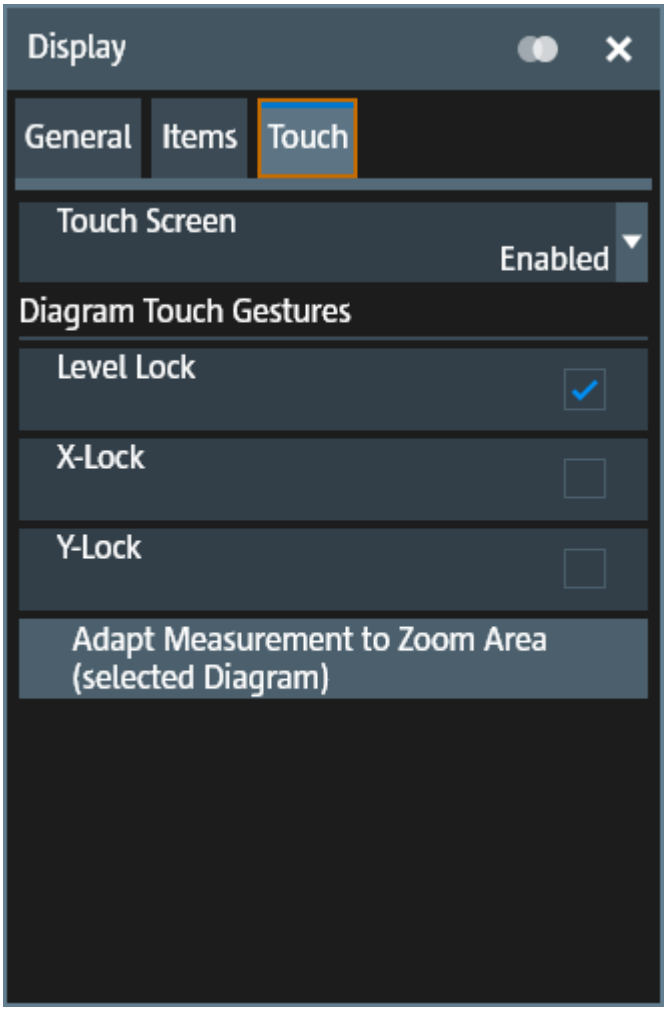
Note: You can also show the mini front panel using the key combination [ALT + m] (be aware of the keyboard language defined in the operating system!). That is useful when you are working from a remote PC and the front panel function is not active.

Touch(screen) settings

Access: > "Display" > "Touch"

These options concern the behavior of the firmware for touch gestures on the screen.

Note that these settings remain unchanged after an application preset.



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Adapt Measurement to Zoom Area (selected diagram) 432

Enabling and disabling the Touch Screen

You can disable the touchscreen function, e.g. when you are using the instrument for demonstration purposes and you do not want to provoke an action by tapping the screen.

To reenable the touchscreen, simply press on the front panel. The "Display" dialog box is opened automatically and the "Touch Screen" option is set to "On".

"Enabled" Touchscreen function is active for the entire screen.

"Disabled" Touchscreen is disabled for the entire screen.

"Disabled for Diagrams"
Touchscreen is disabled for the diagram area of the screen, but active for the surrounding softkeys, toolbars and menus.

Remote command:
DISPlay:TOUChscreen[:STATe] on page 846

Level Lock
If enabled (default), the reference level (and thus the attenuation) is locked, that is: remains unchanged during touch gestures on the screen.

X-Lock
If enabled, the x-axis of the diagram is not changed during subsequent touch gestures.

Y-Lock
If enabled, the y-axis of the diagram is not changed during subsequent touch gestures.

Adapt Measurement to Zoom Area (selected diagram)
If you already performed a graphical zoom using the "Single Zoom" on page 336 or "Multi-Zoom" on page 336 functions, this function automatically adapts the measurement settings to maintain the currently zoomed display.

4.11.6.2 How to work with the soft front panels

Basic operation with the soft front panels is identical to normal operation, except that you select keys on the screen using the mouse cursor.

Mini front panel

The mini front panel provides only the keys on the touchscreen, to operate the FSWX via an external monitor or remote desktop.

To display the soft front panel or mini front panel

1. Press and select "Display".
2. Select the "Displayed items" tab.
3. Select "Front Panel": "On" or "Mini Front Panel": "On".

To hide or show the front panel, press [F6] on the external keyboard (if available) or on the remote computer.

To hide or show the "Mini Front Panel", double-click the title of the softkey menu. As an alternative, press [ALT + m] on the external keyboard (if available) or on the remote computer. Be aware of the keyboard language defined in the operating system!

If the softkey menu is visible, you can display the "Mini Front Panel" quickly and easily by double-clicking the title of the softkey menu.

To close the mini front panel

► Select the "Close" icon at the top of the panel.

4.11.6.3 Reference: Keyboard shortcuts for the mini front panel

The mini front panel provides an alternative way to access the functionality of the hardkeys when you are operating the instrument remotely. You can access the keys either using a mouse or using keyboard shortcuts on the remote computer. The following table provides an overview of the assigned keyboard shortcuts *for a German keyboard* layout. Be aware of the keyboard language defined in the operating system!



To hide or show the "Mini Front Panel", double-click the title of the softkey menu. As an alternative, press [ALT + m].

Hardkey on instrument	Keyboard shortcut
[Freq.]	[Alt+Shift+J]
[Span]	[Alt+Shift+K]
[Ampt./Scale]	[Alt+Shift+C]
[Auto Set]	[Alt+Shift+N]
[BW]	[Alt+Shift+L]
[Sweep]	[Alt+Shift+M]
[Trace]	[Alt+Shift+F]
[Trigger]	[Alt+Shift+S]
[Meas]	[Alt+Shift+A]
[Meas Config]	[Alt+Shift+W]
[Lines]	[Alt+Shift+B]
[Input/Output]	[Alt+Shift+I]
[Marker]	[Alt+Shift+G]
[Peak Search]	[Alt+Shift+R]
[Marker Function]	[Alt+Shift+Q]
[Marker ->]	[Alt+Shift+H]
[Undo]	[CTRL+Shift+U]
[Redo]	[CTRL+Shift+R]
[Run Single]	[Alt+Shift+D]
[Run Cont.]	[Alt+Shift+E]
	[Alt+Shift+T]
[Print]	[Alt+CTRL+P]
[File]	[CTRL+S]
[Mode]	[Alt+Shift+P]
[GHz s -dBm V]	[CTRL+Shift+G]

Hardkey on instrument	Keyboard shortcut
[MHz ms dBm mV]	[CTRL+Shift+M]
[kHz µs dB µV]	[CTRL+Shift+K]
[Hz ns dB.. nV]	[CTRL+Shift+H]
[Preset]	[Alt+Shift+U]

4.11.7 Synchronizing application configuration (parameter coupling)

Access: > "Parameter Coupling"

The FSWX usually treats each application as an independent entity regarding its configuration. Changing a setting in one application does not automatically change the corresponding setting in another application.

For example, changing the frequency in the "Spectrum" application does not, by default, change the frequency in the vector signal analysis ("VSA") application.

However, sharing settings can be convenient for certain measurement tasks. The FSWX provides a tool to couple (or synchronize) selected parameters across applications - the coupling manager.

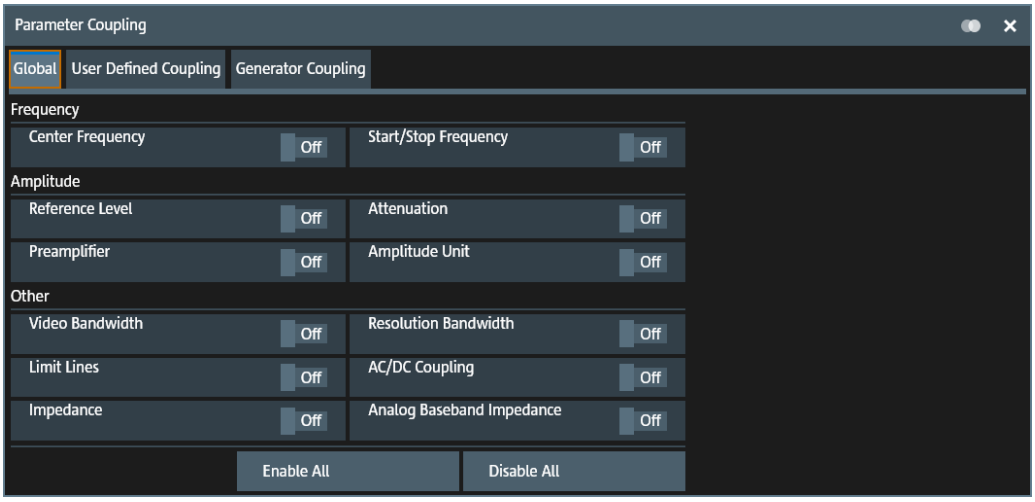
The coupling manager allows you not only to couple parameters, but also markers and lines across applications.

- General parameter coupling....434
- User-defined parameter coupling....437
- Generator coupling....440
- How to synchronize parameters....443
- Example for a user-defined parameter coupling....444

4.11.7.1 General parameter coupling

Access: > "Parameter Coupling" > "General"

The "General" tab of the coupling manager contains several parameters that you can couple across all (active) application instances - if the application supports the corresponding parameter.



When you couple a parameter across all active application instances, a change in the currently selected application instance is passed on to all other active application instances.

Note that the accuracy of time marker couplings is ±1 sample.

Synchronizing parameters across all application instances.....435
Enable All Items / Disable All Items.....437
Default Config.....437

Synchronizing parameters across all application instances
To synchronize a specific parameter, enable the corresponding function.

Note that you cannot synchronize all parameters at the same time, because some parameters are interdependent. For example, you cannot synchronize the resolution and video bandwidth simultaneously, because the video bandwidth depends on the resolution bandwidth and vice versa.

"Center Frequency"
Synchronizes the center frequency.

Remote command:
`INSTrument:COUPle:CENTer` on page 870

"Start / Stop Frequency"
Synchronizes the start and stop frequencies for measurements in the frequency domain.
Note: The start and stop frequencies can automatically change when you change another frequency parameter, such as center frequency or span.

Remote command:
`INSTrument:COUPle:SPAN` on page 872

"Reference Level"
Synchronizes the reference level.
Remote command:
INSTrument:COUPle:RLEVel on page 872

"Attenuation"
Synchronizes the attenuation.
Remote command:
INSTrument:COUPle:ATTen on page 869

"Preamplifier"
Synchronizes the gain of the optional preamplifier.
Remote command:
INSTrument:COUPle:GAIN on page 870

"Amplitude Unit"
Synchronizes the unit of the level axis.
Remote command:
INSTrument:COUPle:AUNit on page 869

"Video Bandwidth"
Synchronizes the video bandwidth
Note: You cannot synchronize the video bandwidth and the resolution bandwidth is not possible.
Remote command:
INSTrument:COUPle:VBW on page 872

"Resolution Bandwidth"
Synchronizes the measurement bandwidth.
Note: You cannot synchronize the video bandwidth and the resolution bandwidth simultaneously.
Remote command:
INSTrument:COUPle:BANDwidth on page 869

"Limit Lines"
Enables the limit line over all application instances.
Note: Limit lines are only synchronized if the limit line is compatible to the application instance configuration (in particular, units of the x- and y-axis).
Remote command:
INSTrument:COUPle:LIMit on page 871

"AC DC Coupling"
Synchronizes the Input Coupling.
Remote command:
INSTrument:COUPle:ACDC on page 868

"Impedance"
Synchronizes the impedance for RF input.
Remote command:
INSTrument:COUPle:IMPedance on page 871

Enable All Items / Disable All Items
Enables or disables all items available in the general coupling manager.

Note that you cannot actually enable all items, because some of them are mutually exclusive.

Remote command:
Not supported

Default Config
Restores the default parameter coupling configuration.

Remote command:
Not supported

4.11.7.2 User-defined parameter coupling

Access: > "Parameter Coupling" > "User Coupling"

User couplings allow you to synchronize user-defined parameters, and markers and lines, between application instances.

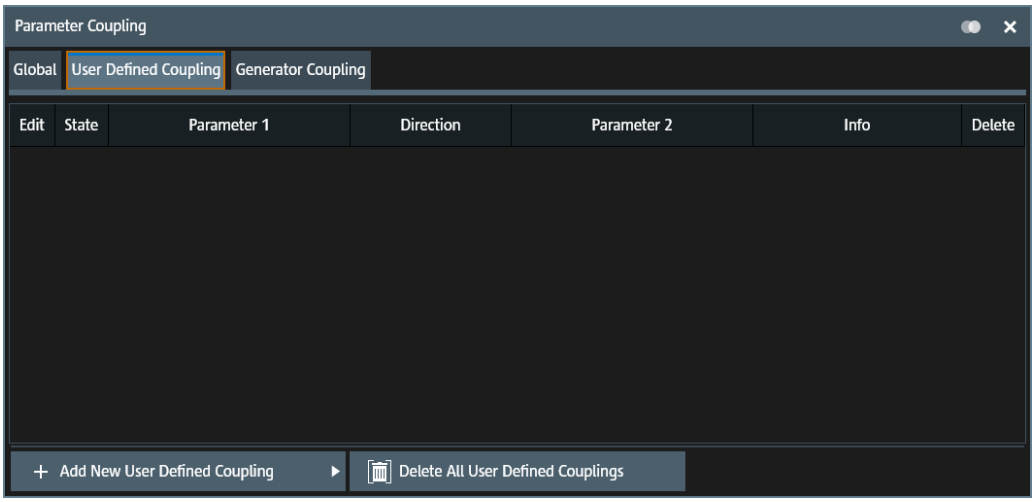
Compared to the predefined couplings, user couplings do not necessarily have to synchronize all active application instances. Instead, you can define specific application instances that are synchronized with each other, in any combination, while other application instances remain independent.

Example:

You currently run two instances of the "Spectrum" application, two instances of the "VSA" application, and one instance of the "AM/FM/PM Analog Demod" application.

You can synchronize only the first instance of the "Spectrum" application with the first instance of the "VSA" application, while the other three application instances remain independent.

Alternatively, you can synchronize all instances of the "VSA" application, while the "Spectrum" and "AM/FM/PM Analog Demod" applications remain independent.



Any existing user-defined couplings are displayed in the dialog box.

Index 438
Edit coupling definition 438
Parameter 1 / Parameter 2 438
State 438
Direction 438
Delete coupling definition 439
Info 439
Delete All 439
Add New User Coupling 439
└ Category 440
└ Channel 1 / Channel 2 440
└ Specifics for Window 440
└ Coupling Element 1 / Coupling Element 2 440
└ Couple Selected Parameters 440

Index
Index of the user-defined parameter coupling, used to identify the definition in remote operation.

Remote command:
`INSTrument:COUPle:USER<uc>:NUMBers:LIST?` on page 878



Edit coupling definition
Opens a dialog box to edit the selected coupling. See "Add New User Coupling" on page 439.

Remote command:
`INSTrument:COUPle:USER<uc>` on page 873

Parameter 1 / Parameter 2
The coupled parameters, markers, or lines.

Remote command:
`INSTrument:COUPle:USER<uc>:NEW?` on page 877

State
Enables or disables the coupling.

Remote command:
`INSTrument:COUPle:USER<uc>:STATe` on page 880

Direction
Determines which parameter controls the other.

"<-" Parameter 2 controls parameter 1. If parameter 2 is changed, parameter 1 is adapted. If parameter 1 is changed, parameter 2 remains unchanged.

Remote command:
`INST:COUP:USER:REL RTOL`

"->" Parameter 1 controls parameter 2. If parameter 1 is changed, parameter 2 is adapted. If parameter 2 is changed, parameter 1 remains unchanged.

Remote command:
`INSTrument:COUPle:USER<uc>:RELation` on page 879

"<->" Both parameters are equal. If one parameter is changed, the other parameter is adapted and vice versa.

Remote command:
`INST:COUP:USER:REL BID`

Delete coupling definition
Deletes the selected coupling definition permanently.

Remote command:
`INSTrument:COUPle:USER<uc>:REMove` on page 879

Info
Shows information for the selected coupling, for example, restrictions regarding the coupling.

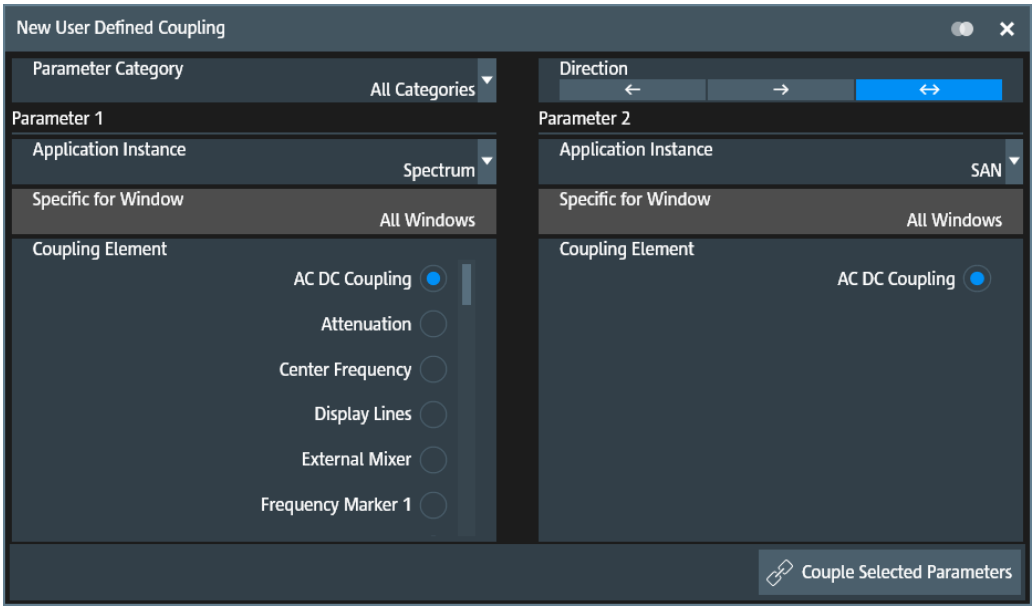
Note that usually, no information is displayed.

Remote command:
`INSTrument:COUPle:USER<uc>:INFO` on page 876

Delete All
Deletes all current coupling definitions. Parameters are no longer coupled.

Remote command:
`INSTrument:COUPle:USER<uc>:REMove` on page 879

Add New User Coupling
Opens a dialog box to create a new user-defined coupling definition.



Remote command:
INSTrument:COUPle:USER<uc>:NEW? on page 877

Category ← Add New User Coupling
Selects the category of parameters to be displayed in the Coupling Element 1 / Coupling Element 2 selection list.

Channel 1 / Channel 2 ← Add New User Coupling
Selects the application instances for which the parameters are coupled. Only active application instances are available for selection. If no other active applications have the selected parameter, "Channel 2" is not available.

The following selections are possible:
- Individual application instances
- All instances of the same application
- All application instances

Remote command:
INSTrument:COUPle:USER<uc>:CHANnel:LIST? on page 875

Specifics for Window ← Add New User Coupling
Selects the windows of the selected application instance for which the parameters are coupled. This setting is only available for "AM/FM/PM Analog Demod" application instances. Only frequency markers can be coupled for individual windows.

Remote command:
INSTrument:COUPle:USER<uc>:WINDow:LIST? on page 880

Coupling Element 1 / Coupling Element 2 ← Add New User Coupling
Defines the parameter or marker to be coupled. All available elements in the selected applications are displayed. If no other active applications have the selected "Coupling Element 1", "Coupling Element 2" is not available.

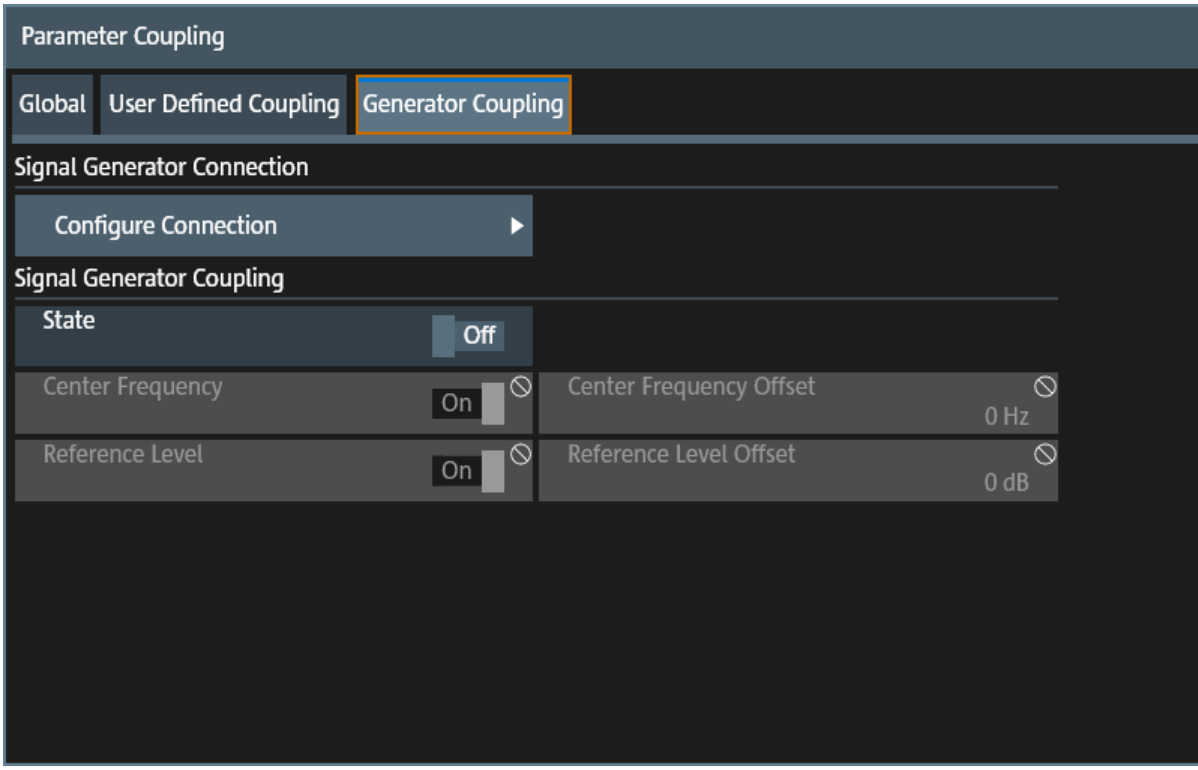
In addition to the parameters for general parameter coupling (see Synchronizing parameters across all application instances), further parameters are available. Use the remote command to query the list of parameters you can couple for a specific application.

Remote command:
INSTrument:COUPle:USER<uc>:ELEMent:LIST? on page 875

Couple Selected Parameters ← Add New User Coupling
Closes the dialog box and adds the new user-defined coupling definition to the list.

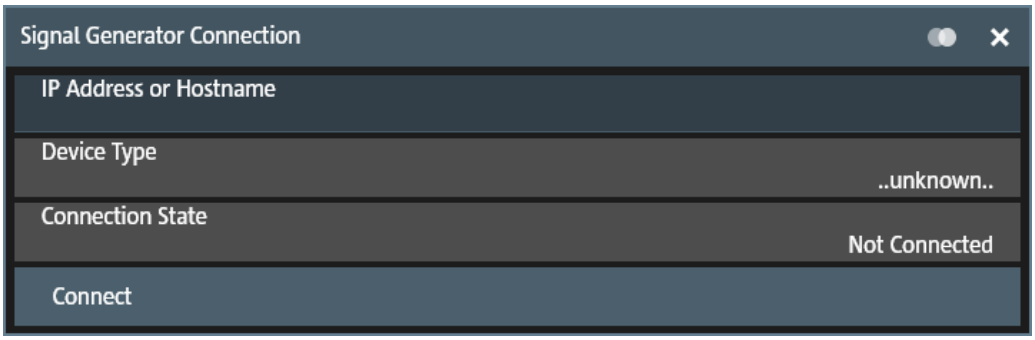
4.11.7.3 Generator coupling

You cannot only couple parameters between FSWX application instances, but also between the FSWX and a connected signal generator. Coupling parameters is especially useful when you use the "SCPI Recorder" and need to include generator commands (see "Combined Recording of spectrum analyzer and R&S signal generator" on page 511).



Configure signal generator connection 441
Connect 442
Device Type 442
Connection State 442
Coupling State 442
Center Frequency 442
Generator Frequency Offset 442
Reference level 442
Generator Reference Level Offset 442

Configure signal generator connection
Configures the connection to the signal generator.



See "IP Address or Host Name" on page 524.

If a connection to a signal generator is already configured, the connection data is provided for information only.

Connect
Connects the FSWX to the specified signal generator.

Remote command:
CONFigure:GENerator:CONNection[:STATe] on page 864

Device Type
If connected, the device type of the signal generator is indicated.

Connection State
Indicates the state of the connection to the specified signal generator.

Remote command:
CONFigure:GENerator:CONNection:CSTate? on page 863

Coupling State
Enables or disables coupling between the FSWX and a connected signal generator.

Note that only one application instance can control a generator at any time. If an application instance already has control of the connected generator and you enable parameter coupling, the control is disabled in the other application instance.

Remote command:
INSTrument:COUPle:GENerator:STATe on page 883

Center Frequency
Couples the center frequency of the connected signal generator to the FSWX.

This setting requires the Coupling State to be enabled.

Remote command:
INSTrument:COUPle:GENerator:CENTer[:STATe] on page 882

Generator Frequency Offset
Defines a fixed offset to the center frequency of the FSWX for the coupled signal generator.

This setting requires the Coupling State to be enabled.

Remote command:
INSTrument:COUPle:GENerator:CENTer:OFFSet on page 881

Reference level
Couples the reference level of the connected signal generator to the FSWX.

This setting requires the Coupling State to be enabled.

Remote command:
INSTrument:COUPle:GENerator:RLEVel[:STATe] on page 882

Generator Reference Level Offset
Defines a fixed offset to the reference level of the FSWX for the coupled signal generator.

This setting requires the Coupling State to be enabled.

Remote command:
INSTrument:COUPle:GENerator:RLEVel:OFFSet on page 882

4.11.7.4 How to synchronize parameters

Access: > "Parameter Coupling"

User-defined couplings allow you to couple additional parameters. Thus, you can create highly customized couplings between application instances.

Compared to the predefined couplings, user couplings do not necessarily have to synchronize all active application instances. Instead, you can define specific application instances that are synchronized with each other, in any combination, while other application instances remain independent.

How to use predefined parameter couplings

1. Select .
2. Select "Parameter Coupling".
3. In the "General" tab, set the parameter you want to synchronize over all application instances to "On".
4. Close the dialog box.

How to create user-defined parameter couplings

1. Select .
2. Select "Parameter Coupling".
3. Select the "User Coupling" tab.
4. Select "Add New User Coupling".
5. From the "Channel 1" list, select the application instances to couple.
6. From the "Coupling Element 1" list, select the parameter or marker to couple for the selected application instances.
   To shorten the list and restrict it to a certain type of parameters, select a "Category" first.
7. For "AM/FM/PM Analog Demod" application instances and frequency markers only, select the individual windows (in the frequency domain) to couple.
8. To couple specific application instances rather than all application instances:
   a) Select the second application instance for coupling from the "Channel 2" list
   b) Select the parameter that the first parameter is coupled to from the "Coupling Element 2" list.
   c) For "AM/FM/PM Analog Demod" application instances and frequency markers only, select the individual windows (in the frequency domain) from the second "AM/FM/PM Analog Demod" application instance to couple.
9. Select "Couple Selected Parameters".

   The "Add New User Coupling" dialog box is closed, and the new user-defined coupling is added to the list in the "Parameter Coupling" dialog box.

10. If specific application instances are coupled, select the "Direction" to define which application instance controls the other, that is: which application instance adapts the parameter if the other instance is changed.

11. Close the dialog box.

    From now on, if you change a coupled parameter in one application instance, the parameter in the coupled application instance is set to the same value.

How to edit user-defined parameter couplings

1. Select .
2. Select "Parameter Coupling".
3. Select the "User Coupling" tab.
4. Select the "Edit" icon for the parameter coupling that you want to edit.
5. Continue as described in "How to create user-defined parameter couplings" on page 443, step 5.

How to disable user-defined parameter couplings

1. Select .
2. Select "Parameter Coupling".
3. Select the "User Coupling" tab.
4. To disable the coupling temporarily, without deleting the coupling definition entirely, set the "State" of the coupling to "Off".
   To delete the coupling permanently, select the "Delete" icon for the parameter coupling you want to remove.
5. Close the dialog box.

4.11.7.5 Example for a user-defined parameter coupling

Currently two "Spectrum" application instances are active, one "I/Q Spectrum Analyzer" application instance, and two "AM/FM/PM Analog Demod" application instances.

Synchronizing all Spectrum application instances

The following example demonstrates how to synchronize the center frequency in all "Spectrum" application instances, while the "I/Q Spectrum Analyzer" and "AM/FM/PM Analog Demod" application instances remain independent.

1. Select .
2. Select "Parameter Coupling".
3. Select the "User Coupling" tab.
4. Select "Add New User Coupling".

5. From the "Channel 1" list, select "All Spectrum".
6. From the "Coupling Element 1" list, select "Center Frequency".
7. Select "Couple Selected Parameters".
8. Close the "Parameter Coupling" dialog box.
9. In the first "Spectrum" application instance, change the "Center Frequency" to 1 GHz.
10. Switch to the second "Spectrum" application instance.

    The center frequency in the second "Spectrum" application instance is also set to 1 GHz.

Synchronizing specific application instances

The following example demonstrates how to synchronize the attenuation only for the first "Spectrum" application instance and the first "AM/FM/PM Analog Demod" application instance, while the other three application instances remain independent.

1. Select "Add New User Coupling".
2. From the "Channel 1" list, select "Spectrum 1".
3. From the "Coupling Element 1" list, select "Attenuation".
4. From the "Channel 2" list, select "AnaDemod 1".
5. From the "Coupling Element 2" list, select "Attenuation".
6. Select "Couple Selected Parameters".
7. Close the "Parameter Coupling" dialog box.
8. In the first "Spectrum" application instance, change the "Attenuation" to 15 dB.
9. Switch to the first "AM/FM/PM Analog Demod" application instance.

    The attenuation in the second "AM/FM/PM Analog Demod" application instance is also set to 15 dB.

Synchronizing markers in AM/FM/PM Analog Demod windows

Now you have two "AM/FM/PM Analog Demod" application instances. `AnaDemod1` has an "FM Spectrum" and an "FM Time Domain" window. `AnaDemod2` has an "RF Spectrum" and an "RF Time Domain" window. When the frequency marker in the "FM Spectrum" window moves, the marker in the "RF Spectrum" window moves to the same position.

1. Select "Add New User Coupling".
2. From the "Channel 1" list, select "AnaDemod 1".
3. From the "Coupling Element 1" list, select "Frequency Marker 1".
4. From the "Specifics for Window" list, select window "1" (which is the FM Spectrum window).

5. From the "Channel 2" list, select "AnaDemod 2".
6. From the "Coupling Element 2" list, select "Frequency Marker 1".
7. From the "Specifics for Window" list, select window "1" (which is the "RF Spectrum" window).
8. Select "Couple Selected Parameters".
9. In the "Parameter Coupling" dialog box, for the coupling definition for the frequency markers in the "AM/FM/PM Analog Demod" application instances, select the "Direction": "->"
10. Close the "Parameter Coupling" dialog box.
11. In the `AnaDemod 1` application instance, set the frequency marker in the "FM Spectrum" to *900 MHz*.

    In the `AnaDemod 2` application instance, the frequency marker in the "RF Spectrum" is also at 900 MHz.
12. In the `AnaDemod 2` application instance, set the frequency marker in the "RF Spectrum" to *1100 MHz*.

    In the `AnaDemod 1` application instance, the frequency marker in the "FM Spectrum" is still at 900 MHz.

4.11.8 Instrument configuration

Access: ⚙ > "Instrument Configuration"

- Hardware information....446
- Versions and firmware....447
- Options and licensing....448
- General (other) configuration settings....452
- AC power loss behavior....453

4.11.8.1 Hardware information

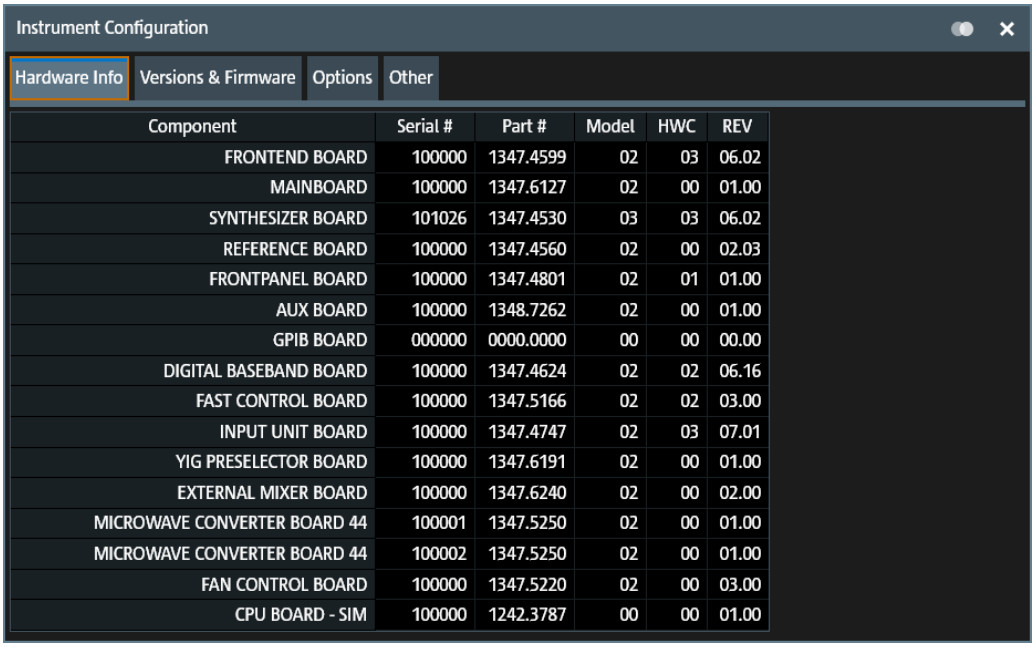
Access: ⚙ > "Instrument Configuration" > "Hardware Info"

The FSWX provides an overview of the installed hardware.

Every listed component is described by its:

- Serial number
- Part number
- Model information
- Hardware code ("HWC")
- Hardware revision ("REV")

This information can be useful when problems occur with the instrument and you require support from Rohde & Schwarz.



Component	Serial #	Part #	Model	HWC	REV
FRONTEND BOARD	100000	1347.4599	02	03	06.02
MAINBOARD	100000	1347.6127	02	00	01.00
SYNTHESIZER BOARD	101026	1347.4530	03	03	06.02
REFERENCE BOARD	100000	1347.4560	02	00	02.03
FRONTPANEL BOARD	100000	1347.4801	02	01	01.00
AUX BOARD	100000	1348.7262	02	00	01.00
GPIB BOARD	000000	0000.0000	00	00	00.00
DIGITAL BASEBAND BOARD	100000	1347.4624	02	02	06.16
FAST CONTROL BOARD	100000	1347.5166	02	02	03.00
INPUT UNIT BOARD	100000	1347.4747	02	03	07.01
YIG PRESELECTOR BOARD	100000	1347.6191	02	00	01.00
EXTERNAL MIXER BOARD	100000	1347.6240	02	00	02.00
MICROWAVE CONVERTER BOARD 44	100001	1347.5250	02	00	01.00
MICROWAVE CONVERTER BOARD 44	100002	1347.5250	02	00	01.00
FAN CONTROL BOARD	100000	1347.5220	02	00	03.00
CPU BOARD - SIM	100000	1242.3787	00	00	01.00

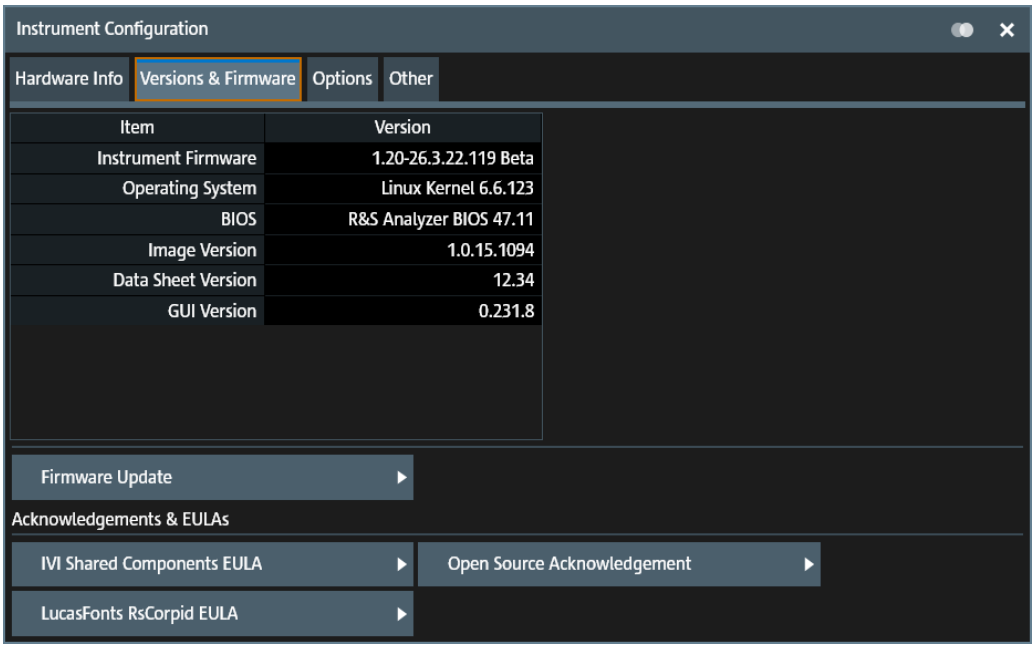
Remote command:

`DIAGnostic:SERVice:HWINfo?` on page 859

4.11.8.2 Versions and firmware

Access: > "Instrument Configuration" > "Versions & Firmware"

The installed firmware versions are indicated for reference. This information is useful especially when you contact Rohde & Schwarz support.



During instrument start, the FSWX checks the installed hardware against the current firmware version to ensure that the hardware is supported. If not, an error message is displayed ("Wrong firmware version") and you are asked to update the firmware. Until you update the firmware version, self-alignment fails. To see which components are not supported, see the Instrument messages.

Possibly, you also have to update the firmware on your FSWX to enable additional new features or if reasons for improvement come up. Ask your sales representative or check the Rohde & Schwarz website for availability of firmware updates. A firmware update package includes at least a setup file and release notes.

Remote commands for version information:

`SYSTem:FORMat:IDENt` on page 862

`DIAGnostic:SERVice:BIOSinfo?` on page 858

`DIAGnostic:SERVice:VERSinfo?` on page 859

`SYSTem:OSYStem?` on page 863

Obtaining copyright information on used third-party sources

The "Versions & Firmware" tab also provides copyright information on used third-party sources.

Firmware Update
Opens the system settings dialog to update the instrument firmware from a connected USB storage device.

See Section 4.12.5.1, "Installation utility", on page 476.

Remote command:
`SYSTem:FIRMware:UPDate` on page 862

Open Source Acknowledgment
Displays a PDF file containing information on open-source code used by the FSWX firmware.

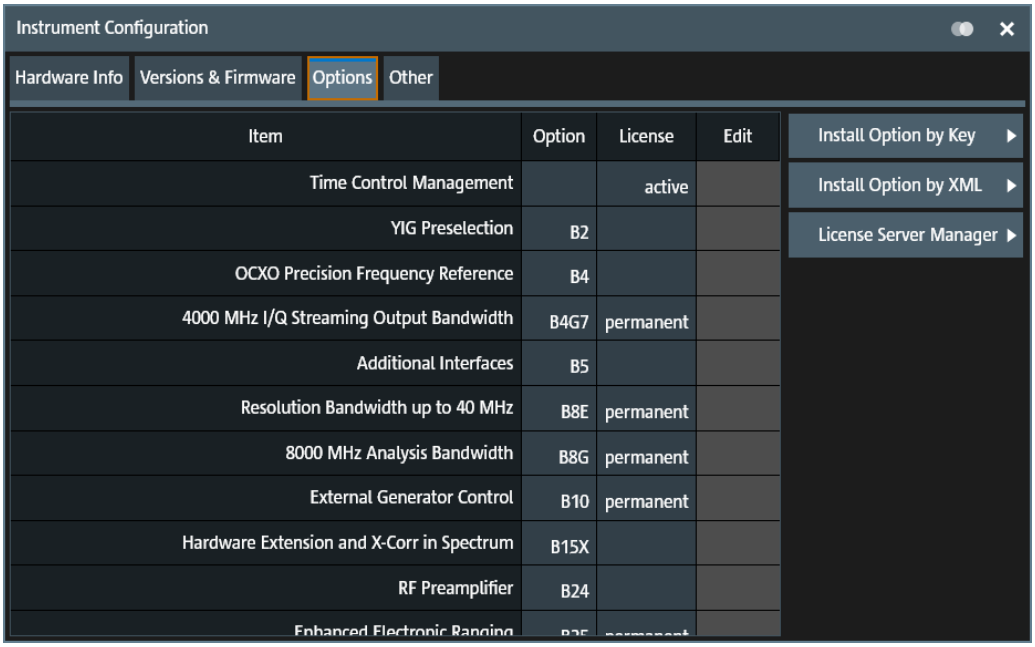
LucasFonts RsCorpid EULA
Displays a PDF file containing license information on the font used by the FSWX firmware.

IVI Shared Components EULA:
Displays a PDF file containing ilicense nformation on IVI shared components used by the FSWX firmware.

4.11.8.3 Options and licensing

Access: ⚙ > "Instrument Configuration" > "Options"

The FSWX provides information on the installed optional licenses and allows you to install further options.



Expired option licenses

If a timed option license is about to expire, the FSWX informs you by a message box. You can then use the "Install Option" function to enter a new license key, or you can enable a new floating license.

If a timed option license has already expired, you have to confirm a message box. In this case, the optional functions and applications are unavailable until you enter a new license key or enable a floating license.

Using a floating license server

As an alternative to license key files installed on the FSWX, software licenses can also be provided by an R&S®License Server. In this case, all available licenses are stored on a specified server. When you need a particular application, you obtain a license from the server. When you no longer need the license, you return it to the server and it becomes available to other users again. These licenses are also referred to as *floating licenses*, as opposed to permanently assigned licenses.

If the predefined number of available licenses for a particular option are currently occupied by other users, you cannot open a further instance of the optional application until a license is returned. Per option, you only require a single license for any number of application instances.

The R&S®License Server must be set up as described in the R&S®License Server - Managing Floating Licenses - User Manual.

Two different types of licenses are available.

Common floating license

A common floating license enables you to use an option as long as you need it, but requires a permanent connection to the license server.

The license is retrieved from the license server only when you select the application in the "Mode" dialog box. Only one license per option is retrieved, but the option can be used in multiple application instances. It is returned shortly after you close the (last) application instance. The license is blocked for other users only while at least one application instance is in use.

If the connection to the license server is lost for longer than approximately 10 minutes, the FSWX assumes that no license is available and closes the application.

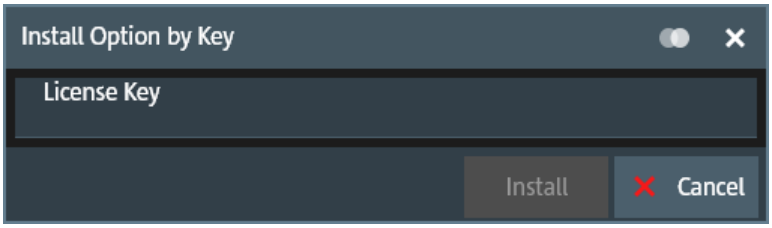
Occupied license

An occupied license is retrieved once from the license server and stored locally for up to 7 days, depending on the selected time period. During the occupied period, the license is blocked for other users. After this time, the license automatically expires and becomes available on the license server again. During the occupied period, no further access to the license server is required. The license cannot be returned or disabled manually before it expires, but it can be extended.

When the license expires, you must retrieve a new license from the license server. If the connection to the license server is not available or no more licenses are available, the FSWX closes the application.

Install Option by Key 450
Install Option by XML 450
License state (Edit) 450
└ Enabling/disabling floating licenses 451
License Server Manager 452

Install Option by Key
Opens an edit dialog box to enter the (permanently assigned) license key for an option.



Only user accounts with administrator rights are able to install options and enable licenses.

Install Option by XML
Opens a file selection dialog box to install an additional (permanently assigned) option license to the FSWX using an XML file. Enter or browse for the name of an XML file that contains the option license key and select "Select".

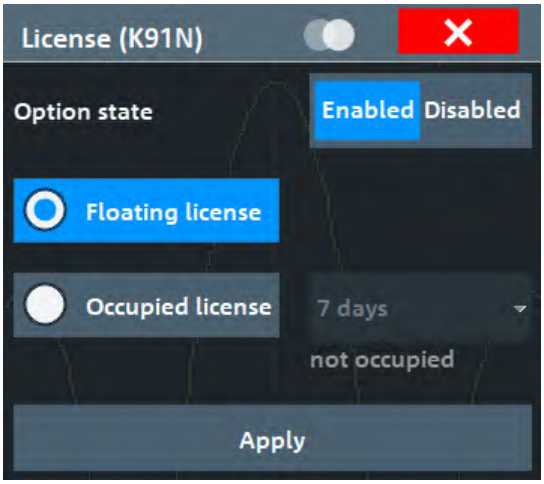
Only user accounts with administrator rights are able to install options and enable licenses.

License state (Edit)
Provides functions to enable or disable a floating license for an installed option. These functions are only available if a floating license server is configured (see "Using a floating license server" on page 449).

Remote command:
Query available licenses: `SYSTem:OPTion:LICense[:LIST]?` on page 862

Enabling/disabling floating licenses ← License state (Edit)
If a floating license server is configured (see "Using a floating license server" on page 449), you can enable or disable a license for the selected option in the "License" dialog box. Two different types of licenses are available.

You cannot change a license state that is currently in use by an application. The change in license usage becomes effective when you select "Apply". Restarting the firmware is not necessary.



"Enabled" If enabled, the license is retrieved from the license server when you select the application in the "Mode" dialog box.
Some options are available for multiple applications, such as power sensor support. In this case, the license is retrieved if you select any application that supports the option.
For options with suboptions, e.g. K91 with suboptions K91AC, K91N, all suboptions are automatically enabled together with the main option by default.

"Disabled" If the license is disabled, it is not retrieved from the server when you open the main application. The option is grayed out in the "Versions + Options" dialog box. Disabling licenses is useful for suboptions (e.g. K91N) or options that are available for multiple applications.

"Occupied license" period
Defines the time period that an occupied license is stored locally after it is retrieved from the license server. A time period between 1 and 7 days is available. You cannot return or disable the license manually before it expires, but you can extend it.

Remote command:
`SYSTem:OPTion:LICense[:LIST]?` on page 862

License Server Manager
To use floating licenses, you must set up one or more floating license servers. The FSWX software checks the configured servers for available floating licenses when it starts up. Only options for which licenses are found are available in the FSWX. After adding new options on the floating license server, you must restart the FSWX before using them.

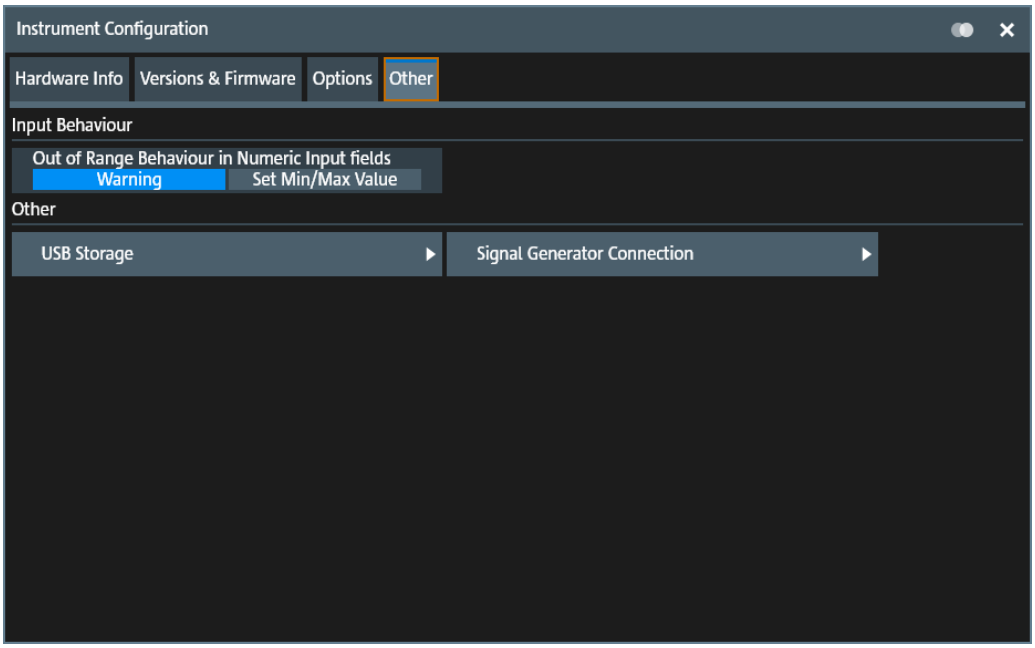
For details on the floating license concept, see "Using a floating license server" on page 449.

For details on configuring floating license servers, see the R&S®License Server - Managing Floating Licenses - user manual.

4.11.8.4 General (other) configuration settings

Access: > "Instrument Configuration" > "Other"

You can configure general instrument settings, for example concerning the initial behavior of the FSWX after booting.



Out-of-range Behavior in Numeric Input 452
USB Storage 453
Signal Generator Connection 453

Out-of-range Behavior in Numeric Input
Determines what happens if you enter a numeric value that is outside the valid range for a setting.

"Warning" (Default): The FSWX does not accept the value and displays a warning.

"Set Min/Max Value" The FSWX automatically adjusts invalid values. Entries below the minimum value are adjusted to the minimum value, and entries above the maximum value are adjusted to the maximum value. Automatic adjustment avoids errors and facilitates setting correct values.

USB Storage
Opens the system settings dialog to restrict access to any USB storage devices connected to the instrument.

See "USB Storage" on page 472.

Signal Generator Connection
Displays the settings to configure a signal generator connection, for example for external generator control or NPR measurements.

See Section 4.13.5.5, "Signal generator settings", on page 523.

If a connection to a signal generator is already configured, the connection data is provided for information only.

4.11.8.5 AC power loss behavior

Access: BIOS > "Advanced" > "Miscellaneous Configuration" > "AC Loss Control"

Using a specific configuration setting in the BIOS of the FSWX, you can define how the instrument behaves after the AC power supply is interrupted. The setting applies regardless whether the interruption occurs due to an irregular power outage in the mains supply, by removing the power cable, or by switching the instrument power supply off.

The setting supports the following values:

- "Previous": (Default) Instrument restores the state that it was in before the outage occurred.
- "Always Off": Instrument remains switched off.
- "Always On": Instrument automatically switches on as soon as power supply is restored.

To change the instrument's power loss behavior

Prerequisite: the instrument is switched off and a keyboard is connected.

1. Switch on the power switch on the rear panel of the FSWX.
2. Watch for the prompt on the display, then press [DEL] on the keyboard to enter the BIOS setup.
3. In the BIOS menu, select "Advanced" > "Miscellaneous Configuration" > "AC Loss Control".
4. Select the required setting as described above.
5. In the BIOS menu, select "Save & Exit" > "Save Changes and Exit".

4.11.9 Service and support

Access: > "Service & Support"

When unexpected problems arise with the FSWX some service functions can help you solve them.

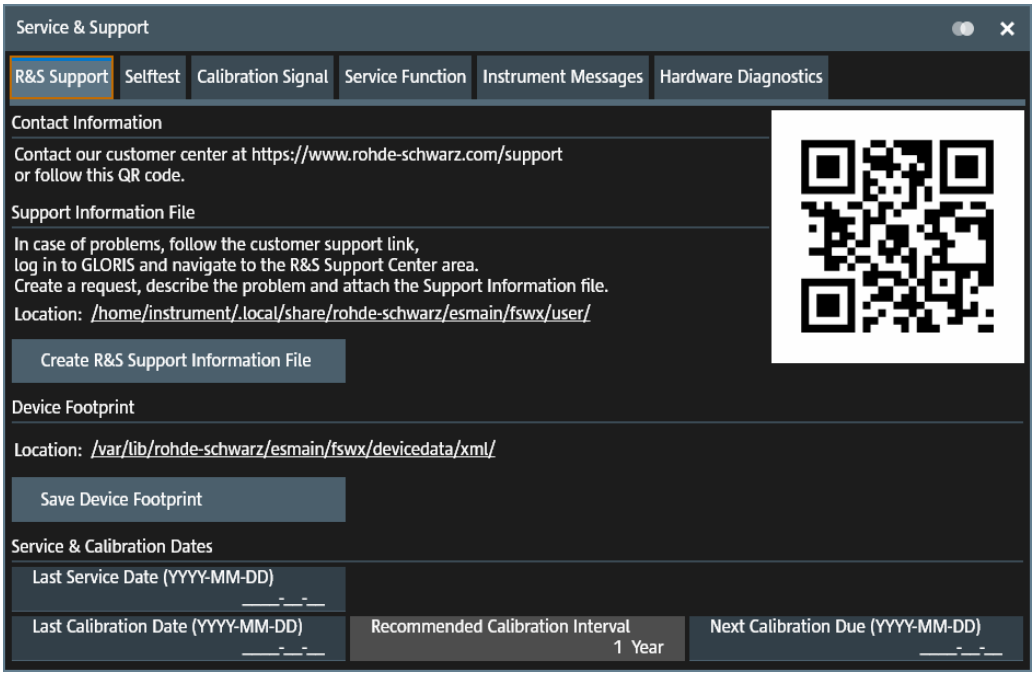
For more helpful information for support, see also Section 7.7, "Collecting information for support", on page 1482.

- R&S support information....454
- Self-test settings and results....456
- Calibration signal display....457
- Service functions....458
- Instrument messages....459
- Hardware diagnostics....461

4.11.9.1 R&S support information

Access: > "Service & Support" > "R&S Support"

If errors occur, you can store useful information for troubleshooting and send it to your Rohde & Schwarz support center.



Create R&S Support Information File....455
Device Footprint....455
Last Service Date....455
Last Calibration Date....455
Recommended Calibration Interval....456
Next Calibration Due....456

Create R&S Support Information File
Creates a ZIP file with important support information, including:

- System configuration information ("Device Footprint")
- Current EEPROM data
- A screenshot of the screen display

This data is stored to the home/instrument/.local/share/rohde-schwarz/esmain/fswx/user directory on the instrument.

The filename consists of the unique device ID and the current date and time of the file creation.

If you contact the Rohde & Schwarz support to get help for a certain problem, send these files to identify and solve the problem faster.

Remote command:
DIAGnostic:SERVice:SINFo? on page 866

Device Footprint
Creates an XML file including information on:

- Installed hardware
- Installed software versions
- Installed image
- FPGA version

The XML file is stored on the instrument under var/lib/rohde-schwarz/esmain/fswx/devicedata/xml. It is also included in the service ZIP file (see "Create R&S Support Information File" on page 455).

Remote command:
SYSTem:DFPRint on page 860

Last Service Date
Opens a calendar to define the date that the FSWX was inspected by Rohde & Schwarz service. The service date is updated by the service technicians. For new instruments, the last service date (= date of production) is entered during production.

If the field contains no date, we recommend that you enter the date of last service according to the service certificates you received after the FSWX has been serviced.

If the FSWX has not been serviced yet, leave the field empty.

Remote command:
DIAGnostic:SERVice:DATE on page 857

Last Calibration Date
Opens a calendar to define the date that the FSWX was calibrated. For new instruments, we recommend you enter the factory calibration date specified on the calibration certificate.

Remote command:
DIAGnostic:SERVice:CALibration:DATE on page 818

Recommended Calibration Interval
Indicates the calibration interval recommended for the instrument by Rohde & Schwarz.

Remote command:
DIAGnostic:SERVice:CALibration:INTerval on page 819

Next Calibration Due
Opens a calendar to define the date that the FSWX needs its next calibration. The recommended calibration interval is specified in a read-only field next to this input field.

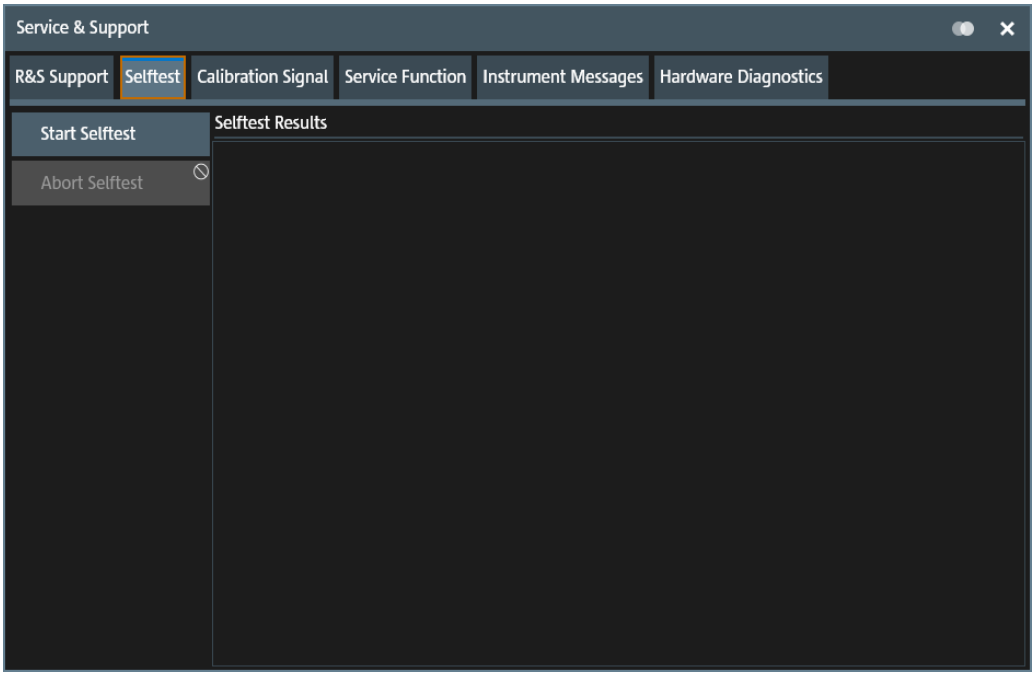
Due to ISO17025, you must configure this date yourself.

Remote command:
DIAGnostic:SERVice:CALibration:DUE:DATE on page 818

4.11.9.2 Self-test settings and results

Access: > "Service & Support" > "Selftest"

If the FSWX fails, you can perform a self-test of the instrument to identify any defective modules.



Once the self-test starts, the FSWX checks all modules consecutively and displays the test result. You can abort a running test.

If the self-test fails, the FSWX displays a short description of the failed test, the defective module, the associated value range and the corresponding test results.

A running "Sequencer" process is aborted when you start a self-test.

If you start a self-test remotely, then select "Local" while the test is still running, the instrument only returns to the manual operation state after the test is completed. In this case, you cannot abort the self-test.

Remote command:

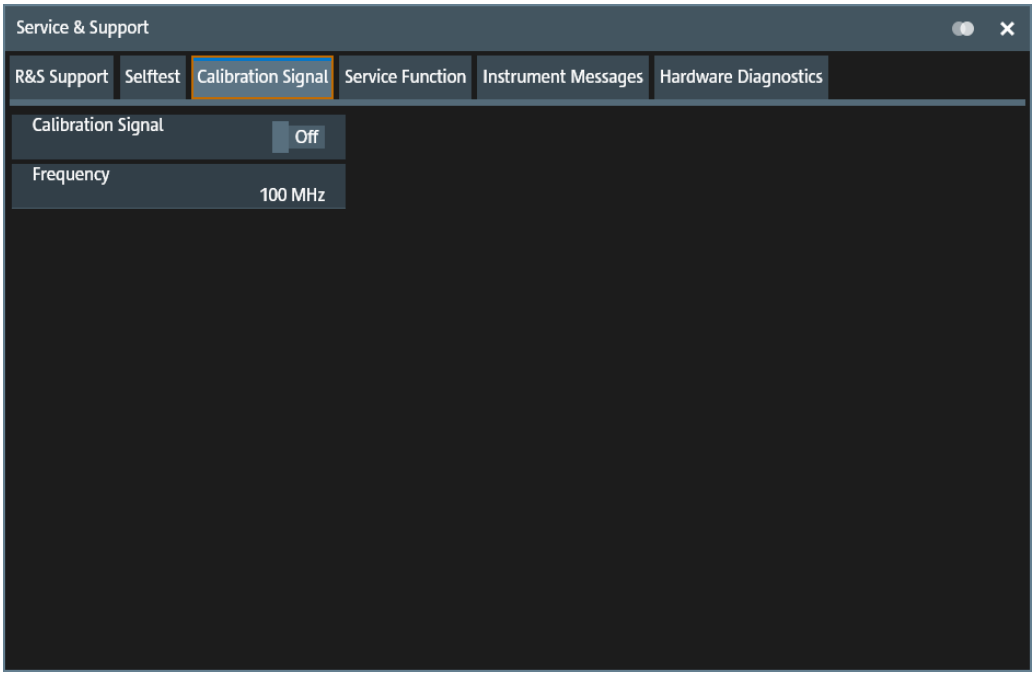
`*TST?` on page 539

`DIAGnostic:SERVice:STESt:RESult?` on page 821

4.11.9.3 Calibration signal display

Access: > "Service & Support" > "Calibration Signal"

As an alternative to the RF input signal from the front panel connector, you can use the instrument's calibration signal as the input signal, for example to perform service functions on. Note that for multi-input instruments, the calibration signal is always applied to *all* RF input connectors simultaneously.



Calibration Signal
Determines whether a calibration signal is provided as input to the FSWX.

"Off" No calibration signal is provided (default).

"On" A calibration signal at the specified frequency is provided as input to the FSWX.

Remote command:
`DIAGnostic:SERVice:INPut[:SELect]` on page 821

Calibration Signal Frequency
Defines the frequency of the provided calibration signal.

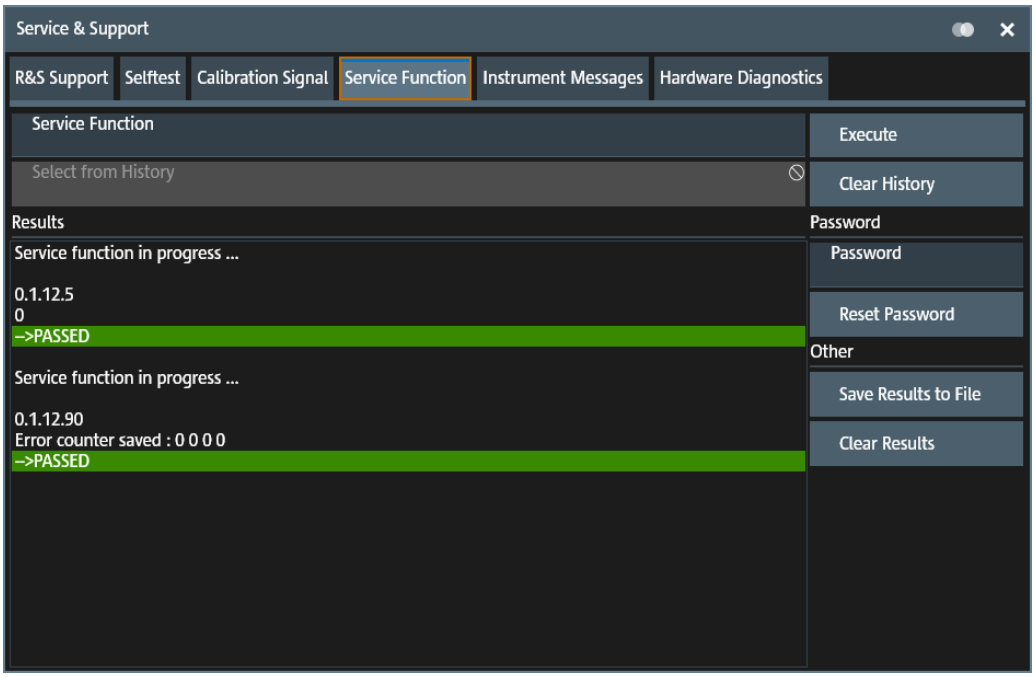
The following values are supported:
- 100 MHz
- 125 MHz
- 250 MHz
- 500 MHz

Remote command:
`DIAGnostic:SERVice:INPut:RF:CFRequency` on page 820

4.11.9.4 Service functions

Access: > "Service & Support" > "Service Function"

The service functions are not necessary for normal measurement operation. Incorrect use can affect correct operation or data integrity of the FSWX. Therefore, only user accounts with administrator rights can use service functions and many of the functions require entering a password. These functions are described in the instrument service manual.



Service Function 459
Select from History 459
Execute 459
Clear History 459
Password 459
Save Results to File 459
Clear Results 459
Result List 459

Service Function
Selects the service function by its numeric code or textual name.

Remote command:
DIAGnostic:SERVice:SFUNction on page 865

Select from History
The selection list includes all functions previously selected (since the last "Clear History" action).

Execute
Starts the selected service function.

Remote command:
DIAGnostic:SERVice:SFUNction on page 865

Clear History
Deletes the list of previously selected service functions.

Password
Most service functions require a special password as they can disrupt normal operation of the FSWX. There are different levels of service functions, depending on how restrictively their use is handled. Each service level has a different password.

"Reset Password" clears any previously entered password and returns to the most restrictive service level.

Remote command:
SYSTem:PASSword[:CENable] on page 867
SYSTem:PASSword:RESet on page 867

Save Results to File
Saves the results of all previously performed service functions to a file stored as `var/lib/rohde-schwarz/esmain/fswx/results/Servicelog.txt`.

Remote command:
DIAGnostic:SERVice:SFUNction:RESults:SAVE on page 866

Clear Results
Clears the result display for all previously performed service functions.

Remote command:
DIAGnostic:SERVice:SFUNction:RESults:DELete on page 866

Result List
Indicates the status and results of the executed service functions.

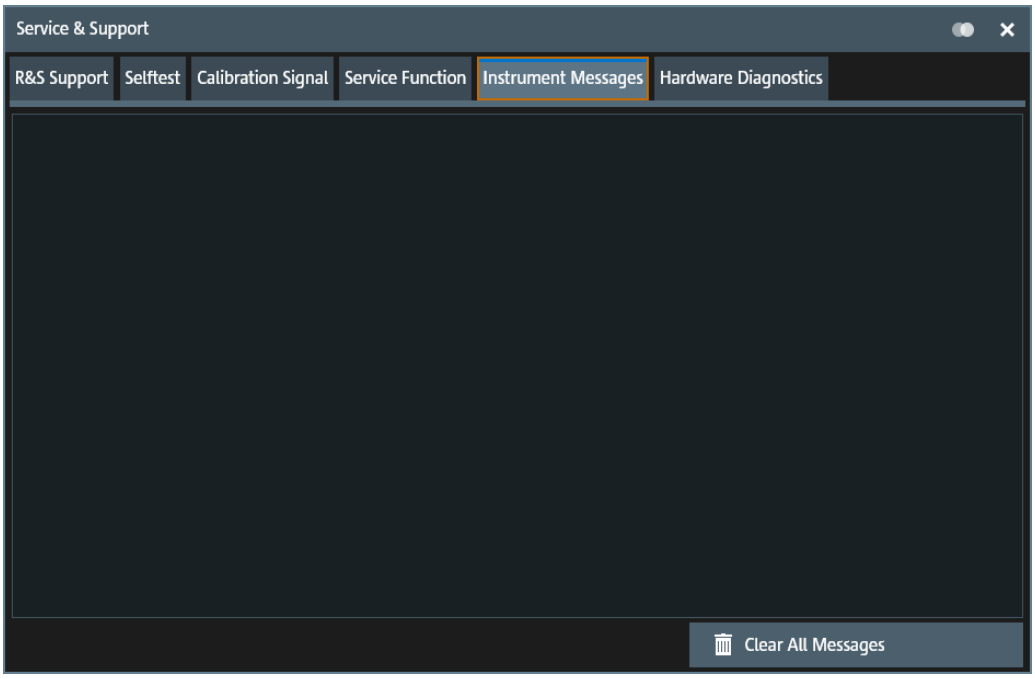
Remote command:
DIAGnostic:SERVice:SFUNction:LASTresult? on page 865

4.11.9.5 Instrument messages

Access: > "Instrument Configuration" > "Instrument Messages"

The messages generated by the FSWX are displayed here.

The messages are displayed in the order of their occurrence. The most recent messages are placed at the top of the list. Messages that have occurred since you last visited the "Instrument Messages" tab are marked with an asterisk '*'.



If the number of error messages exceeds the capacity of the error buffer, "Message Buffer Overflow" is displayed. To clear the message buffer, select Clear All Messages.

The following information is available:

Label	Description
"No"	Device-specific error code
"Message"	Brief description of the message
"Component"	Hardware messages: name of the affected module
	Software messages: name of the affected software
"Date/Time"	Date and time that the message occurred

Remote command:

`SYSTem:ERRor:LIST?` on page 861

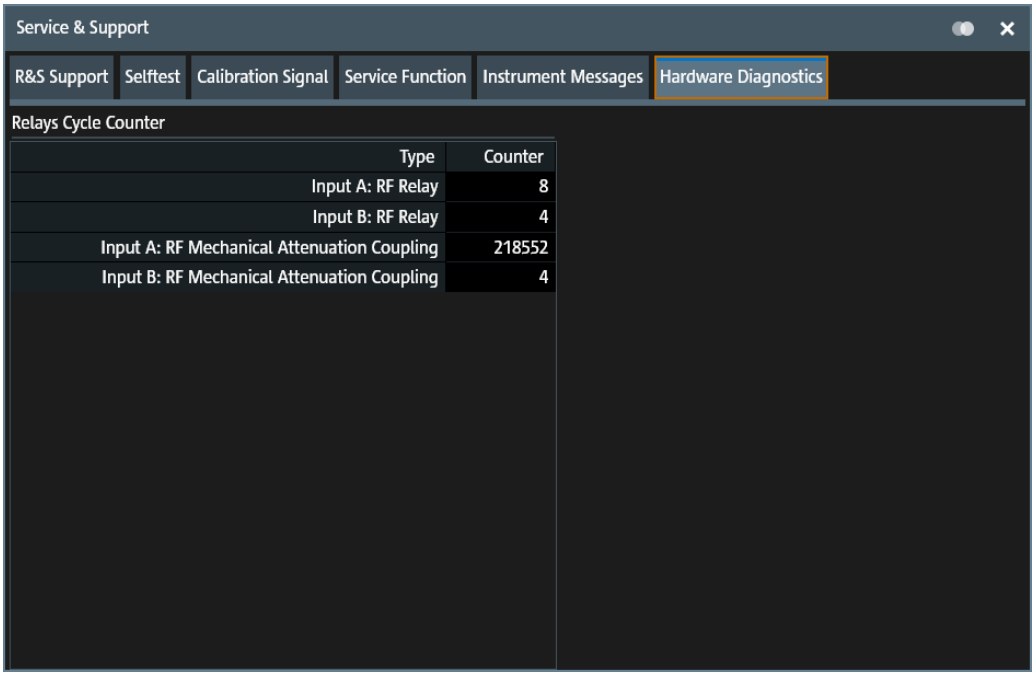
Clear All Messages
Deletes all instrument messages.

Remote command:
`SYSTem:ERRor:CLEar:ALL` on page 859

4.11.9.6 Hardware diagnostics

Access: > "Service & Support" > "Hardware Diagnostics"

If problems occur with the instrument hardware, some diagnostic tools provide information that can support troubleshooting.



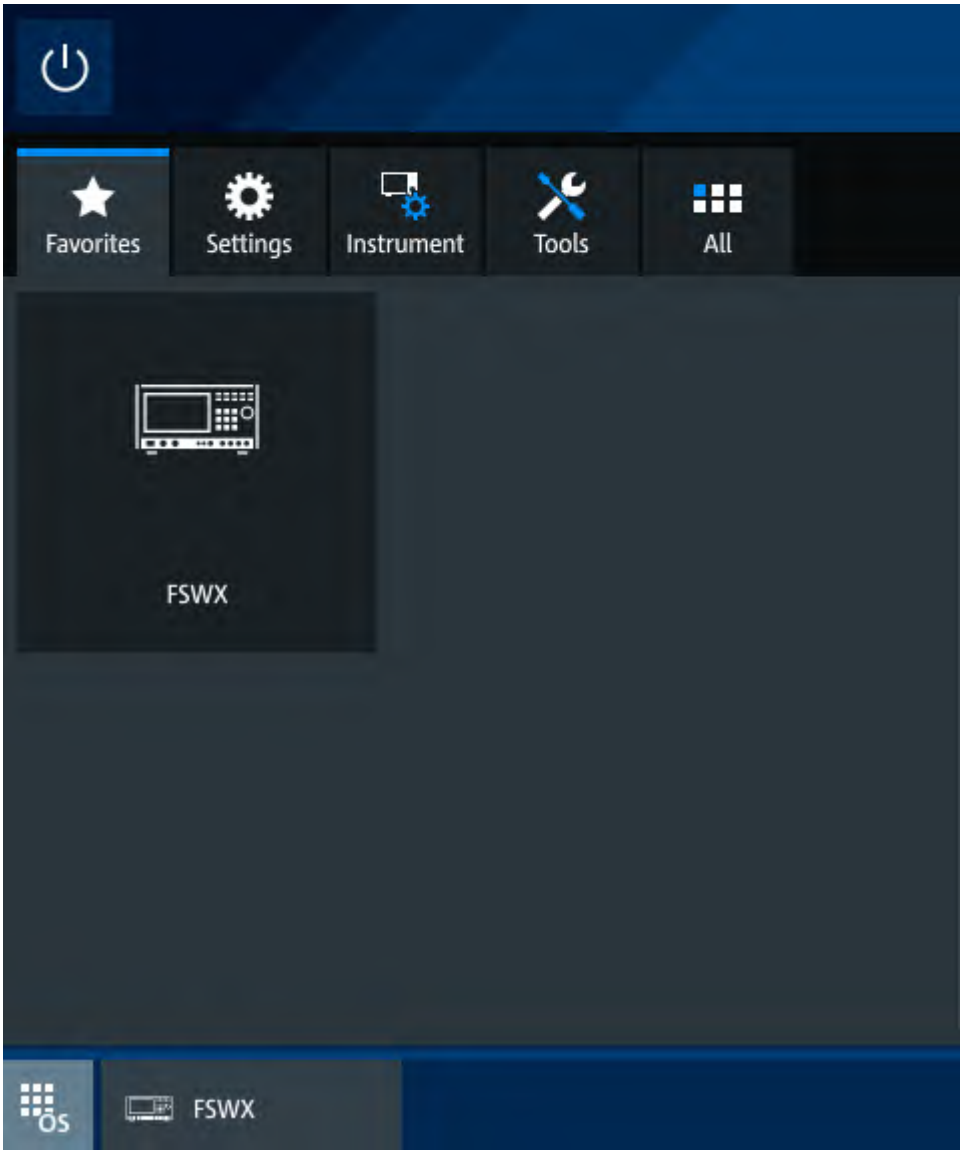
Relays Cycle Counter
The hardware relays built into the FSWX can fail after many switching cycles (see specifications document). The counter indicates how many switching cycles the individual relays have performed since they were installed.

Remote command:
`DIAGnostic:INFO:CCOunt?` on page 857

4.12 System settings and functions

Basic settings and functions concerning the instrument operating system are provided in an OS menu. Related settings or functions are combined in individual tabs.

For context-sensitive help on a particular setting, press [F1] or right-click the setting.



- Power functions....462
- Favorites....463
- System settings....463
- Instrument control....475
- Tools....476
- All (Others)....476

4.12.1 Power functions

The power functions allow you to control instrument operation.

Shutdown
Shuts down the entire instrument in a controlled manner. Before shutting down, the instrument stores a file with the current state of the firmware. This file is loaded and the settings are restored when you start the firmware the next time.

If problems arise, you can delete the shutdown file to start with a factory preset state. See "Delete Shutdown File".

Restart
Shuts down and then restarts the instrument.

Lock
Locks the user interface of the instrument to prevent unwanted or unauthorized operation. To unlock the instrument, enter the instrument password.

4.12.2 Favorites

You can add frequently used functions and settings to the "Favorites" tab to access them quickly.

To add a favorite, right-click the item in one of the other tabs and select "Add to favorites".

4.12.3 System settings

The "Settings" tab contains general settings that are controlled by the operating system.



Once you have opened the "Settings" tab, you can return to it from the common instrument display by selecting "Settings" from the taskbar.

4.12.3.1 Date and time

The following settings are available to set the date and time values of the instrument.

Date....463
Time....464
Time Zone....464
Time Source....464
NTP Server....464
NTP Status....464
Regional Settings....464

Date
Indicates or sets the current date of the internal real-time clock on the instrument in the format specified by Regional Settings (read-only for NTP).

Time
Indicates or sets the current time of the internal real-time clock on the instrument in the format specified by Regional Settings (read-only for NTP).

Time Zone
Defines the time zone that the instrument is located in. The Date and Time settings refer to this time zone.

Time Source
Defines the source of the date and time settings.

"Manual Time Setting"
Time settings defined manually

"NTP" Network Time Protocol
Time settings taken from instrument network
Requires an NTP server.

NTP Server
Prerequisite: Time Source = "NTP"

Address of the network time protocol (NTP) server providing the date and time to the instrument.

NTP Status
Prerequisite: Time Source = "NTP"

Synchronization status of the network time protocol server with the instrument (for reference only).

Regional Settings
Defines the used date and time format. An example for the current date and time is displayed for reference.

German format DD.MM.YYYY hh:mm:ss
24 h Format

US format MM/DD/YYYY hh:mm:ss
12 h format (AM/PM)

4.12.3.2 Display settings

The following settings are provided for the instrument display, if applicable.

Display Layout
Determines which monitor the instrument uses to display the results and functions, if an external monitor is connected.

"Show only on <x>" Only the instrument monitor or only the connected external monitor is used.

"Duplicate" The same functions and results are displayed on both monitors.

"Extend" The instrument results and functions are distributed over both the instrument monitor and a connected external monitor.
You can rearrange the monitors by moving the screen boxes in the dialog box.

4.12.3.3 Firewall settings

Configure the instrument firewall to define which communication links are allowed on the instrument. Not all settings are available on all instruments.

Default settings after firmware update

Firmware updates can reset the firewall settings to their default values. Check the firewall settings after an update to ensure the correct configuration.

Unlock Settings / Lock Settings....465
Restrict Device Access....465
Only allow from IP....465
Avahi (Zeroconf)....465
HiSLIP....465
HTTP(S)....466
ICMP....466
Remote Support....466
SCPI-Raw....466
SMB....466
Software Update....466
VNC....466
VXI-11....466

Unlock Settings / Lock Settings
Some settings require additional rights. If a user with limited access rights is logged on to the system, those settings are locked. To unlock the settings, you must provide login information for the "Security" user.

After changing these settings, lock them again to protect them from unauthorized changes.

Restrict Device Access
If enabled, the IP access restrictions are applied.

Only allow from IP
If defined and if device access is restricted, you can only access the instrument from the specified IP address.

You can change the IP address regardless of the state of restriction.

Avahi (Zeroconf)
Disables or enables communication to the avahi server.

HiSLIP
Disables or enables communication using HiSLIP.

HTTP(S)
Disables or enables communication to the (secure) HTTP server.

ICMP
Disables or enables communication via ICMP to obtain error messages and operational information indicating network status.

Remote Support
Allows or denies access to the instrument for remote support.

SCPI-Raw
Disables or enables communication using SCPI commands via the LAN connection. The commands are transferred to the instrument as raw text.

SMB
Disables or enables communication to the instrument via LAN using the Samba (SMB) protocol.

Software Update
Allows or denies updating the instrument's operating system software.

VNC
Disables or enables communication via VNC, e.g. to operate the instrument via a web browser.

VXI-11
Disables or enables communication using VXI-11.

4.12.3.4 Keyboard settings

The instrument automatically detects a keyboard when you connect it. The default input language is English (US). However, you can also connect foreign-language keyboards.

This setting also applies to the on-screen keyboard if the instrument provides one.

Currently, the following languages are supported:

- English (US)
- German (DE)



We highly recommend using the same language setting on the instrument and a keyboard connected via VNC. Otherwise, the instrument only accepts keys that are available in the language layout of the instrument keyboard. Some special characters, such as [/] on a German VNC keyboard, do not work on an English instrument keyboard, and vice versa.

4.12.3.5 Network settings

For each available network adapter on the instrument, a separate tab indicates its state and parameters. If available, the alias name is displayed, which is usually more helpful than the actual interface name. The active interfaces are shown first.

To edit the state or any parameters, select "Edit Network Settings" on the corresponding tab.

Depending on the used internet protocol of the network adapter, the parameters differ.

- General network settings 467
- IPv4 settings 467
- IPv6 settings 468

General network settings

Instrument Name 467
(Adapter) State 467
(Connection) Status 467
MAC Address 467
Edit Network Settings 467

Instrument Name
Name of the instrument in the network.

(Adapter) State
Enables or disables the network adapter.

(Connection) Status
Indicates the connection status of the instrument in the network.

MAC Address
Indicates the Media Access Control (MAC) address, a unique identifier for the network adapter in the instrument.

Edit Network Settings
Opens a dialog to edit the settings for the selected network adapter.

IPv4 settings

IPv4 State 467
IP Address Mode 468
IP Address 468
Subnet Mask 468
Gateway 468
DNS Address Mode 468
Preferred DNS Server 468
Alternate DNS Server 468

IPv4 State
Enables or disables use of the IPv4 protocol.

IP Address Mode
Defines how the instrument address is determined.

"Auto (DHCP)" Default: the instrument is configured to use DHCP. The instrument address, subnet mask and gateway are determined automatically.

"Manual" Define the instrument address, subnet mask and gateway manually.

IP Address
Defines the IP address. The IP address consists of four number blocks separated by dots. Each block contains a maximum of 3 digits from 0 to 255, e.g. 100.100.100.100.

Subnet Mask
Defines the subnet mask. The subnet mask consists of four number blocks separated by dots. Each block contains a maximum of 3 digits from 0 to 255, e.g. 100.100.100.100.

Gateway
Defines the gateway address. This address identifies the router on the same network as the instrument that is used to forward traffic to destinations beyond the local network.

DNS Address Mode
Defines how the DNS is determined.

"Auto (DHCP)" Default: the DNS is configured to use DHCP. The DNS address is determined automatically.

"Manual" Define the DNS address manually.

Preferred DNS Server
Defines the preferred server for name resolution.

Alternate DNS Server
Defines an alternative server for name resolution in case the preferred server is not available.

IPv6 settings

IPv6 State....468
IPv6 Address List....468

IPv6 State
Enables or disables use of the IPv6 protocol.

IPv6 Address List
The IPv6 protocol allows the instrument to automatically configure an IP address and other related networking settings. The IPv6 addresses detected in the instrument are indicated.

4.12.3.6 Password Manager

The operating system requires that users identify themselves by entering a user name and password in a login window. By default, the instrument provides the following user accounts:

- **"instrument"**: a standard user account with limited access
- **"security"**: a user account with special rights, e.g. for firewall or security settings
- **"VNC"**: a special user account to access the instrument via vnc (including the "Device web browser" application).

Passwords

For all default user accounts, the initial password is *894129*. Note that this password is very weak, and it is recommended that you change the password for all users after initial login.

Some settings that are relevant for security, e.g. firewall settings, require a security password.

Auto-login

When shipped, the instrument automatically logs on the default "Instrument" user to the operating system (with full access) using the default password.

Password settings

The following settings are available to manage passwords for the instrument users. Changing passwords requires administration rights.

Password for Account....469
Old Password....469
New Password / Confirm New Password....469
Change Password....469

Password for Account
Select the user account you want to change the password for.

Old Password
Enter the currently valid password for the selected user account.

New Password / Confirm New Password
Enter the new password for the selected user account twice to prevent a false password.

Change Password
Changes the password for the selected user account. This function is only available to users with administration rights. It only becomes available when you start editing one of the password input fields.

4.12.3.7 Personalization

You can adjust the instrument display according to your preferences.

Color Theme
The theme defines the colors and style used to display softkeys and other screen objects.

"Dark"	Uses a dark background
"Bright"	Uses a white background

4.12.3.8 Security settings

The security settings of the operating system help you protect your instrument against uncontrolled access and changes.

Changing security settings requires special rights.

See the "Password Manager".

Protecting data using internal volatile memory

During normal operation, the instrument uses an internal media memory module to store its operating system, instrument firmware, instrument self-alignment data, and any user data created during operation.

Optionally, a removable media memory module (MMM) is available. You can remove the MMM from the instrument and lock it in a secure place to protect any classified data it contains.

Redirecting storage to volatile memory

To avoid storing any sensitive data on the instrument permanently, the instrument provides an *internal volatile memory mode*. In internal volatile memory mode, the instrument's internal media memory module is write-protected so that no information can be written to memory permanently. Data that the instrument normally stores on the internal MMM is redirected to volatile memory instead. Content in the volatile memory remains available only until the instrument is switched off. This data includes:

- Operating system files
- Firmware shutdown files containing information on the last instrument state
- Self-alignment data
- General instrument settings such as the **IP address**
- Measurement settings
- User data created during operation
- Any data created by other applications installed on the instrument. For example, text editors (Notepad), the clipboard, or drawing tools.

You can access data that is stored in volatile memory as in normal operation. However, when the instrument's power is switched off, all data in this memory is cleared. Thus, in internal volatile memory mode, the instrument always starts in a defined, fixed state when switched on.

To store data such as measurement results permanently, you must store the data to an external storage device, such as a memory stick.

Limited storage space

The volatile memory used to store data in internal volatile memory mode is restricted by the hardware. Thus, a "Memory full" error can occur although the media memory module indicates that storage space is still available.

Storing required data permanently

Store any data that is required in subsequent sessions with the instrument on the instrument *before enabling the internal volatile memory mode*. Relevant data includes predefined instrument settings, correction factors and self-alignment data.

Operating system updates

In rare cases, the operating system updates trigger a reboot.

To avoid unwanted system updates, we recommend one of the following:

- Using internal volatile memory mode only in private LAN without access to the internet
- Disconnecting LAN
- Disabling software updates in the firewall settings

In preparation for system updates, disable internal volatile memory mode temporarily.

Restricted operation

Since permanent storage is not possible, the following functions are not available in internal volatile memory mode:

- Firmware update
- Activating a new option key

Furthermore, some general instrument settings are not available. Refer to the description of the individual system settings or the basic instrument setup to find out which functions are affected.

Memory settings

Memory settings determine the accessiblity of the instrument's storage components.

Unlock Settings / Lock Settings

Some settings require additional rights. If a user with limited access rights is logged on to the system, those settings are locked. To unlock the settings, you must provide login information for the "Security" user.

After changing these settings, lock them again to protect them from unauthorized changes.

Volatile Internal

By default, this function is disabled.

If enabled, all data that the instrument normally stores on the internal media memory module is redirected to volatile memory instead. Data that is stored in volatile memory can be accessed by the user during the current instrument session. However, when the instrument's power is removed, all data in volatile memory is erased.

For details, see "Protecting data using internal volatile memory" on page 470.

When you enable the use of volatile internal storage, the instrument requires a reboot and then automatically starts in internal volatile memory mode.

USB Storage
You can restrict access to any USB storage devices connected to the instrument.

USB ports can pose a security threat in high-security locations. Typically, this threat comes from small USB storage devices, which can quickly read or write several GBytes of data.

Note that when you change the USB storage state, all removable USB storage devices are unmounted. Then they are mounted again according to the new USB storage state.

"Enabled" (Default:) Enables full access to USB storage devices on the instrument.

"Read-only" Enables only read access to connected USB storage devices on the instrument. The instrument cannot write to any USB mass memory device which is plugged into the instrument.

"Disabled" Disables read or write access to storage devices at any USB port connected to the instrument. Disabling read access prevents potentially harmful actions on the instrument by tools or files stored on the USB device.

Manual Operation

The "Manual Operation" setting allows you restrict local operation on the instrument.

Manual Operation
Depending on the setting, manual operation can be restricted to local or VNC operation, or both operating methods can be used in parallel.

"Default" The instrument can be operated both locally and via VNC simultaneously.

"Exclusive" The instrument can run either in VNC mode or local operation exclusively. That means that during local operation, no VNC connections are active. During a VNC connection, local operation is not possible, except to return to local operation.
When you switch to "Exclusive" manual operation, any existing VNC connections are closed.
If a user establishes a VNC connection while another user is operating the instrument locally, the instrument screen is locked and a message is displayed indicating that a VNC connection was started. To return to local operation, the local user must enter the instrument password. In this case, the VNC connection is closed.

Unlock Settings / Lock Settings
Some settings require additional rights. If a user with limited access rights is logged on to the system, those settings are locked. To unlock the settings, you must provide login information for the "Security" user.

After changing these settings, lock them again to protect them from unauthorized changes.

4.12.3.9 System snapshot settings

You can store the current state of the instrument solid state drive as a snapshot to recall again later. Thus, you can return to a defined working state if any problems occur. You can store up to 10 different snapshots. A default snapshot of the factory delivery state is automatically stored and can always be restored.

A snapshot contains all system files on the solid state drive. Personal user files stored in the `/home/` directory are not part of the system snapshot. Thus, if you restore a system snapshot, your personal files are not lost.

The following parameters and functions are available for system snapshots.

ID....473
Name....473
Creation Date & Time....473
Create....473
Restore....473
Delete....474
Rename....474

ID
Unique ID of the stored system snapshot for further reference.

Name
User-defined name of the stored system snapshot.

Creation Date & Time
Date and time the system snapshot was stored.

Create
Creates a new system snapshot with all system files on the solid state drive. Define a name for the snapshot.

If the maximum number of 10 snapshots already exist, you must delete an existing snapshot first.

Restore
Restores the system files on the solid state drive that were stored in the selected snapshot. Your personal files in the `/home/` directory are maintained. The instrument creates a new snapshot with the current files first, then overwrites all system files with the stored files.

You can always restore the default snapshot with the factory delivery state.

If the maximum number of 10 snapshots already exist, you must delete an existing snapshot first.

Delete
Deletes the the selected existing system snapshot. Delete older or no longer required snapshots regularly to make room on the instrument for new snapshots.

Rename
Renames the selected existing system snapshot using the specified name.

4.12.3.10 Virtual machine manager

With the Virtual Machine OS Windows license, you can create a virtual machine (VM) with a Windows operating system directly on the instrument.

Thus, you can:

- Execute Windows-based scripts, tools and programs
- Transfer files easily between the instrument firmware and a Windows-based host
- Control the instrument remotely from a Windows-based host

In the "Virtual Machine Manager", you can start and stop the virtual machine and configure its behavior during operation.

Start....474
Shutdown....474
RAM....474
Number of virtual Processors....475
Network Mode....475
Access USB Devices....475
Start VM on Startup of Device....475
VM Priority....475
Factory Reset....475

Start
Starts the operating system of the virtual machine. Note that virtual machine settings are not available while the VM is running. Optionally, the VM can start up automatically when you start the instrument. See "Start VM on Startup of Device" on page 475.

Shutdown
Shuts down the virtual machine entirely, releasing any blocked resources.

Note: When you shut down the instrument, the virtual machine is automatically shut down first.

RAM
Defines the amount of RAM that the VM can occupy while running. Note that the amount of RAM on the instrument is limited, and is required both by the instrument firmware and the VM. Consider the minimum requirements of the Windows operating system on the VM.

Number of virtual Processors
Defines the number of (virtual) processors that the VM can use while running. Note that the processing ressources on the instrument are limited, and are required both by the instrument firmware and the VM.

Network Mode
Determines how the virtual machine is connected to the network.

"None" The virtual machine is not connected to the network. It can only communicate with the instrument itself. You cannot access the VM from outside the instrument.

"Bridge" The VM is connected to the network. You can use the VM to access the instrument from outside, using it as a bridge to the network.

Access USB Devices
Defines whether the VM is allowed to access any USB devices connected to the instrument. You can enable or disable access for each USB connector individually. Note that access changes are only applied after you restart the virtual machine.

Start VM on Startup of Device
If enabled, the virtual machine is automatically started when the instrument is started.

VM Priority
Determines how the ressources on the instrument are distributed between the instrument and the virtual machine.

Factory Reset
During initial system start, the instrument creates an automatic snapshot of the virtual memory. This snapshot is considered to be the factory VM snapshot. You can restore this initial factory state on the instrument anytime using the "Factory Reset".

4.12.4 Instrument control

The "Instrument" tab contains functions to control the instrument firmware.

Start / Stop FSWX
Starts or stops the FSWX firmware.

When you stop the firmware, all other tools and the operating system continue to operate.

To shut down the instrument completely, use the "Shutdown" function.

Delete Shutdown File
When you shut down the instrument firmware using a shutdown function, the instrument stores a file with the current state of the firmware. This file is loaded and the settings are restored when you start the firmware the next time. If problems arise, you can delete the shutdown file to start with a factory preset state.

4.12.5 Tools

The "Tools" tab contains useful tools that are not integrated in the operating system or the instrument firmware.

4.12.5.1 Installation utility

Access: > "Tools" > "Installation Utility"

You can update the base unit firmware from an executable file on a connected USB storage device. Contact your Rohde & Schwarz sales representative to obtain the installation file.

Before updating the firmware on your instrument, read the release notes delivered with the firmware version.

You do not require administrator rights to update the firmware.

Firmware updates can reset the firewall settings to their default values. Check the firewall settings after an update to ensure the correct configuration.

To install an update

If you start installing while the instrument firmware is running, the utility stops the firmware before starting the update.

1. Select the installer file from the USB storage device.
   Installer files in `EXE` or `RSI` format are supported.
   The default storage directory is `/run/media`, which is the default directory for mounted USB storage devices.
2. Select "Open".
3. Select "Start installation".

   Installation begins. Watch for error messages in the utility window. When the installation is complete, the firmware starts again.

Remote command:

`SYSTem:FIRMware:UPDate` on page 862

4.12.6 All (Others)

The "All" tab contains all functions and settings that are available from the operating system dialog box. If you cannot find a particular option in any of the other tabs, you can search here.

The following settings and functions that are not described in the other tabs are available.

- File Manager 477
- Open Source Acknowledgment 479

4.12.6.1 File Manager

The "File Manager" supports you in managing files stored on the instrument. Using remote access or an optional virtual machine on the instrument, you can also exchange files between an external host and the instrument using the "File Manager".

The "File Manager" displays the file and folder structure on the instrument.

System files and the system directory are protected and not accessible.

File naming conventions

To enable files to be used in different file systems, consider the following file naming conventions:

- The filename can be of any length.
- The name is case-sensitive, i.e. uppercase and lowercase letters are considered to be different.
- All letters and numbers are permitted. However, do not begin a filename with a number.
- You can also use underscores, hyphens, periods. However, do not begin a filename with a hyphen.
- Do not use slashes "\" and "/". These symbols are used in file paths.
- Do not user special characters, such as ":", "*", "?", "$", "%" or brackets, which have special meanings in the operating system and can cause problems.
- Avoid using the following filenames: `CLOCK$`, `CON`, `COM1 to COM4`, `LPT1 to LPT3`, `NUL` or `PRN`
  They are reserved by the operating system.

The "File Manager" provides the following functions.

Select / Deselect checkbox....478
Filter / Sort....478
Name....478
Date Modified....478
Size (Bytes)....478
New Folder....478
Copy / Paste....478
Move....478
Rename....478
Delete....478
Preview....478
Show Hidden Items....478
Go Folder Back / Forward / Up....479
Home....479
Refresh....479

Select / Deselect checkbox
Selects or deselects the file or folder for subsequent operations, e.g. moving or deleting.



Filter / Sort
Sorts the files or folders according to the selected column, or filters the files or folders according to the search term.

"Sort 1 to N" / "Sort A to Z"	Sorts the files or folders in ascending order.
"Sort N to 1" / "Sort Z to A"	Sorts the files or folders in descending order.
"Search..."	Filters the files or folders, showing only items that contain the specified search term.

Name
Filename or folder name

Date Modified
Date and time the file or folder was modified last.

Size (Bytes)
File size in bytes (not available for folders).

New Folder
Inserts a new subfolder in the currently selected folder. Define the name of the new folder in the next step.

Consider the "File naming conventions" on page 477.

Copy / Paste
Copies the selected files or folders to the destination you select in the next step.

Move
Moves the selected files or folders to the destination you select in the next step.

Rename
Renames the selected file or folder according to the name you define in the next step.

Consider the "File naming conventions" on page 477.

Delete
Deletes the selected files or folders.

Preview
Shows a preview of the contents of the selected file. This function is not available for all file types.

Show Hidden Items
In the Linux operating system, directories that start with a "." are hidden by default.

This setting shows or hides these directories.

Go Folder Back / Forward / Up
Navigates within the folder structure on the instrument.

Home
Returns to the home directory of the instrument file system.

Refresh
Updates the file directory display. This function is useful if a user added or deleted files on the instrument since the display was first opened.

4.12.6.2 Open Source Acknowledgment

Displays a list of acknowledgments for open-source code used by the instrument.

4.13 Network operation and remote control

In addition to working with the FSWX directly, using the touchscreen and the keys, you can also operate the instrument from a remote PC. The FSWX supports various methods for remote operation:

- Using a VNC client in a local area network (LAN)
- Using the device web browser interface in a LAN
- Using the Windows Remote Desktop application on a virtual machine
- Remote control with SCPI commands via the GPIB interface of the instrument

Basic information on operating the FSWX via remote control is provided here. This information applies to all applications on the FSWX.

The following descriptions provide information required to operate the FSWX remotely. This information applies to all applications on the FSWX.

Definitions specified in the SCPI standard are not provided. For basic knowledge on remote control operation and additional information, see the following documents available from the Rohde & Schwarz website:

- Remote control via SCPI
- 1EF62: Hints and Tricks for Remote Control of Spectrum and Network Analyzers
- 1MA171: How to use Rohde & Schwarz Instruments in MATLAB
- 1MA208: Fast Remote Instrument Control with HiSLIP

How to configure the remote control interfaces is described in Section 4.13.6, "How to set up a network and remote control", on page 526.

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- Device web applications (LAN browser interface)....482
- Status reporting system....491
- Automating tasks with remote command scripts....504

- Network and remote control settings.....516
- How to set up a network and remote control.....526
- Reference: Conversion of Windows paths to Linux paths..... 531

4.13.1 Remote control interfaces and protocols

The instrument supports different interfaces and protocols for remote control. The following table gives an overview.

For a description of the protocols refer to Remote control via SCPI.

Table 4-37: Remote control interfaces and protocols

Interface	Protocols, VISA*) address string	Port **)	Remarks
Local Area Network (LAN)	**HiSLIP** High-Speed LAN Instrument Protocol (IVI-6.1) `TCPIP::host address::hislip0[::INSTR]`	TCP port: 4880	A LAN connector is located on the rear panel of the instrument.
	VXI-11 `TCPIP::host address::inst0[::INSTR]` Library: VISA	TCP or UDP port: 111 TCP port: well-known ports (600 - 1023) for Linux or registered ports (1024 - 49151) for Windows	
	socket communication (Raw Ethernet, simple Telnet) `TCPIP::host address[::LAN device name]::<port>::SOCKET` Library: VISA or socket controller	SCPI raw, TCP port: 5025, 5125 SCPI telnet, TCP port: 5024, 5124	
	VNC	via VNC client: 5800/5900 Device web: 5850	
	Device web / web control	80	
GPIB (IEC/IEEE Bus Interface)	VISA*) address string: `GPIB::primary address[::INSTR]` (no secondary address)		An optional GPIB bus interface according to the IEC 625.1/IEEE 488.1 standard is located on the rear panel of the instrument, if installed.

*) VISA is a standardized software interface library providing input and output functions to communicate with instruments. A VISA installation on the controller is a prerequisite for remote control using the indicated interfaces.

**) By default, FSWX uses these ports for communication via the LAN control interface. If necessary, adapt your firewall to allow for use of these ports.

4.13.1.1 LAN interface

To be integrated in a LAN, the instrument is equipped with a LAN interface, consisting of a connector, a network interface card and protocols. The network card can be operated with the following interfaces:

- 10 Mbit/s Ethernet IEEE 802.3

- 100 Mbit/s Ethernet IEEE 802.3u
- 1Gbit/s Ethernet IEEE 802.3ab

For remote control via a network, the PC and the instrument must be connected via the LAN interface to a common network with TCP/IP network protocol. They are connected using a commercial RJ-45 cable (shielded or unshielded twisted-pair category 5). The TCP/IP network protocol and the associated network services are preconfigured on the instrument. Software for instrument control and the VISA program library must be installed on the controller.

IP address

You only require the IP address or a valid DNS host name to set up the connection to the FSWX. The host address is part of the "VISA resource string" used by the programs to identify and control the instrument.

The VISA resource string has the form:

```
TCPIP::host address[::LAN device name][::INSTR]
```

Or

```
TCPIP::host address::port::SOCKET
```

Where:

- **TCPIP** designates the network protocol used
- **host address** is the IP address or host name of the device
- **LAN device name** defines the protocol and the instance number of a subinstrument;
  - `inst0` selects the VXI-11 protocol (default)
  - `hislip0` selects the HiSLIP protocol
- **INSTR** indicates the instrument resource class (optional)
- **port** determines the used port number
- **SOCKET** indicates the raw network socket resource class

Example:

- Instrument has the IP address *192.1.2.3*; the valid resource string using the VXI-11 protocol is:
  `TCPIP::192.1.2.3::INSTR`
- The DNS host name is *FSWX3026-123456*; the valid resource string using HiSLIP is:
  `TCPIP::FSWX3026-123456::hislip0`
- A raw socket connection can be established using:
  `TCPIP::192.1.2.3::5025::SOCKET`

Identifying instruments in a network

If several instruments are connected to the network, each instrument has its own IP address and associated resource string. The controller identifies these instruments by the resource string.

For details on configuring the LAN connection, see Section 4.13.6, "How to set up a network and remote control", on page 526.

4.13.2 Device web applications (LAN browser interface)

The FSWX installation includes a web server which provides various useful web applications for the instrument, called the device web. If you connect the instrument to a LAN, you can access the device web using any web browser on a connected device in the LAN.

The instrument's LAN browser interface works correctly with all W3C compliant browsers.

The device web allows you to control the instrument remotely from another device without additional installation requirements. Manual instrument controls are available via the front panel simulation. You can also upload and download files between the instrument and the remote device. Several users can access *and operate* the FSWX via web control simultaneously. This is useful for troubleshooting or training purposes.

The device web uses VNC to access the instrument. Using VNC requires a special password.



The navigation menu of the browser interface contains the following applications:

- "Home" provides basic instrument information.
  See Section 4.13.2.2, "Instrument homepage", on page 483.
- "LAN configuration" allows you to configure the LAN directly from the web browser.
  See Section 4.13.2.3, "LAN configuration", on page 485.
- "Web control" emulates the front panel and shows the instrument display. You see a live image of the instrument, and you can operate the instrument remotely. You

can use the keys, the knobs and the menus in the same way as directly on the instrument.
See Section 4.13.2.4, "Web control", on page 487.

- "HUMS"
  The health and utilization monitoring system (HUMS) provides information about the FSWX. The aim is to increase the overall utilization, to avoid downtime and to increase the overall security level of a fleet of instruments.
  For details, see the R&S®HUMS User Manual.
- "Security"
  Ensures secure communication between the instrument and other devices using certificates.
  See the R&S®ISEC - Instrument Security Service User Manual.
- "License Management" / "License Analytics" / "License Server Configuration"
  Allows you to manage, configure and analyze licenses for the instrument.
  See the R&S®License Server - Managing Floating Licenses - user manual.
- "File manager" provides access to the user data that is saved on the instrument, and allows you to upload and download files.
  See Section 4.13.2.7, "File manager", on page 489.

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- How to disable the browser interface....489
- File manager....489

4.13.2.1 How to display the LAN browser interface (device web)

The instrument's LAN browser interface works correctly with all W3C compliant browsers.

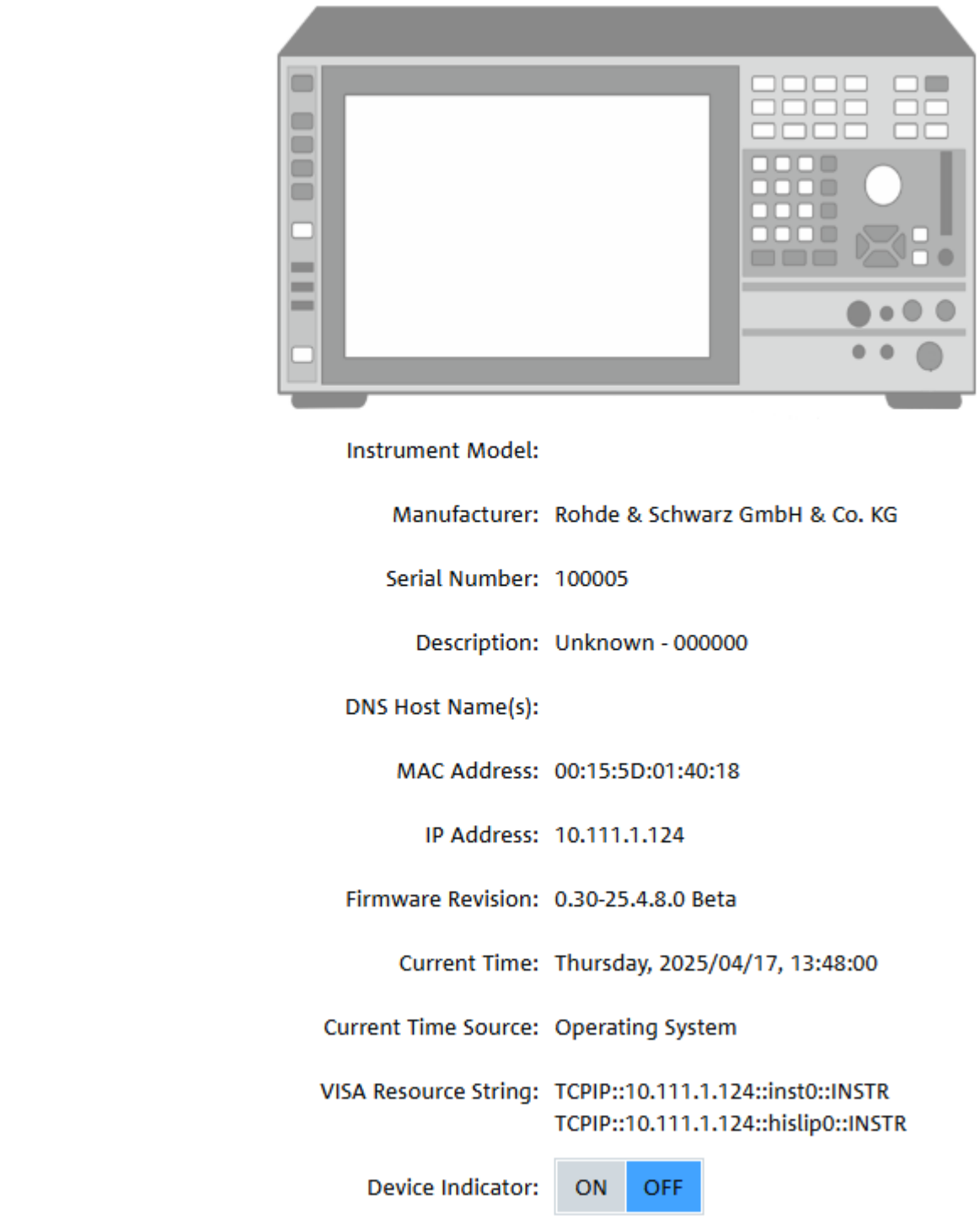
1. Open a browser on a computer connected to the instrument via LAN.
2. Type the instrument's host name or IP address in the address field of the browser on your PC, e.g. "http://11.111.11.222".

   The device web home page opens.

For details, see Section 4.13.2.2, "Instrument homepage", on page 483.

4.13.2.2 Instrument homepage

The instrument homepage displays the device information in read-only format, including DNS host names, IP address, and the VISA resource strings.



At the bottom of the homepage, you find the "Device Indicator". Enable the indicator to find the instrument in the LAN. In the instrument GUI, the LAN status icon starts blinking.

4.13.2.3 LAN configuration

The LAN configuration consists of several parts:

- "General"
- "IP configuration" provides all mandatory LAN parameters.
- "Advanced configuration" provides LAN settings that are not declared mandatory by the standard.
- "Ping client" provides the ping utility to verify the connection between the instrument and other devices.

Changing the LAN parameters possibly requires a password, if defined on the instrument.

General settings

The "General" tab provides the name and an optional description of the instrument. You can also change the used instrument port.

Instrument Name
Name of the instrument in the network.

Description
Optional description of the instrument.

HiSLIP Port
Port used for the LAN connection

IP configuration

The "LAN Configuration" > "IP configuration" tab displays all mandatory LAN parameters and allows you to modify them.

Register Device at DNS Server Automatically
Defines how the DNS is determined. If enabled, the DNS address is determined automatically.

If disabled, define the DNS address manually.

IP Address Mode
Controls how the IP address for the instrument is assigned.

"Auto (DHCP)"	Default: the instrument is configured to use DHCP. The instrument address, subnet mask and gateway are determined automatically.
"Manual"	Define the instrument address, subnet mask and gateway manually.

IP Addresses
Defines the IP address. The IP address consists of four number blocks separated by dots. Each block contains a maximum of 3 digits from 0 to 255, e.g. 100.100.100.100.

Subnet Masks (IPv4)
Defines one or more subnet masks. The subnet mask consists of four number blocks separated by dots. Each block contains a maximum of 3 digits from 0 to 255, e.g. 100.100.100.100.

Prefixes (IPv6)
Prefixes used to identify the scope and type of an IPv6 address.

Examples:
- 64 for addresses in a local network
- 7 for addresses in private, internal networks
- 3 for globally accessible addresses on the internet

Default Gateway
Defines the gateway address. This address identifies the router on the same network as the instrument that is used to forward traffic to destinations beyond the local network.

DNS Servers
Defines one or more DNS servers for name resolution.

Advanced configuration

Some special LAN parameters are available in the advanced configuration.

mDNS / DNS-SD
Multicast DNS and DNS Service Discovery are protocols used for device communication in zero configuration networks working without DNS and DHCP.

ICMP Ping
Allows the instrument to use the ping utility.

VXI-11 Discovery (IPv4)
Enables the protocol that is used to detect the instrument in the LAN.

Privacy Extension (IPv6)
Allows the instrument to generate a temporary, random IPv6 address, which is used for outgoing connections.

Ping client

Ping is a utility that verifies the connection between the instrument and another device. The ping command uses the `ICMP` echo request and echo reply packets to determine whether the LAN connection is functional. Ping is useful for diagnosing IP network or router failures. The ping utility is not password-protected.

To initiate a ping between the compliant instrument and a second connected device:

1. On the "Advanced Configuration" page, make sure "ICMP ping" is enabled (default).

2. On the "Ping client" page, enter the IP address of the second device **without the ping command and without any further parameters** into the "Destination address" field (e.g. *11.113.11.203*).
3. Click "Submit".

4.13.2.4 Web control

"Web Control" emulates the front panel and shows the instrument display. You see a live image of the instrument, and you can operate the instrument remotely. You can use the keys, the knobs and the menus in the same way as directly on the instrument.

We highly recommend using the same language setting on the instrument and a keyboard connected via VNC. Otherwise, the instrument only accepts keys that are available in the language layout of the instrument keyboard. Some special characters, such as [/] on a German VNC keyboard, do not work on an English instrument keyboard, and vice versa.



The "Web control" title bar above the emulated display provides some options:

Front panel
Hides or shows the front panel.

Scaling
Scales the diagram to show it completely. If disabled, the diagram is shown in its original size.

Read-only
Disables operating, only viewing is possible.

Take Screenshot
Creates a screenshot of the current screen as a file.

Minimize / Maximize
Hides or shows the device web menu.

4.13.2.5 How to control the FSWX via the browser interface (device web)

Via the LAN browser interface to the FSWX, one or more users can control the instrument remotely from another device without additional installation. Most instrument controls are available via the front panel simulation. File upload and download between the instrument and the remote device is also available.

Prerequisites:

- Browser that supports HTML5 (W3C compliant)
- Ports 5850 (for the Device web) and 80 (for Web control) are enabled in the firewall

To access the FSWX via the browser interface

1. Type the instrument's host name or IP address in the address field of the browser on your PC, e.g. "http://11.111.11.222".

   The device web home page opens.

2. In the navigation pane, select "Web Control".
3. Enter the VNC password for the instrument.

   The instrument's display is shown in the browser window, with a virtual front panel displayed beside or below it.

4. If necessary, enter the instrument password for remote control.
5. Use the mouse cursor to access the functionality in the virtual front panel or in the display as you would directly on the instrument's front panel.

We highly recommend using the same language setting on the instrument and a keyboard connected via VNC. Otherwise, the instrument only accepts keys that are available in the language layout of the instrument keyboard. Some special characters, such as [/] on a German VNC keyboard, do not work on an English instrument keyboard, and vice versa.

To exchange files with the FSWX

You can download files, for example stored measurement data, from the FSWX to the remote device, or upload files, for example limit line definitions, from the device to the FSWX.

1. On the device web home page, select "File Manager".

   The basic folders for firmware data and user data are displayed.

2. To download a file from the FSWX:

   a) Select the file from the displayed folders.
   b) From the "File Manager" menu, select "Download".

3. To upload a file to the FSWX:

a) Select the folder on the FSWX to which you want to copy a file.
b) From the "File Manager" menu, select "Upload".
c) From the file selection dialog box, select the required file on the connected device.
d) Select "Open".
e) Optionally, change the name of the file to store on the instrument.
f) Select "OK" to copy the file from the connected device to the defined folder on the FSWX.

4.13.2.6 How to disable the browser interface

If you want to prevent other users in the LAN from accessing or operating the FSWX via its LAN browser interface, you must disable VNC access in the firewall settings. Note that **a firmware update** can reset the firewall settings to their default values so that access can be available again. Check the firewall settings after an update to ensure the correct configuration.

To disable the LAN browser interface

1. Select the icon in the toolbar to access the operating system.
2. Select "Firewall settings".
3. Disable "VNC".

   The next time a user enters the IP address of the instrument in a browser, an error message is displayed:
   `Failed to connect to server (code. 1006)`

4.13.2.7 File manager

The file manager on the instrument's webpage provides access to the user data that is stored on the instrument, or on a USB flash device connected to the instrument.

Note that possibly only a restricted part of the instrument file system is accessible from the Device web File Manager application. For example, operating system files can be hidden. Such files are only available directly on the instrument.

In the web file manager, you can organize the data:

- Create folders.
- Copy files within the instrument's file system, or from and to a USB flash device. Multiple files selection is possible.
- Move files within the instrument's file system, or from and to a USB flash device. Multiple files selection is possible.
- Rename files.
- Delete files.
- Upload files from the operating computer to the instrument. Multiple files can be uploaded at once.

- Download files from the instrument to the operating computer. Multiple file selection is possible.

Notes on USB flash devices

If no USB flash device is connected to the instrument, the "USB" folder is empty but still listed. Do NOT upload files to this main "USB" folder because data will be lost. Upload files only to the subfolders of connected USB flash devices.

After attaching a USB flash device, creating a screenshot or other actions, the file manager might not display the last change.

► Click the "Refresh" icon on the right of the address field to update the display.

The "Eject" button for USB flash devices has no function when operating the instrument remotely.

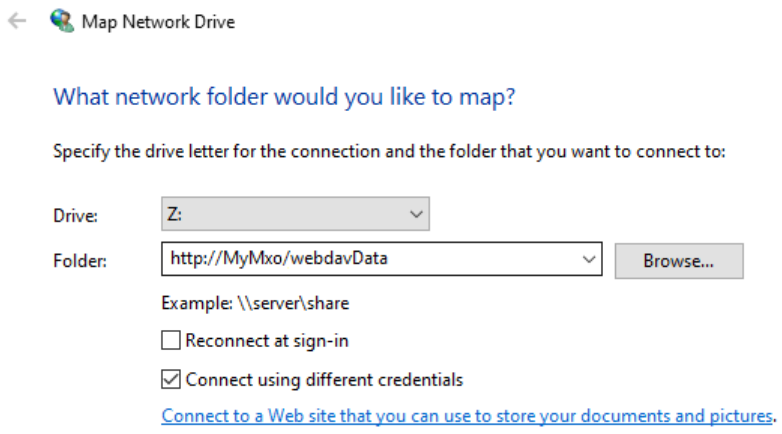
Mapping the instrument's file system as a network drive

Using web-based distributed authoring and versioning (WebDAV), you can access and exchange files over the internet: move, cut, copy and paste files from the instrument to the computer and vice versa. Therefore, map the instrument's file system as network drive in the file explorer of the operating computer:

The instrument is connected to LAN, and the connection status icon in the instrument's display is green.

1. Open the file explorer on the operating computer.
2. In the left list, right-click "Network" or the entry of the operating computer, and select "Map network drive".
3. Enter the path to the instrument's file system:
   `http://<hostname>/webdavData`.

   The default host name is <instrument_model>-<serial_number>.
4. Enable "Connect using different credentials".



5. Click "Finish".

6. Leave the "User name" and "Password" empty. Click "OK".

If there are problems with the connection, check if the "WebClient" service is running: "Task Manager" > "Services" tab. If the "WebClient" service is not running, start it.

4.13.3 Status reporting system

The status reporting system stores all information on the current operating state of the instrument, and on errors which have occurred. This information is stored in the status registers and in the error queue. You can query both the status registers and the error queue via the GPIB bus or LAN interface using the `STATus...` commands.

(See Section 4.14.14, "Using the status register", on page 883).

For background information on the status reporting system, see Remote control via SCPI on the internet.

- Hierarchy of status registers 491
- Contents of the status registers 492
- Reset values of the status reporting system 503

4.13.3.1 Hierarchy of status registers

As shown in the following figure, the status information is of hierarchical structure.

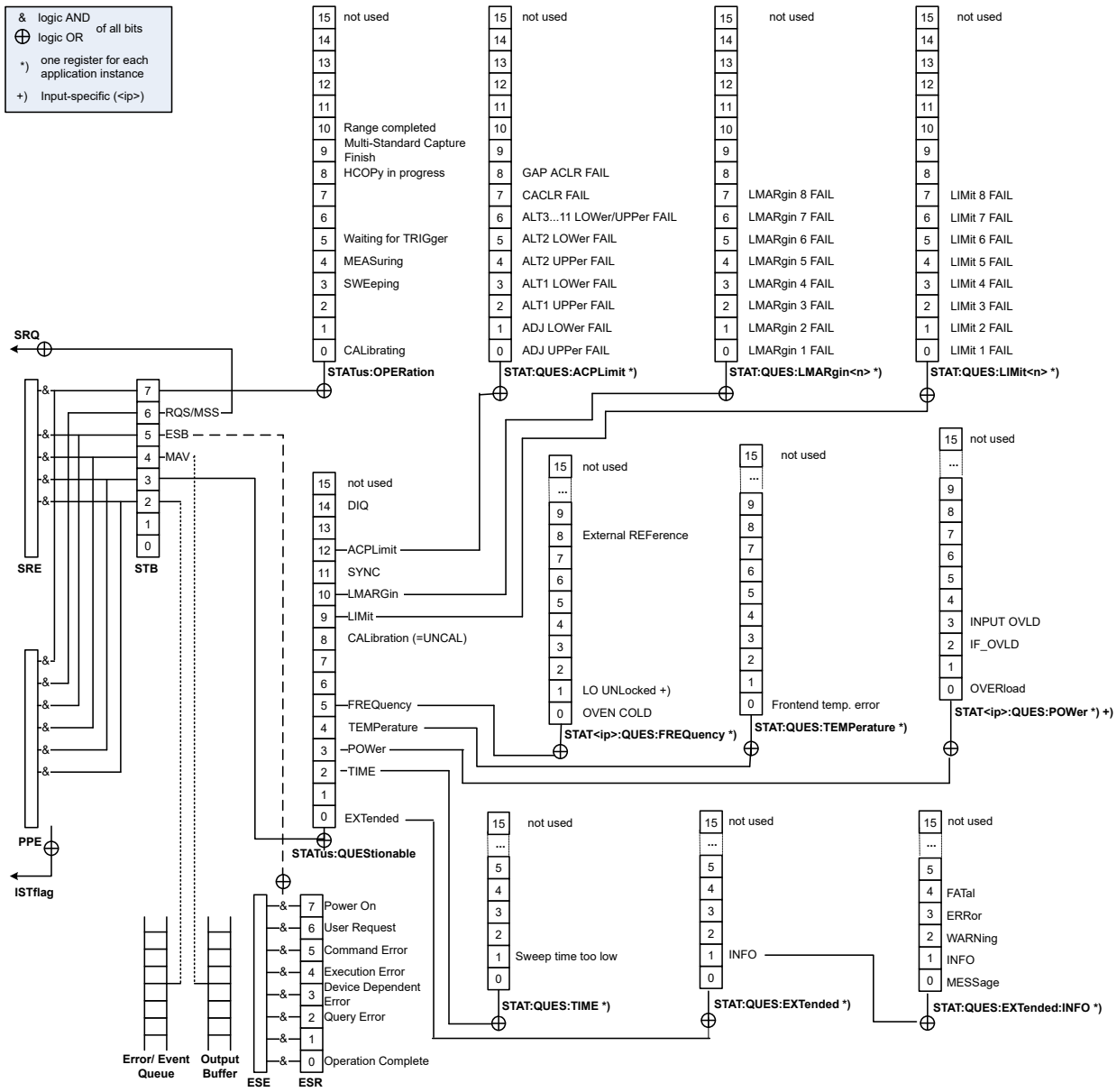


Figure 4-56: Graphical overview of the FSWX status registers hierarchy

All status registers have the same internal structure.

4.13.3.2 Contents of the status registers

In the following sections, the contents of the status registers are described in more detail.

STATus:QUEStionable:SYNC register

The `STATus:QUEStionable:SYNC` register is used by the FSWX applications and is described in the individual sections (manuals) for each application.

- Status byte (STB) and service request enable register (SRE)....493
- IST flag and parallel poll enable register (PPE)....494
- Event status register (ESR) and event status enable register (ESE)....494
- STATus:OPERation register....495
- STATus:QUEStionable register....496
- STATus:QUEStionable:ACPLimit register....497
- STATus:QUEStionable:EXTended register....498
- STATus:QUEStionable:EXTended:INFO register....498
- STATus<ip>:QUEStionable:FREQuency register....499
- STATus:QUEStionable:LIMit register....500
- STATus:QUEStionable:LMARgin register....500
- STATus<ip>:QUEStionable:POWer register....501
- STATus:QUEStionable:SYNC register....502
- STATus:QUEStionable:TEMPerature register....502
- STATus:QUEStionable:TIMe register....503
- STATus:QUEStionable:TRANsducer register....503

Status byte (STB) and service request enable register (SRE)

The `STatus Byte` (STB) is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.

Thus, the STB is comparable to the `CONDition` part of a SCPI register and assumes the highest level within the SCPI hierarchy.

Read the STB using the command `*STB?` or a serial poll.

The `STatus Byte` (STB) is linked to the `Service Request Enable` (SRE) register. Each bit of the STB is assigned to a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a service request (SRQ) is generated. Set the SRE using the command `*SRE` on page 539. Read it using the command `*SRE?`.

Table 4-38: Meaning of the bits used in the status byte

Bit No.	Meaning
0...1	Not used
2	Error Queue not empty The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a service request. Thus, you can recognize and specify an error in greater detail by polling the error queue. The poll provides an informative error message. This procedure reduces the problems involved with remote control considerably.
3	QUEStionable status register summary bit The bit is set if an `EVENt` bit is set in the `QUEStionable` status register and the associated `ENABle` bit is set to 1. A set bit indicates a questionable instrument status. To find more details, query the `STATus:QUEStionable` status register.
4	MAV bit (message available) The bit is set if a message is available in the output queue which can be read. You can use this bit to read data from the instrument by the controller automatically.

Bit No.	Meaning
5	ESB bit Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting this bit indicates a serious error. Find details by polling the event status register.
6	MSS bit (main status summary bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this register is set together with its mask bit in the service request enable register SRE.
7	`STATus:OPERation` status register summary bit The bit is set if an `EVENt` bit is set in the `OPERation` status register and the associated `ENABle` bit is set to 1. A set bit indicates that the instrument is currently performing an action. Find out the type of action by querying the `STATus:OPERation` status register.

IST flag and parallel poll enable register (PPE)

As with the SRQ, the IST flag combines the entire status information in a single bit. You can read it using a parallel poll or the `*IST?` command.

The parallel poll enable register (PPE) determines which bits of the STB contribute to the IST flag. The bits of the STB are "ANDed" with the corresponding bits of the PPE. Bit 6 is used as well, in contrast to the SRE. The IST flag results from the "ORing" of all results. Set the PPE using the `*PRE` command. Read it using `*PRE?`.

Event status register (ESR) and event status enable register (ESE)

The ESR is defined in IEEE 488.2. It is comparable to the `EVENt` part of a SCPI register. Read the event status register using the `*ESR?` command.

The ESE corresponds to the `ENABle` part of a SCPI register. If a bit is set in the ESE and the associated bit in the ESR changes from 0 to 1, the ESB bit in the STB is set. Set the ESE register using the `*ESE` command. Read it using the `*ESE?` command.

Table 4-39: Meaning of the bits used in the event status register

Bit No.	Meaning
0	`Operation Complete` This bit is set on receipt of the *OPC command as soon as all previous commands have been executed.
1	Not used
2	`Query Error` This bit is set if: • The controller wants to read data from the instrument without having sent a query. • The controller does not fetch requested data and sends new instructions to the instrument instead. The cause is often a faulty query which cannot be executed.
3	`Device-dependent Error` A device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue.

Bit No.	Meaning
4	`Execution Error` A received command is syntactically correct but cannot be performed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue.
5	`Command Error` A command is received that is undefined or syntactically incorrect. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the error queue.
6	`User Request` This bit is set when the instrument is switched to manual control.
7	`Power On` (supply voltage on) This bit is set on switching on the instrument.

STATus:OPERation register

The `STATus:OPERation` register contains information on the current activities of the FSWX. It also contains information on activities that have been executed since the last read out.

You can read out the register with `STATus:OPERation:CONDition` or `STATus:OPERation[:EVENt]`.

Table 4-40: Meaning of the bits used in the STATus:OPERation register

Bit No.	Meaning
0	`CALibrating` Instrument is performing a self-alignment.
1-2	Not used
3	`SWEeping` Sweep is being performed in base unit (applications are not considered); identical to bit 4 In applications, this bit is not used.
4	`MEASuring` Measurement is being performed in base unit (applications are not considered); identical to bit 3 In applications, this bit is not used.
5	`Waiting for TRIgger` Instrument is ready to trigger and waiting for the trigger signal.
6-7	Not used
8	`HardCOPy` in progress Instrument is printing a hardcopy.
9	
10	`Range completed` A range in the sweep list is completed and "Stop after Sweep" is enabled (see "Stop After Sweep" on page 1079).

Bit No.	Meaning
11-14	Not used
15	This bit is always 0.

STATus:QUEStionable register

The `STATus:QUEStionable` register contains information on instrument states that do not meet the specifications.

The `STAT:QUES:SYNC` register is used by the applications and is thus described in the individual applications' user manuals.

You can read out the register with `STAT:QUES:COND` or `STAT:QUES:EVEN`.

The `STATus:QUEStionable` register "sums up" the information from all subregisters (e.g. bit 2 sums up the information for all `STATus:QUEStionable:TIMe` registers). For some subregisters, there can be separate registers for each active application instance. Thus, if a status bit in the `STATus:QUEStionable` register indicates an error, the error can have occurred in any of the application instance-specific subregisters. In this case, you must check the subregister of each application instance to determine which application instance caused the error. By default, querying the status of a subregister always returns the result for the currently selected application instance.

Table 4-41: Meaning of the bits used in the STATus:QUEStionable register

Bit No.	Meaning
0	`EXTended` This bit indicates further status information not covered by the other status registers in any of the active application instances.
1	Unused
2	`TIMe` A time error occurs in any of the active application instances. The STATus:QUEStionable:TIMe register provides more information on the error type.
3	`POWer` The measured power level in any of the active application instances is questionable. The STATus<ip>:QUEStionable:POWer register provides more information on the error type.
4	`TEMPerature` The temperature is questionable.
5	`FREQuency` There is anything wrong with the frequency of the local oscillator or the reference frequency in any of the active application instances. The STATus<ip>:QUEStionable:FREQuency register provides more information on the error type.
6 - 7	Unused

Bit No.	Meaning
8	CALibration The FSWX is unaligned ("UNCAL" display)
9	LIMit (device-specific) A limit value is violated in any of the active application instances in any window. The STATus:QUEStionable:LIMit register provides more information on the error type.
10	LMARgin (device-specific) A margin is violated in any of the active application instances in any window. The STATus:QUEStionable:LMARgin register provides more information on the error type.
11	SYNC (device-specific) The FSWX is not synchronized to the signal that is applied. The FSWX is not synchronized if: • it cannot synchronize to midamble during a measurement or premeasurement • it cannot find a burst during a measurement or premeasurement • the results deviate too much from the expected value during premeasurements
12	ACPLimit (device-specific) A limit during ACLR measurements is violated in any of the active application instances. The STATus:QUEStionable:ACPLimit register provides more information on the error type.
13	Unused
14	
15	This bit is always 0.

STATus:QUEStionable:ACPLimit register

The STATus:QUEStionable:ACPLimit register contains information about the results of a limit check during ACLR measurements. A separate ACPLimit register exists for each active application instance.

You can read out the register with STATus:QUEStionable:ACPLimit:CONDition or STATus:QUEStionable:ACPLimit[:EVENt].

Table 4-42: Meaning of the bits used in the STATus:QUEStionable:ACPLimit register

Bit No.	Meaning
0	ADJ UPPer FAIL The limit is exceeded in the **upper adjacent** channel.
1	ADJ LOWer FAIL The limit is exceeded in the **lower adjacent** channel.
2	ALT1 UPPer FAIL The limit is exceeded in the **upper 1st alternate** channel.
3	ALT1 LOWer FAIL The limit is exceeded in the **lower 1st alternate** channel.
4	ALT2 UPPer FAIL The limit is exceeded in the **upper 2nd alternate** channel.

Bit No.	Meaning
5	ALT2 LOWer FAIL The limit is exceeded in the **lower 2nd alternate** channel.
6	ALT3 to ALT11 LOWer/UPPer FAIL The limit is exceeded in one of the lower or upper alternate channels 3 to 11.
7	CACLR FAIL The CACLR limit is exceeded in one of the gap channels.
8	GAP ACLR FAIL The ACLR limit is exceeded in one of the gap channels.
9 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:EXTended register

The STATus:QUEStionable:EXTended register contains further status information not covered by the other status registers of the FSWX. A separate EXTended register exists for each active application instance.

You can read out the register with STATus:QUEStionable:EXTended:CONDition or STATus:QUEStionable:EXTended[:EVENt].

Table 4-43: Meaning of the bits used in the STATus:QUEStionable:EXTended register

Bit No.	Meaning
0	not used
1	INFO A status message is available for the application. Which type of message occurred is indicated in the STATus:QUEStionable:EXTended:INFO register.
2 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:EXTended:INFO register

The STATus:QUEStionable:EXTended:INFO register contains information on the type of messages that occur during operation of the FSWX. A separate INFO register exists for each active application instance.

You can read out the register with STATus:QUEStionable:EXTended:INFO:CONDition or STATus:QUEStionable:EXTended:INFO[:EVENt]. You can query all messages that occur for a specific application instance using the SYSTem:ERRor:EXTended command.

Table 4-44: Meaning of the bits used in the STATus:QUEStionable:EXTended:INFO register

Bit No.	Meaning
0	SUCCess The measurement was successful.
1	INFO An informational status message is available for the application.
2	WARNing An irregular situation occurred during measurement, e.g. the settings no longer match the displayed results, or the connection to an external device was interrupted temporarily.
3	ERRor An error occurred during a measurement, e.g. due to missing data or wrong settings, so that the measurement cannot be completed correctly.
4	FATal A serious error occurred in the application and regular operation is no longer possible.
5 to 14	Unused
15	This bit is always 0.

STATus<ip>:QUEStionable:FREQuency register

The STATus:QUEStionable:FREQuency register contains information about the condition of the local oscillator and the reference frequency. A separate frequency register exists for each active application instance.

You can read out the register with STATus<ip>:QUEStionable:FREQuency:CONDition or STATus<ip>:QUEStionable:FREQuency[:EVENt].

Table 4-45: Meaning of the bits used in the STATus:QUEStionable:FREQuency register

Bit No.	Meaning
0	OVEN COLD The reference oscillator has not yet attained its operating temperature. "OCXO" is displayed.
1	LO UNLocked The local oscillator no longer locks. "LOUNL" is displayed. This setting is input-specific. (Some applications allow you to define different center frequencies for each RF input.)
2 to 7	Not used
8	EXTernalREFerence You have selected an external reference oscillator but did not connect a usable external reference source. In that case the synthesizer cannot lock. Most likely, the frequency is not accurate.
9 to 14	Not used
15	This bit is always 0.

STATus:QUEStionable:LIMit register

The STATus:QUEStionable:LIMit register contains information about the results of a limit check when you are working with limit lines.

A separate LIMit register exists for each active application instance and for each window.

You can read out the register with STATus:QUEStionable:LIMit<1|2|3|4>:CONDition or STATus:QUEStionable:LIMit<1|2|3|4>[:EVENt].

Table 4-46: Meaning of the bits used in the STATus:QUEStionable:LIMit register

Bit No.	Meaning
0	LIMit 1 FAIL This bit is set if limit line 1 is violated.
1	LIMit 2 FAIL This bit is set if limit line 2 is violated.
2	LIMit 3 FAIL This bit is set if limit line 3 is violated.
3	LIMit 4 FAIL This bit is set if limit line 4 is violated.
4	LIMit 5 FAIL This bit is set if limit line 5 is violated.
5	LIMit 6 FAIL This bit is set if limit line 6 is violated.
6	LIMit 7 FAIL This bit is set if limit line 7 is violated.
7	LIMit 8 FAIL This bit is set if limit line 8 is violated.
8 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:LMARgin register

This register contains information about the observance of limit margins.

A separate LMARgin register exists for each active application instance and for each window and trace.

You can read it using the commands STATus:QUEStionable:LMARgin<1|2|3|4>:CONDition and STATus:QUEStionable:LMARgin<1|2|3|4>[:EVENt].

Table 4-47: Meaning of the bits used in the STATus:QUEStionable:LMARgin register

Bit No.	Meaning
0	`LMARgin 1 FAIL` This bit is set if the limit margin 1 is violated.
1	`LMARgin 2 FAIL` This bit is set if the limit margin 2 is violated.
2	`LMARgin 3 FAIL` This bit is set if the limit margin 3 is violated.
3	`LMARgin 4 FAIL` This bit is set if the limit margin 4 is violated.
4	`LMARgin 5 FAIL` This bit is set if the limit margin 5 is violated.
5	`LMARgin 6 FAIL` This bit is set if the limit margin 6 is violated.
6	`LMARgin 7 FAIL` This bit is set if the limit margin 7 is violated.
7	`LMARgin 8 FAIL` This bit is set if the limit margin 8 is violated.
8 to 14	Not used
15	This bit is always 0.

STATus<ip>:QUEStionable:POWer register

The `STATus:QUEStionable:POWer` register contains information about overload situations that occur during operation of the FSWX. A separate power register exists for each active application instance and each input source or stream.

You can read out the register with `STATus<ip>:QUEStionable:POWer:CONDition` or `STATus<ip>:QUEStionable:POWer[:EVENt]`.

Table 4-48: Meaning of the bits used in the STATus:QUEStionable:POWer register

Bit No.	Meaning
0	`OVERload` An overload occurs at the RF input, causing signal distortion but not yet damaging the device. The FSWX displays the keyword "RF OVLD".
1	Unused
2	`IF_OVerload` An overload occurs in the IF path. The FSWX displays the keyword "OVLD".

Bit No.	Meaning
3	`Input Overload` The signal level at the RF input connector exceeds the maximum. The RF input is disconnected from the input mixer to protect the device. To re-enable measurement, decrease the level at the RF input connector and reconnect the RF input to the mixer input. For details on the protection mechanism see "RF input protection" on page 115 or `INPut<ip>:ATTenuation:PROTection:RESet` on page 553. The FSWX displays the keyword "INPUT OVLD".
4 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:SYNC register

This register contains information about the state of the I/Q data acquisition.

The status of the `STATus:QUESTionable:SYNC` register is indicated in bit 11 of the `STATus:QUESTionable` register.

You can read out the state of the register with `STATus:QUEStionable:SYNC:CONDition` on page 885 and `STATus:QUEStionable:SYNC[:EVENt]` on page 885.

Bit No.	Meaning
	not used
8	**I/Q data acquisition error** This bit is set if an error occurs during I/Q data acquisition because the input sample rates or number of samples between the signal source and the FSWX do not match.
9-14	not used
15	This bit is always set to 0.

STATus:QUEStionable:TEMPerature register

The `STATus:QUEStionable:TEMPerature` register contains information about temperature deviations that occur during operation of the FSWX. A separate temperature register exists for each active application instance.

You can read out the register with `STATus:QUEStionable:TEMPerature:CONDition` or `STATus:QUEStionable:TEMPerature[:EVENt]`.

Table 4-49: Meaning of the bits used in the STATus:QUEStionable:TEMPerature register

Bit No.	Meaning
0	The frontend temperature sensor deviates by a certain degree from the self-alignment temperature. During warm-up, this bit is always 1. For details see "Temperature check" on page 420.
1 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:TIMe register

The `STATus:QUEStionable:TIMe` register contains information about time errors that occur during operation of the FSWX. A separate time register exists for each active application instance.

You can read out the register with `STATus:QUEStionable:TIME:CONDition` or `STATus:QUEStionable:TIME[:EVENt]`.

Table 4-50: Meaning of the bits used in the STATus:QUEStionable:TIMe register

Bit No.	Meaning
0	not used
1	`Sweep time too low` The sweep time is too low.
2 to 14	Unused
15	This bit is always 0.

STATus:QUEStionable:TRANsducer register

The `STATus:QUEStionable:TRANsducer` register contains information about transducer errors that occur during operation of the FSWX. A separate transducer register exists for each active application instance.

You can read out the register with `STATus:QUEStionable:TRANsducer:CONDition` or `STATus:QUEStionable:TRANsducer[:EVENt]`.

Table 4-51: Meaning of the bits used in the STATus:QUEStionable:TRANsducer register

Bit No.	Meaning

4.13.3.3 Reset values of the status reporting system

The following table contains the different commands and events causing the status reporting system to be reset. None of the commands, except `*RST` and

SYSTem:PRESet, influence the functional instrument settings. In particular, DCL does not change the instrument settings.

Table 4-52: Resetting the status reporting system

Event	Switching on supply voltage Power-On-Status-Clear		DCL, SDC (Device Clear, Selected Device Clear)	*RST or SYSTem:PRESet	STATus:PRESet	*CLS
Effect	0	1				
Clear STB, ESR	-	yes	-	-	-	yes
Clear SRE, ESE	-	yes	-	-	-	-
Clear PPE	-	yes	-	-	-	-
Clear EVENt parts of the registers	-	yes	-	-	-	yes
Clear ENABle parts of all OPERation and QUEStionable registers; Fill ENABle parts of all other registers with "1".	-	yes	-	-	yes	-
Fill PTRansition parts with "1"; Clear NTRansition parts	-	yes	-	-	yes	-
Clear error queue	yes	yes	-	-	-	yes
Clear output buffer	yes	yes	yes	1)	1)	1)
Clear command processing and input buffer	yes	yes	yes	-	-	-
1) The first command in a command line that immediately follows a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.						

4.13.4 Automating tasks with remote command scripts

To configure a test setup quickly and make complex test setups or repetitive measurements reproducible, you can automate the required settings with scripts. A script contains a series of SCPI commands corresponding to the settings. When completed, it is converted to an executable format, saved in a file, and can be run whenever needed.

Creating a SCPI script

Using the "SCPI Recorder" functions, you can create a SCPI script directly on the instrument and then export the script for use on the controller. You can also edit or write a script manually, using a suitable editor on the controller. For manual creation, the instrument supports you by showing the corresponding command syntax for the current setting value.

You can create a SCPI script directly on the instrument at any time of operation, in the following ways:

- Recording all performed steps automatically
  The instrument records the SCPI command and settings value of each step that you perform, and then writes the commands to the file system. You can start, stop and resume automatic recording, and also record individual commands manually.
  See "How to record SCPI commands automatically" on page 512.
- Recording individual steps manually
  In manual recording mode, you can record an individual SCPI command using the "Add SCPI Command to Recording" function, see "How to record SCPI commands manually" on page 513.
- Copying commands from the context-sensitive "SCPI Recorder" menu and pasting them into an editor
  The "SCPI Recorder" allows you to copy the SCPI command and the current setting shown in the context-sensitive menu and paste them into any suitable editor, see "To edit a SCPI command list" on page 513.

4.13.4.1 Context-sensitive SCPI command menu

The "SCPI Recorder" provides information on the required SCPI command for the available measurement settings, functions, and results in a context-sensitive menu. To display the SCPI command menu, tap and hold (right-click) any interface element that allows you to define a setting, perform a function, or displays results, for example:

- Softkeys
- Buttons or input fields in dialog boxes
- Traces or markers in a diagram



Figure 4-57: Context-sensitive SCPI command menu for a trace in a result display

The menu provides the syntax of the remote command with the current setting, and some functions to help you create your script.

Show SCPI result query commands 505
Show SCPI command 506
└ Copy SCPI Command to Clipboard 506
└ Help 506
└ Add SCPI Command to Recording 506
Help 506

Show SCPI result query commands
This menu item is displayed for a result display.

All possible commands to query the results in the display are shown. Select the query command that you are interested in to display the SCPI command dialog box, as described in "Show SCPI command" on page 506.

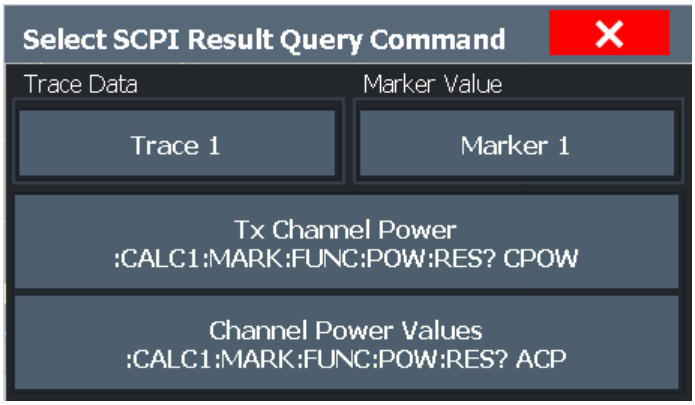


Figure 4-58: Possible result query commands for an ACLR measurement

Show SCPI command
This menu item is displayed for a setting or function.

A dialog box displays the SCPI command required to perform the setting or function.

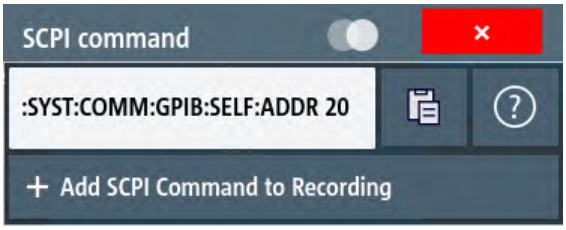


Figure 4-59: SCPI command dialog for a setting in a dialog



Copy SCPI Command to Clipboard ← Show SCPI command
Copies the command and the current value for the selected setting to the clipboard.



Help ← Show SCPI command
Provides help on the displayed SCPI command, its syntax and possible parameter values.

Add SCPI Command to Recording ← Show SCPI command
Adds the command and the current value for the selected setting to the recorded SCPI list.

Help
Provides help on the selected setting, function, or result display, as opposed to the SCPI command itself. This function is identical to selecting the context-sensitive help icon in the toolbar and then the interface element.

4.13.4.2 SCPI recorder



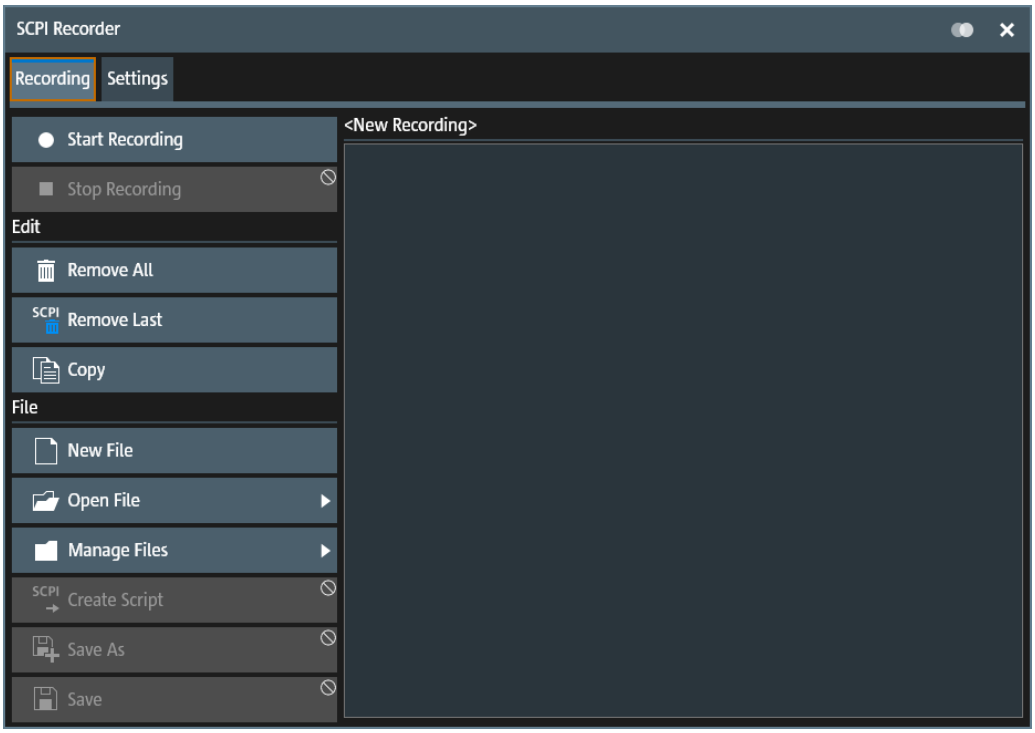
Access: Toolbar

The "SCPI Recorder" displays a list of the currently recorded commands and provides functions to create and export a script of SCPI commands. Some additional settings for recording are available.

- Managing recordings....507
- Recorder settings....510

Managing recordings

You can manage existing recordings in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpirecordings` directory directly from the "SCPI Recorder".



Start Recording / Stop Recording.... 508
Current recording / script editor....508
Remove All....508
Remove Last....508
Copy....508
New File.... 508
Open File....508
Manage Files....509
Create Script (export)....509
Save As....510
Save....510

Start Recording / Stop Recording
When you start recording, the "SCPI Recorder" automatically records the required SCPI commands and parameter values for the settings and functions you use while operating the FSWX.

To view the list of currently recorded SCPI commands at any time, select the "SCPI Recorder" icon in the toolbar.

To stop recording, select "Stop Recording".

To continue recording, select "Start Recording" again.

To start a new SCPI command list, select Remove All before selecting "Start Recording".

Note:
- Some parameters cannot be set by a SCPI command.
- The FSWX automatically clears the SCPI command list after booting.

Remote command:
`SYSTem:SRECorder[:AUTO]` on page 890

Current recording / script editor
The currently recorded commands are displayed in a basic editor directly in the "SCPI Recorder" dialog box. You can edit the commands directly in the editor, e.g. to correct a parameter value. When you edit a recorded or loaded script in the editor, an asterisk (*) is indicated next to the script title.

Remote command:
`SYSTem:SRECorder:DATA[:ALL]?` on page 891

Remove All
Removes all recorded commands from the current SCPI command list.

Remote command:
`SYSTem:SRECorder:CLEar` on page 891

Remove Last
Deletes the most recently recorded SCPI command from the list.

Copy
Copies the current recording to the clipboard.

Remote command:
`SYSTem:SRECorder:DATA[:ALL]?` on page 891

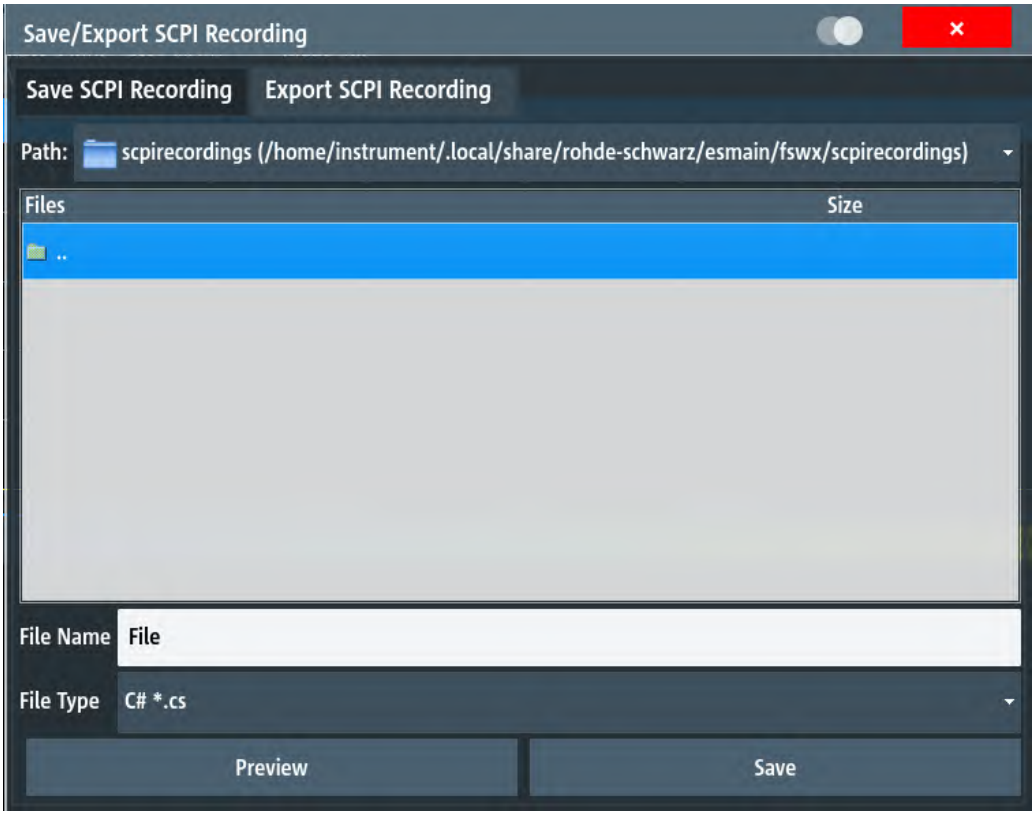
New File
Starts a new recording file. If the editor contains recorded commands, you must confirm a message to overwrite them.

Open File
Loads an existing script in ASCII format (`*.inp`) from a file to the script editor. If the editor contains recorded commands, you must confirm a message to overwrite them. A file selection dialog box is displayed.

Manage Files
Opens the operating system file manager to manage the scpi recording files.

The default scpi directory home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpirecordings is opened.

Create Script (export)
Exports the current SCPI command list to the specified file and directory in the selected format. By default, the file is stored in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpirecordings` directory. Besides the recorded commands themselves, the exported script includes all format-specific header data required to execute the script using an external program on the controller.



Before storing the file, you can display a **"Preview"** of the file in the selected format.

Currently, the following file formats are supported:

"C#"	A commonly used general programming language for various applications (`*.cs`)
"C++"	A commonly used general programming language for various applications (`*.cpp`)
"MATLAB® (Instrument Control Toolbox)"	A programming environment, frequently used in signal processing and test and measurement applications (`*.m`) You can use this format directly with the MATLAB® Instrument Control Toolbox.

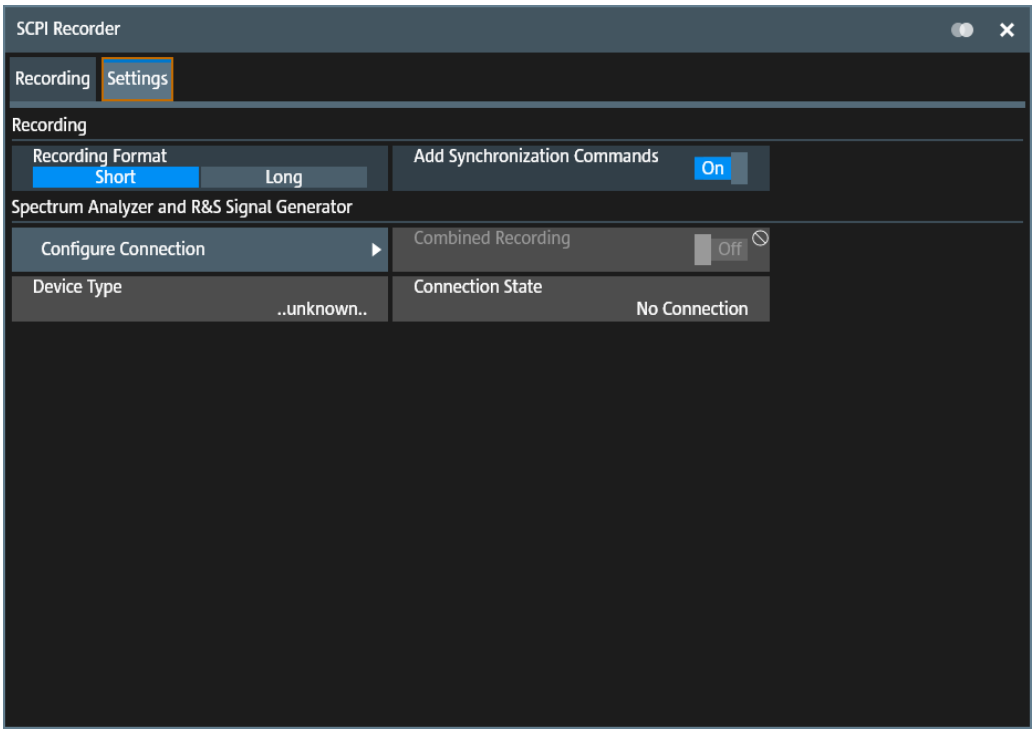
"MATLAB® (R&S Toolkit)"	You can use this format directly with the MATLAB® Toolkit (`*.m`).
"NICVI"	An ANSI C programming environment designed for measurements and tests (`*.cvi`) You can use this format directly with National Instruments LabWindows CVI.
"Plain SCPI"	Represents SCPI base format, that is ASCII format, saved as a text file (`*.inp`); contains no additional header data. Use this format to load a recorded script back to the editor later.
"Python"	A commonly used general programming language for various applications (`.py`)

Remote command:
`SYSTem:SRECorder:EXPort` on page 893

Save As
Saves the current SCPI command list to a new file in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpirecordings` directory in ASCII format with the file extension `.inp`.

Save
Saves the current SCPI command list to the currently loaded or most recently saved `.inp` recording file.

Recorder settings



Some additional settings are available to configure the exported SCPI command files.

Recording Format....511
Add Synchronization Commands....511
Combined Recording of spectrum analyzer and R&S signal generator....511
Configure Connection....511
Connect....511
Device Type....511
Connection State....511

Recording Format
Defines whether the commands are recorded using the short or long SCPI notation.

"Short" The shortform of the keyword is used.
Example: `FREQ:CENT`

"Long" The entire keyword is used.
Example: `FREQuency:CENTer`

Remote command:
`SYSTem:SRECorder:FORMat` on page 894

Add Synchronization Commands
If enabled, additional commands are included in the script to synchronize the recorded commands when necessary. For instance, when a measurement is started, a `*WAI` command is inserted to ensure that the next command is only executed after the measurement has finished.

Remote command:
`SYSTem:SRECorder:SYNC` on page 894

Combined Recording of spectrum analyzer and R&S signal generator
If enabled, the "SCPI Recorder" records commands both from the FSWX and from a connected Rohde & Schwarz signal generator.

Remote command:
`CONFigure:GENerator:RECording:COMBine` on page 895

Configure Connection
Configures the connection to the signal generator.

See "IP Address or Host Name" on page 524.

If a connection to a signal generator is already configured, the connection data is provided for information only.

Connect
Connects the FSWX to the specified signal generator.

Remote command:
`CONFigure:GENerator:CONNection[:STATe]` on page 864

Device Type
If connected, the device type of the signal generator is indicated.

Connection State
Indicates the state of the connection to the specified signal generator.

Remote command:
CONFigure:GENerator:CONNection:CSTate? on page 863

4.13.4.3 How to determine the required SCPI command

The "SCPI Recorder" provides information on the required SCPI command for the available measurement settings, functions, and results in a context-sensitive menu.

1. Define the setting, or navigate to the function you need the SCPI command for.
   To find the query command for trace or marker results, select the result diagram.
2. On the screen, tap and hold, or right-click the measurement setting, function, or result display.

   The context-sensitive menu for that particular setting, function, or result is displayed.

   Tip: If the SCPI command menu is not displayed, you probably tapped outside of a softkey or input field, for example in a block diagram. Tap within the corresponding softkey, button or input field, or in a result display, to display the context-sensitive SCPI command menu.
3. Select "Show SCPI result query commands" or "Show SCPI command", depending on which item you selected.

   A dialog box with the required command and some functions is displayed.
   If multiple commands are possible, for example to query different measurement results, all possible commands are displayed.
4. To display the SCPI command dialog box for a query command, select the query command you are interested in from the list.

4.13.4.4 How to create and export SCPI scripts

Using the "SCPI Recorder" functions, you can create a SCPI script directly on the instrument and then export the script for use on the controller. The "SCPI Recorder" allows you to record SCPI command lists either automatically or manually.

How to record SCPI commands automatically

The following procedure explains how to record SCPI commands automatically during operation.



1. On the toolbar, select the "SCPI Recorder" icon.

   The "SCPI Recorder" dialog box is displayed.
2. Select "Start Recording".

   From now on, the commands required to execute all steps you perform on the instrument are recorded.
3. To query results in the SCPI script:

a) Right-click (or tap and hold) in the result display.
   All possible commands to query the results in the diagram are displayed in the SCPI command menu.
b) Select the results you want to query.
c) Select "Add SCPI Command to Recording".

4. To stop SCPI recording, select the "SCPI Recorder" icon again.

   The "SCPI Recorder" dialog box with the recorded command list is displayed.

5. Select "Stop Recording".

6. Save the recorded command list to a file for later use.

   a) Select "Save As".
   b) Define a filename for the script file.

How to record SCPI commands manually

1. Determine the required SCPI command as described in Section 4.13.4.3, "How to determine the required SCPI command", on page 512.

2. From the SCPI command dialog box, select "Add SCPI Command to Recording".

   The command is added to the "SCPI Recorder" command list.

3. Repeat these steps for any settings, functions, or results you want to record.



4. To check the progress of the recording, select the "SCPI Recorder" icon in the toolbar.

   The "SCPI Recorder" dialog box with the currently recorded command list is displayed.

5. Save the recorded command list to a file for later use.

   a) Select "Save As".
   b) Define a filename for the script file.

To edit a SCPI command list

You can edit all command lists after recording, either directly on the instrument or in any suitable editor on the controller. The following functions describe how to edit the SCPI command list directly in the "SCPI Recorder" dialog box.



1. On the toolbar, select the "SCPI Recorder" icon.

   The "SCPI Recorder" dialog box with the currently recorded command list is displayed.



2. To load a stored script in ASCII format:
   a) In the "SCPI Recorder" dialog box, select "Open file".
   b) If necessary, confirm the message to overwrite existing commands in the editor.
   c) Select the stored `*.inp` file.
   d) Select "Select".

   The stored commands are displayed in the editor.
3. To remove the most recently recorded command, select "Remove Last" in the "SCPI Recorder" dialog box.
4. Edit or remove any other command in the recorded command list as in a common editor.
5. Select "Save As" to store the changes to the script.

How to check a SCPI script

The easiest way to check a script is to execute it.

Some suggestions on how you can check and improve a recorded SCPI script:

- Remove unnecessary commands written after a preset.
- Rearrange the commands to a reasonable order. For example, if you move a `STATe` command to the end of your script, you can avoid intermediate calculations of the signal.
- Check the script for completeness by comparing its results with the modified settings in manual mode.

How to export a SCPI script

When you save a command list to a file, only the recorded commands are stored in a text file. However, to execute a script in an external programming environment, it requires additional header data according to the specific format.



1. On the toolbar, select the "SCPI Recorder" icon.

   The "SCPI Recorder" dialog box with the currently recorded command list is displayed.
2. Select "Create Script".
3. Define a filename and storage location for the script file.
4. Select the "File Type" which defines the format of the script.
5. Select "Save".

   A script with the required header data for the selected format is stored to a file.

4.13.4.5 Example for a recorded SCPI script

The following example shows a recorded SCPI script in Python format. The script configures the ACLR measurement example described in "Measurement example 1 – ACPR measurement on a 5G DL signal" on page 1127.

```
# python script created by : 13:02:2025 12:21:08

import pyvisa as visa

def write_command(instrument, command) :
    instrument.write(command)
    return process_system_error(instrument)

def write_query(instrument, command) :
    buffer = instrument.query(command)
    bSuccess = process_system_error(instrument)
    return bSuccess, buffer

def process_system_error(instrument) :
    bSuccess = True
    EsrErrorMask = 0x3C
    if ((get_esr(instrument) & EsrErrorMask) != 0) :
        print(instrument.query(":SYST:ERR?"))
        instrument.write("*CLS")
        bSuccess = False
    return bSuccess

def get_esr(instrument) :
    esr = instrument.query("*ESR?")
    return int(esr)


VisaResourceManager = visa.ResourceManager()

# connect to analyzer
Analyzer = VisaResourceManager.open_resource("TCPIP::127.0.0.1::inst0::INSTR")

success = write_command( Analyzer, "*RST" )

success = write_command( Analyzer, "*CLS" )

success = write_command( Analyzer, ":SYST:DISP:UPD ON" )

success = write_command( Analyzer, ":INIT:CONT OFF" )

success = write_command( Analyzer, ":SENS1:FREQ:CENT 850000000" )

success = write_command( Analyzer, ":SENS1:FREQ:SPAN 4000000" )
```

```
success = write_command( Analyzer, ":INP1:RLEV 10" )

success = write_command( Analyzer, ":CALC:MARK:FUNC:POW:PRES S2CD" )

# added by SCPI recorder for synchronization
success = write_command( Analyzer, ":SENS1:ADJ:LEV;*WAI" )

# added by SCPI recorder for synchronization
success = write_command( Analyzer, ":INIT:IMM;*WAI" )

success, result = write_query( Analyzer, ":TRAC1:DATA? TRACE1" )

success, result = write_query( Analyzer, ":CALC1:MARK:FUNC:POW:RES? CPOW" )

success, result = write_query( Analyzer, ":CALC1:MARK:FUNC:POW:RES? ACP" )


# back to local mode
success = write_command(Analyzer, "@LOC")

# cleanup
Analyzer.close()
VisaResourceManager.close()
```

4.13.5 Network and remote control settings

Access: > "Network & Remote"

The remote commands required to define these settings are described in Section 4.14.13.6, "Configuring the network and remote control", on page 851.

- Network settings....516
- General remote control (GPIB) settings....517
- Remote Compatibility settings....519
- Remote errors....522
- Signal generator settings....523
- Returning to manual mode ("local")....525

4.13.5.1 Network settings

Access: > "Network & Remote" > "Network" tab

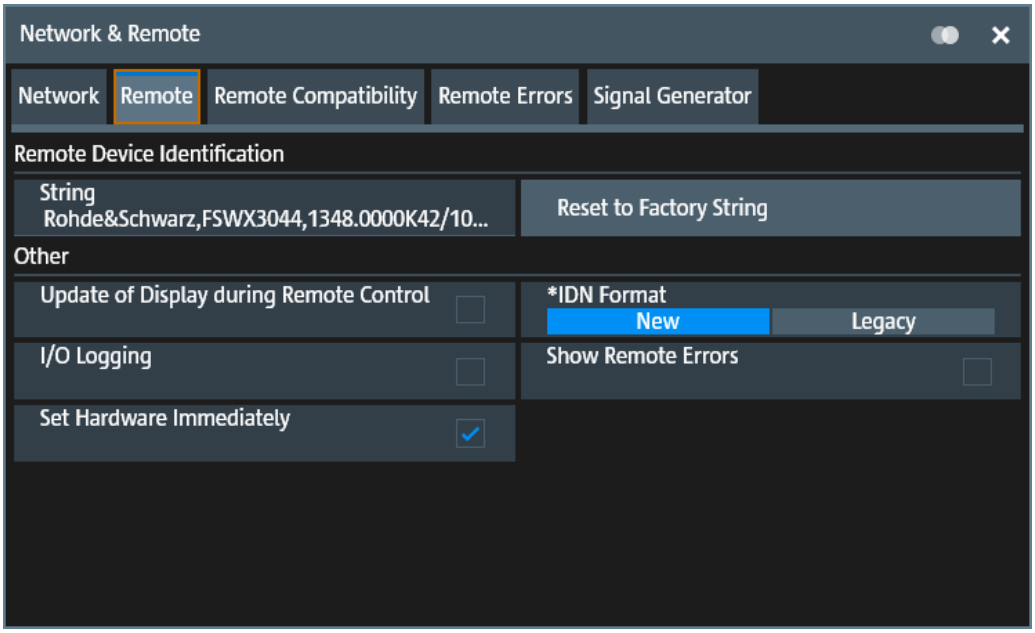
You can connect the FSWX to a local area network (LAN). For details see Section 4.13.1, "Remote control interfaces and protocols", on page 480).

The network settings are defined in the common system dialog. See Section 4.12.3.5, "Network settings", on page 467 .

4.13.5.2 General remote control (GPIB) settings

Access: > "Network & Remote" > "Remote" tab

As an alternative to connecting the FSWX to a LAN, you can use the optional GPIB interface to connect a remote PC. For details see Section 4.13.1, "Remote control interfaces and protocols", on page 480).



Remote Device Identification String....517
Reset to Factory String....517
GPIB Address....518
GPIB Terminator....518
Update Display during Remote Control....518
*IDN Format....518
I/O Logging....518
Show Remote Errors....519
Set Hardware Immediately....519

Remote Device Identification String
Defines the identification string for the FSWX which is provided as a response to the `*IDN?` query. A maximum of 36 characters are allowed.

Remote command:
`SYSTem:IDENtify[:STRing]` on page 854

Reset to Factory String
Restores the default identification string. Each FSWX has a unique ID according to the following syntax:

Rohde&Schwarz,FSWX3026,<Unique number>,1.00

Remote command:
`SYSTem:IDENtify:FACTory` on page 854

GPIB Address
Defines the GPIB address. Values from 0 to 30 are allowed. The default address is 20.

Remote command:
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess on page 852

GPIB Terminator
Changes the GPIB receive terminator.

"LFEOI" According to the standard, the terminator in ASCII is <LF> and/or <EOI>.

"EOI" For binary data transfers (e.g. trace data) from the control computer to the instrument, the binary data block can include the binary code used for <LF>. Thus, the binary code should not be interpreted as a terminator in this particular case. You can avoid misinterpretation by using only the receive terminator EOI.

Remote command:
SYSTem:COMMunicate:GPIB[:SELF]:RTERminator on page 852

Update Display during Remote Control
Defines whether the display of the FSWX is updated when changing from manual operation to remote control.

Turning off the display update function improves performance during remote control.

Note: Usually, this function remains available on the display during remote operation. However, it can be disabled remotely. In this case, the display is not updated during remote operation, and cannot be turned on again locally until local operation is resumed.

Remote command:
SYSTem:DISPlay:UPDate on page 853
SYSTem:DISPlay:LOCK on page 853

***IDN Format**
Defines the response format to the remote command *IDN? (see *IDN? on page 537). This function is intended for re-use of existing control programs together with the FSWX.

"New" FSWX format.

"Legacy" Legacy format, as in the R&S FSP/FSU/FSQ family.

Remote command:
SYSTem:FORMat:IDENt on page 862

I/O Logging
Activates or disables the SCPI error log function. All remote control commands received by the FSWX are recorded in a log file. The files are stored in the directory:

home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpilogging

They are named according to the following syntax:

ScpiLog.<no.>

Where <no.> is a sequential number

A new log file is started each time logging was stopped and is restarted.

Logging the commands can be extremely useful for debug purposes, e.g. to find misspelled keywords in control programs.

Remote command:
SYSTem:CLOGging on page 889

Show Remote Errors
Activates and disables the display of errors that occur during remote operation of the FSWX. If enabled, the FSWX displays a message box at the bottom of the screen that contains the type of error and the command that caused the error.



The error message remains in place when you switch to "Local" mode. To close the message box, select the "Close" icon.

Only the most recent error is displayed in remote mode. However, in local mode, all errors that occurred during remote operation are listed in a separate tab of the "Network & Remote" dialog box (see Section 4.13.5.4, "Remote errors", on page 522).

Remote command:
SYSTem:ERRor:DISPlay on page 853

Set Hardware Immediately
Determines when to execute the remote commands that change hardware settings on the FSWX.

If enabled (default), the FSWX always executes the remote commands immediately when it receives them.

If disabled, the FSWX only executes remote commands that cause changes to the hardware when it receives a command for which the hardware settings are relevant.

Regardless of this setting, the FSWX automatically sets the hardware before it starts a sweep.

Postponing hardware changes is useful, for example, when switching application instances. When you switch application instances, the settings from the previous instance are used by default. However, if you have to change the frequency and level values for the new application instance, the default settings cause unnecessary hardware settling times.

This setting is not changed by the preset function.

Remote command:
SYSTem:SHIMmediate:STATe on page 856
SYSTem:SHIMmediate on page 855

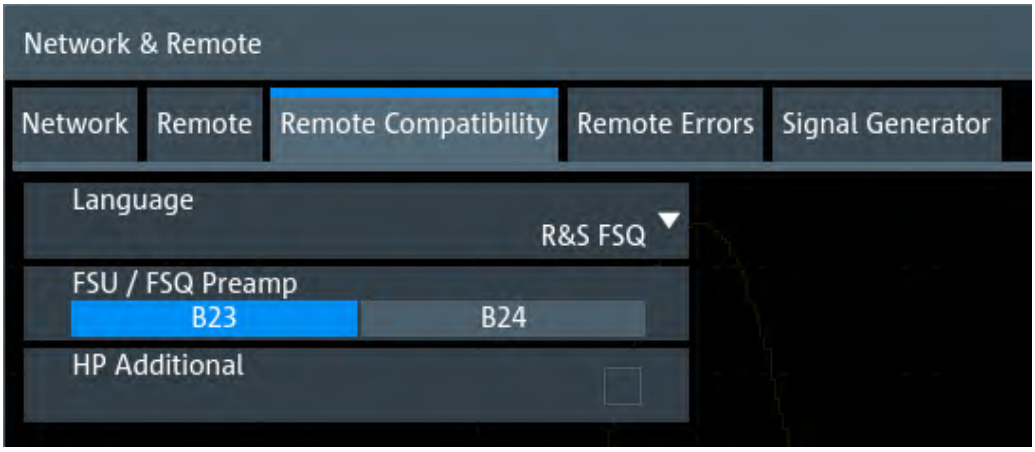
4.13.5.3 Remote Compatibility settings

Access: > "Network & Remote" > "Compatibility" tab

The FSWX can emulate the GPIB interface of other signal and spectrum analyzers, e.g. to use existing control applications.

Compatibility with former R&S signal and spectrum analyzers

As a rule, the FSWX supports most commands from previous Rohde & Schwarz signal and spectrum analyzers such as the FSW or FSV. However, the default values, in particular the number of sweep points or particular bandwidths, vary. Therefore, the FSWX can emulate these other devices, including their default values, to repeat previous measurements or support existing control applications as in legacy systems.



Language 520
FSU/FSQ Preamp 521
Wideband 521
HP Additional 521
IF Gain 521
Sweep Repeat 521
Coupling 522
Revision String 522
Reset Revision String to Factory Revision 522

Language

Defines the system language used to control the instrument.

Note: Emulating previous Rohde & Schwarz signal and spectrum analyzers. This function is also used to emulate previous Rohde & Schwarz signal and spectrum analyzers. As a rule, the FSWX supports most commands from previous Rohde & Schwarz signal and spectrum analyzers such as the FSW, FSV, FSQ, FSP, or FSU. However, the default values, in particular the number of sweep points or particular bandwidths, vary. Therefore, the FSWX can emulate these other devices, including their default values, to repeat previous measurements or support existing control applications as in legacy systems.

For R&S FSP/FSQ/FSU emulation, HP commands are not automatically also allowed. In this case, set HP Additional to `ON`.

Note: For PSA89600 emulation, the option is indicated as "B7J" for the `*OPT?` query ("B7J, 140" or "B7J, 122" if Wideband is enabled, see`SYSTem:PSA:WIDeband` on page 897).

Remote command:
`SYSTem:LANGuage` on page 897

FSU/FSQ Preamp
Prerequisite: R&S FSQ/FSU emulation (see "Language" on page 520)

Defines whether commands apply to the optional B23 or B24 preamplifier.

Wideband
Prerequisite: PSA89600 emulation (see "Language" on page 520)

This setting defines which option is returned when the `*OPT?` query is executed, depending on the state of the wideband option.

"Off" No wideband is used.
The option is indicated as "B7J".

"40 MHz" The 40 MHz wideband is used.
The option is indicated as "B7J, 140".

"80 MHz" The 80 MHz wideband is used.
The option is indicated as "B7J, 122".

Remote command:
`SYSTem:PSA:WIDeband` on page 897

HP Additional
Allows the use of HP commands *in addition to* SCPI commands for R&S FSP/FSQ/FSU emulation (see "Language" on page 520).

Remote command:
`SYSTem:HPADditional` on page 896

IF Gain
Prerequisites:
- HP emulation (see "Language" on page 520)
- Resolution bandwidth < 300 kHz

Configures the internal IF gain settings due to the application needs.

"NORM"	Optimized for high dynamic range, the overload limit is close to reference level.
"PULS"	Optimized for pulsed signals, overload limit up to 10 dB above reference level.

Remote command:
`SYSTem:IFGain:MODE` on page 896

Sweep Repeat
Prerequisite: HP emulation (see "Language" on page 520)

Controls a repeated sweep of the E1 and MKPK HI HP model commands (for details on the commands refer to Section 4.14.17.2, "Reference: GPIB commands of emulated HP models", on page 899). If the repeated sweep is OFF, the marker is set without sweeping before.

Note: In single sweep mode, switch off this setting before you set the marker via the E1 and MKPK HI commands to avoid sweeping again.

Remote command:
`SYSTem:RSWeep` on page 898

Coupling
Prerequisite: HP emulation (see "Language" on page 520)

Controls the default coupling ratios for:

- Span and resolution bandwidth (Span/RBW)
- Resolution bandwidth and video bandwidth (RBW/VBW)

For FSx, the standard parameter coupling of the instrument is used. As a result, usually a shorter sweep time is used than for HP.

Remote command:
`SYSTem:HPCoupling` on page 896

Revision String
Prerequisite: HP emulation (see "Language" on page 520)

Defines the response to the `REV?` query for the revision number.

Max. 36 characters are allowed.

Remote command:
`SYSTem:REVision[:STRing]` on page 898

Reset Revision String to Factory Revision
Prerequisite: HP emulation (see "Language" on page 520)

Resets the response to the `REV?` query for the revision number to the factory default.

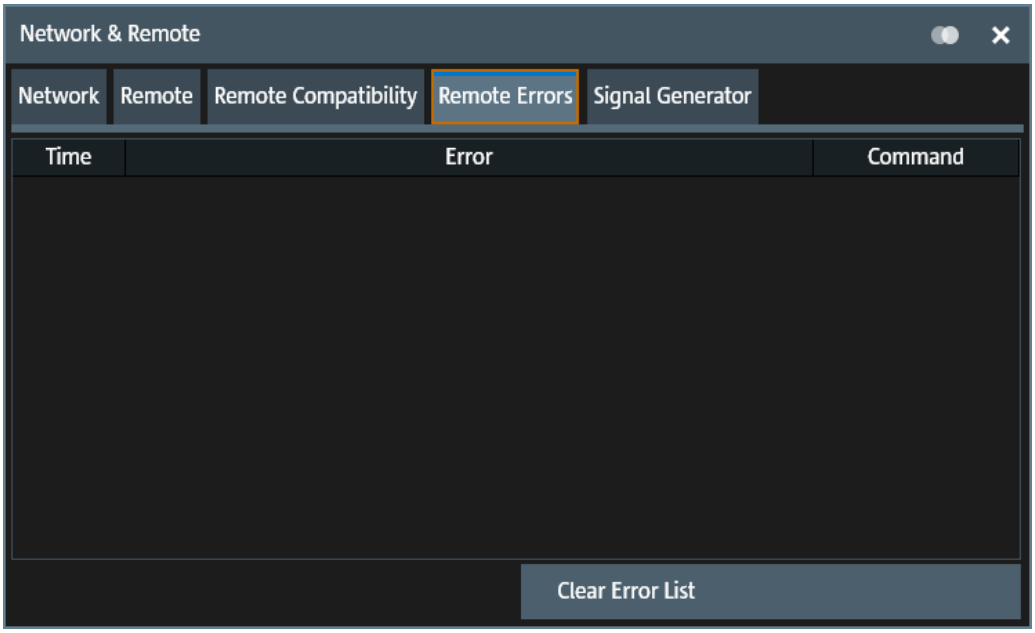
Remote command:
`SYSTem:REVision:FACTory` on page 855

4.13.5.4 Remote errors

Access: > "Network & Remote" > "Remote Errors" tab

The error messages generated by the FSWX during remote operation are displayed here.

The messages are displayed in the order of their occurrence; the most recent messages are placed at the top of the list.



The most recent error message during remote operation can be displayed on the screen, see "Show Remote Errors" on page 519.

If the number of error messages exceeds the capacity of the error buffer, the oldest error message is removed before the newest one is inserted. To clear the message buffer use Clear Error List. It is automatically cleared when you shut down the FSWX.

The following information is available:

No	Device-specific error code
Error	Brief description of the error
Date/Time	Time the message occurred

Remote command:

`SYSTem:ERRor:LIST?` on page 861

Clear Error List
Deletes the error message buffer for remote operation.

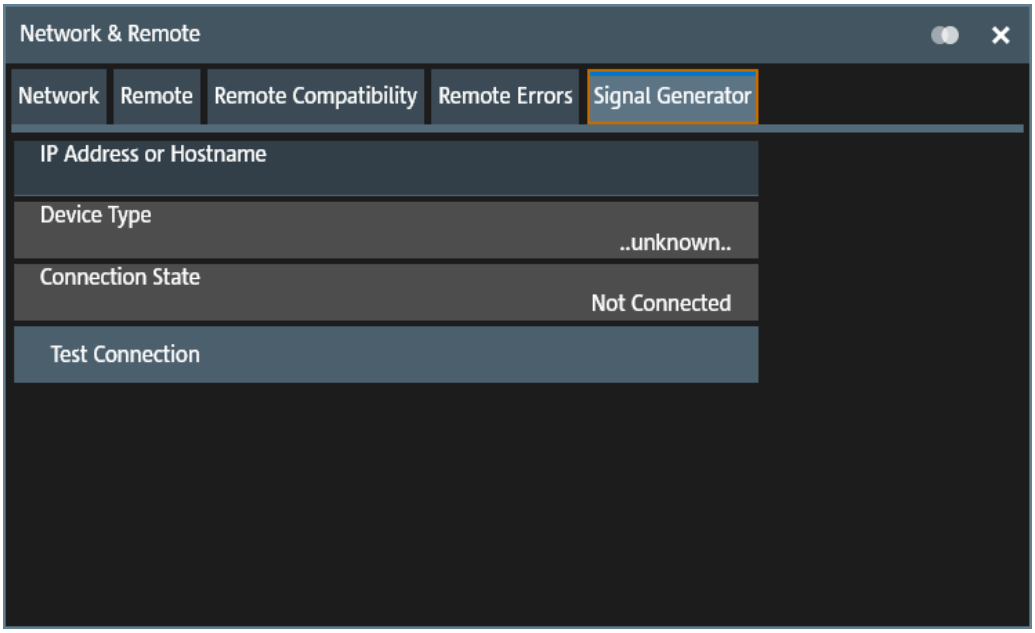
Note: The remote error list is automatically cleared when you shut down the FSWX.

Remote command:
`SYSTem:ERRor:CLEar:REMote` on page 860

4.13.5.5 Signal generator settings

Access: > "Instrument Configuration" > "Network & Remote" > "Signal Generator"

You can configure a connected signal generator for various tasks, for example for external generator control or NPR measurements.



IP Address or Host Name 524
Device Type 524
Connection State 524
Test Connection 525

IP Address or Host Name
The IP address or computer name of the signal generator connected to the FSWX via LAN.

For tips on how to determine the default computer name, see the signal generator's user documentation.

Note:

You cannot change the connection information while a connection to a signal generator is established.

The IP address / computer name is maintained after [Preset], and is transferred between application instances. However, when you switch application instances, the control is disabled in the other application instances. Only one application instance can control a generator at any time.

If a connection to a signal generator is already configured, the connection data is provided for information only.

Remote command:
`CONFigure:GENerator:IPConnection:ADDRess` on page 864

Device Type
If connected, the device type of the signal generator is indicated.

Connection State
Indicates the state of the connection to the specified signal generator.

Remote command:
CONFigure:GENerator:CONNection:CSTate? on page 863

Test Connection
The FSWX attempts to establish a connection to the specified signal generator.

If an instrument is connected, the following information is displayed:
- Device type
- Name and serial number
- Connection state

Remote command:
CONFigure:GENerator:CONNection[:STATe] on page 864

4.13.5.6 Returning to manual mode ("local")

When switched on, the instrument is always in manual measurement mode and can be operated via the front panel. As soon as the instrument receives a remote command, it switches to remote control mode.

In remote control mode, all instrument keys are disabled. The "LOCAL" softkey and the Update Display during Remote Control softkey are displayed.

Local
The instrument switches from remote to manual operation.

Note:
- If the local lockout function (`LLO` or `SYST:KLOC ON`) is enabled in remote control mode, manual operation is no longer available until you execute `GTL` (or `SYST:KLOC OFF`).
- Before you switch back to manual operation, all remote command processing must be completed. Otherwise, the instrument switches back to remote control immediately.
- If you select "Local" while a self-alignment or a self-test is still running (which was started remotely), the instrument only returns to the manual operation state when the alignment or test is completed.

Furthermore, when you return to manual operation, the following happens:
- All front panel keys are enabled.
- The main softkey menu of the current mode is displayed.
- The measurement diagrams, traces and display fields are displayed again.
- If, at the time of selecting "LOCAL", the synchronization mechanism via `*OPC`, `*OPC?` or `*WAI` is active, the currently running measurement procedure is aborted and synchronization is achieved by setting the corresponding bits in the registers of the status reporting system.
- Bit 6 (`User Request`) of the `Event` status register is set.
  If the status reporting system is configured accordingly, this bit immediately causes the generation of a service request (SRQ) to inform the control software that the user wishes to return to front panel control. For example, this can be used to interrupt the control program and to correct instrument settings manually. This bit is set each time you select "LOCAL".

Remote command:
`SYST:COMM:INT:REM OFF`, see `SYSTem:COMMunicate:INTernal:REMote` on page 852

4.13.6 How to set up a network and remote control

Remote operation

You can operate the instrument remotely from a connected computer in a LAN using the device web. The device web is a web interface to the instrument from the LAN. For details, see Section 4.13.2.4, "Web control", on page 487

Remote control

You can also control the instrument remotely from a connected computer using SCPI commands. Before you send remote commands, configure the instrument in a LAN network or connect it to a device via the GPIB interface as described in Section 4.13.6.1, "How to configure a network", on page 526.

Remote Desktop

In production test and measurement, a common requirement is central monitoring of the T&M instruments for remote maintenance and remote diagnostics. If the optional virtual machine with the Windows operating system is installed, you can use the Remote Desktop software to access the FSWX from a remote device. The computer that is used for remote operation is called "controller" here.

The following tasks can be performed using Remote Desktop:

- Access to the control functions via a virtual front panel (soft front panel)
- Printout of measurement results directly from the controller
- Storage of measured data on the controller's hard disk

This documentation provides basic instructions on setting up the Remote Desktop for the FSWX. For details refer to the Windows operating system documentation.

- How to configure a network....526
- How to operate the instrument with a VNC client....529
- How to operate the instrument without a network....530
- How to start a remote control session from a device....530
- How to return to manual operation....531

4.13.6.1 How to configure a network

A precondition for operating or monitoring the instrument remotely is that it is connected to a LAN network or a device connected to the GPIB interface. The setup is described here.

Errors can affect the entire network. Consult your network administrator before performing the following tasks:

- Connecting the instrument to the network
- Configuring the network
- Changing IP addresses
- Exchanging hardware

How to connect the instrument to the network

There are two methods to establish a LAN connection to the instrument:

- A non-dedicated network (Ethernet) connection from the instrument to an existing network made with an ordinary RJ-45 network cable. The instrument is assigned an IP address and can coexist with a computer and with other hosts on the same network.
- A dedicated network connection (Point-to-point connection) between the instrument and a single computer made with a (crossover) RJ-45 network cable. The computer must be equipped with a network adapter and be directly connected to the instrument. The use of hubs, switches, or gateways is not required, however, data transfer is still performed using the TCP/IP protocol. You have to assign an IP address to the instrument and the computer.
  Note: As the instrument uses a 1 Gbit LAN, a crossover cable is not necessary (due to Auto-MDI(X) functionality).

► To establish a non-dedicated network connection, connect a commercial RJ-45 cable to one of the LAN connectors.
To establish a dedicated connection, connect a (crossover) RJ-45 cable between the instrument and a single device.

If the instrument is connected to the LAN, the operating system automatically detects the network connection and enables the required drivers.

The network card can be operated with a 1 Gbit Ethernet IEEE 802.3u interface.

How to assign the IP address

Depending on the network capacities, the TCP/IP address information for the instrument can be obtained in different ways.

- If the network supports dynamic TCP/IP configuration using the Dynamic Host Configuration Protocol (DHCP), all address information can be assigned automatically.
- If the network does not support DHCP, or if the instrument is set to use an alternate TCP/IP configuration, you must define the addresses manually.

By default, the instrument is configured to use a dynamic TCP/IP configuration and obtain all address information automatically. Thus, it is safe to establish a physical connection to the LAN without any previous instrument configuration.

When a DHCP server is used, a new IP address can be assigned each time the device is restarted. You have to determine this address on the device itself. Thus, when using a DHCP server, we recommend using the permanent computer name, which determines the address via the DNS server (see "Using a DNS server to determine the IP address" on page 528).

Assigning the IP address on the instrument

1. Select > "Network Settings".
2. Select "Edit Network Settings".
3. Select "IPv4 Settings" > "Address Mode": "Manual".
4. **NOTICE!** Risk of network errors. Connection errors can affect the entire network. Contact your network administrator to obtain a valid IP address.

   Enter the "IP Address", for example *192.0.2.0*. The IP address consists of four number blocks separated by dots. Every block contains a maximum of 3 numbers.
5. Enter the "Subnet Mask", for example *255.255.255.0*. The subnet mask consists of four number blocks separated by dots. Every block contains a maximum of 3 numbers.
6. Select "Save"

   If you enter an invalid IP address or subnet mask, the message "out of range" is displayed in the status line. If the settings are correct, the configuration is saved, and you are prompted to restart the instrument.
7. Confirm the displayed message to restart the instrument.

Using a DNS server to determine the IP address

If a DNS server is configured on the FSWX, the server can determine the current IP address for the connection using the permanent computer name.

1. Obtain the name of your DNS domain and the IP addresses of the DNS and servers on your network (see "How to change the instrument name" on page 528).
2. Select > "Network Settings".
3. Select "Edit Network Settings".
4. Select "IPv4 DNS Settings" > "Address Mode": "Manual".
5. Enter your DNS server addresses.

How to change the instrument name

In a LAN that uses a DNS server, each device or instrument connected in the LAN can be accessed via an unambiguous computer name instead of the IP address. The DNS server translates the host name to the IP address. Using the computer name is especially useful when a DHCP server is used, as a new IP address can be assigned each time the instrument is restarted.

To change the instrument's computer name

Each instrument is delivered with an assigned computer name, but you can change this name.

1. Select > "Network Settings".
2. Enter your "Instrument Name".
3. Close the dialog box.

   The configuration is saved, and you are prompted to restart the instrument.
4. Confirm the displayed message to restart the instrument.

How to change the GPIB instrument address

To operate the instrument via remote control, it must be addressed using the GPIB address. The remote control address is factory-set to 20, but you can change it if it does not fit in the network environment. For remote control, addresses 0 through 30 are allowed. The GPIB address is maintained after a reset of the instrument settings.

Setting the GPIB address

1. On the FSWX, select .
2. Select "Network & Remote".
3. In the "Network & Remote" dialog box, select the "Remote" tab.
4. In the "GPIB Address" field, enter a value between 0 and 30.

Remote command:

`SYST:COMM:GPIB:ADDR 18`, see `SYSTem:COMMunicate:GPIB[:SELF]:ADDRess` on page 852

4.13.6.2 How to operate the instrument with a VNC client

If the FSWX is connected to a computer via LAN, you can operate the instrument from the computer using a VNC client. To do so, install a VNC client on the computer.

The FSWX installation includes a web server which provides various useful web applications for the instrument, called the device web. If you connect the instrument to a LAN, you can access the device web using any web browser on a connected device in the LAN. You do not require another VNC client. See Section 4.13.2.5, "How to control the FSWX via the browser interface (device web)", on page 488.

To operate the instrument with a VNC client

1. Start the VNC client.
2. Enter the hostname (device name) of the instrument. You find the name in the network settings on the instrument.

3. Connect to the instrument.
4. Enter the password for the VNC user.

   You see the display of the FSWX and can use the menus, dialogs and all operating means of the display.

We highly recommend using the same language setting on the instrument and a keyboard connected via VNC. Otherwise, the instrument only accepts keys that are available in the language layout of the instrument keyboard. Some special characters, such as [/] on a German VNC keyboard, do not work on an English instrument keyboard, and vice versa.

To change the instrument keyboard layout, see Section 4.12.3.4, "Keyboard settings", on page 466.

4.13.6.3 How to operate the instrument without a network

To operate the instrument without a network connection either temporarily or permanently, no special measures are necessary. The operating system automatically detects the interruption of the network connection and does not set up the connection when the instrument is switched on.

4.13.6.4 How to start a remote control session from a device

When you switch on the FSWX, it is always in manual operation state ("local" state) and can be operated via the front panel.

To start remote control

1. Send an addressed command (`GTR` - Go to Remote) from a controller to the instrument.

   The instrument is switched to remote control ("remote" state). Operation via the front panel is disabled. Only the "Local" softkey is displayed to return to manual operation. The instrument remains in the remote state until it is reset to the manual state via the instrument or via remote control interfaces. Switching from manual operation to remote control and vice versa does not affect the other instrument settings.

2. During program execution, send the `SYSTem:DISPlay:UPDate ON` command to enable the display of results (see `SYSTem:DISPlay:UPDate` on page 853).

   The changes in the device settings and the recorded measurement values are displayed on the instrument screen.

3. To obtain optimum performance during remote control, send the `SYSTem:DISPlay:UPDate OFF` command to hide the display of results and diagrams again (default setting in remote control).

4. To prevent unintentional return to manual operation, disable the keys of the instrument using the universal command `LLO`.

   Switching to manual mode is only possible via remote control then. This function is only available for the GPIB interface.

5. To enable the keys of the FSWX again, switch the instrument to local mode (`GTL` - Go to Local), i.e. disable the `REN` line of the remote control interface.



If the instrument is operated exclusively in remote control, it is recommended that you switch off the display. For details see "Update Display during Remote Control" on page 518.

4.13.6.5 How to return to manual operation

Before you switch back to manual operation, all remote command processing must be completed. Otherwise, the instrument switches back to remote control immediately.

► • Manual operation: Select "Local".
  • Remote operation: Use the following GPIB command:

```
status = viGpibControlREN(vi, VI_GPIB_REN_ADDRESS_GTL)
```



If you select "Local" while a self-alignment or a self-test is still running (which was started remotely), the instrument only returns to the manual operation state when the alignment or test is completed.

4.13.7 Reference: Conversion of Windows paths to Linux paths

The FSWX uses a R&S Linux operating system. Previous Rohde & Schwarz signal and spectrum analyzers such as the FSW or FSV were based on Windows operating systems. Thus, if you want to use existing control programs on the FSWX, any common file locations must be converted to the new file structure. The following file locations are converted automatically when you use the compatibility mode (see Section 4.13.5.3, "Remote Compatibility settings", on page 519). Note that you must convert any other file locations used in your scripts manually.

Data type	Windows path	Linux path
Program files, installation directory	C:\Program Files\ Rohde-Schwarz\FSWX	opt/rohde-schwarz/esmain/fswx
Predefined application data	C:\Program Files\ Rohde-Schwarz\FSWX\predefined	opt/rohde-schwarz/esmain/fswx/etc/predefined
Predefined SEM standards (fallback files for restoration)	C:\R_S\instr\sem_backup	opt/rohde-schwarz/esmain/fswx/etc/sem_backup
License server	c:\Program Files\ Rohde-Schwarz\LicenseServer\ bin	opt/rohde-schwarz/license-server/bin/
Log files	C:\R_S\instr\log	var/log/esmain/fswx/runtime/
Transducer files	C:\Program Files\ Rohde-Schwarz\FSWX\<version>\ trd	home/instrument/.local/share/rohde-schwarz/esmain/fswx/trd
SCPI recordings	C:\Program Files\ Rohde-Schwarz\FSWX\ ScpiRecordings\	home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpirecordings
ACP standards	C:\R_S\instr\acp_std	home/instrument/.local/share/rohde-schwarz/esmain/fswx/acp_std
SEM standards	C:\R_S\instr\sem_std	home/instrument/.local/share/rohde-schwarz/esmain/fswx/sem_std
Limit lines	C:\R_S\instr\limits	home/instrument/.local/share/rohde-schwarz/esmain/fswx/limits
Screenshots	C:\R_S\instr\user	home/instrument/.local/share/rohde-schwarz/esmain/fswx/user
Trace export data	C:\R_S\instr\user	home/instrument/.local/share/rohde-schwarz/esmain/fswx
I/Q data export	C:\R_S\instr\user	home/instrument/.local/share/rohde-schwarz/esmain/fswx
Device support information	C:\R_S\instr\user	home/instrument/.local/share/rohde-schwarz/esmain/fswx/user
Quicksave settings	C:\R_S\instr\user\QuickSave\	home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/quicksave
Instrument settings	C:\R_S\instr\Save	home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/quicksave
SCPI log files	C:\R_S\INSTR\ScpiLogging	home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpilogging
Device footprint	C:\R_S\instr\devicedata\xml	var/lib/rohde-schwarz/esmain/fswx/devicedata/xml
Conversion loss files	C:\R_S\instr\user\cvl\	var/lib/rohde-schwarz/esmain/fswx/user/cvl

Data type	Windows path	Linux path
Frequency response files	C:\R_S\instr\user\fresponse\	var/lib/rohde-schwarz/esmain/fswx/user/fresponse
External frontend files	C:\R_S\INSTR\USER\ external_frontends\ <frontend_type>\ touchstonefiles	home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/external_frontends
Waveforms	C:\R_S\instr\user\waveforms\	var/lib/rohde-schwarz/esmain/fswx/user/waveform

4.14 Remote commands

The commands required to perform measurements in the Spectrum application in a remote environment are described here.

It is assumed that the FSWX has already been set up for remote operation in a network as described in Section 4.13.6, "How to set up a network and remote control", on page 526.

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- Common suffixes 535
- Common commands 535
- Performing measurements 540
- Configuring CrossACT measurements 548
- Configuring the data input and output 551
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4.14.1 Conventions used in SCPI command descriptions

The following conventions are used in the remote command descriptions:

- *Command usage*
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- *Parameter usage*
  If not specified otherwise, a parameter can be used to set a value, and it is the result of a query.
  Parameters required only for setting are indicated as "Setting parameters".
  Parameters required only to refine a query are indicated as "Query parameters".
  Parameters that are only returned as the result of a query are indicated as "Return values".
- *Conformity*
  Commands that are taken from the SCPI standard are indicated as "SCPI confirmed". All commands used by the FSWX follow the SCPI syntax rules.
- *Asynchronous commands*

A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an "Asynchronous command".

- *Reset values (*RST)*
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as "*RST" values, if available.
- *Default unit*
  The default unit is used for numeric values if no other unit is provided with the parameter.
- *Manual operation*
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

4.14.2 Common suffixes

In the FSWX, the following common suffixes are used in remote commands. For supported values, see the application-specific sections.

Table 4-53: Common suffixes used in remote commands by the FSWX

Suffix	Description
<n>	Window
<m>	Marker
<t>	Trace
	Limit line By default, the suffixes 1 to 8 correspond to the lines REM1 to REM8. If they are used but do not yet exist, they are created automatically. If a name has been set via `CALCulate:LIMit:NAME`, you can access the corresponding line using its index.
<ip>	Input source For RF and external frontends: input **connector** ("RF A | B") For I/Q files: **stream** within the file assigned to the input signal For "Combined Input" (if supported): input signal, i.e. the column in the source configuration

4.14.3 Common commands

Common commands are described in the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect and are employed in the same way on different devices. The headers of these commands consist of "*" followed by three letters. Many common commands are related to the Status Reporting System.

Available common commands:

*CAL?....536
*CLS....536
*ESE....536

*ESR? 537
*IDN? 537
*IST? 537
*OPC 537
*OPT? 537
*PCB 538
*PRE 538
*PSC 538
*RST 538
*SRE 539
*STB? 539
*TRG 539
*TST? 539
*WAI 540

***CAL?**

Calibration query

Initiates a calibration of the instrument and then queries the calibration status. Responses > 0 indicate errors.

Note: If you start a self-alignment remotely, then select the "Local" softkey while the alignment is still running, the instrument only returns to the manual operation state after the alignment is completed.

Usage: Query only

Manual operation: See "Start Self Alignment" on page 422

***CLS**

Clear status

Sets the status byte (STB), the standard event register (ESR) and the `EVENt` part of the `QUEStionable` and the `OPERation` registers to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

Usage: Setting only

***ESE** <Value>

Event status enable

Sets the event status enable register to the specified value. The query returns the contents of the event status enable register in decimal form.

Parameters:
<Value> Range: 0 to 255

***ESR?**

Event status read

Returns the contents of the event status register in decimal form and then sets the register to zero.

Return values:
<Contents> Range: 0 to 255

Usage: Query only

***IDN?**

Identification

Returns the instrument identification.

Return values:
<ID> "Rohde&Schwarz,<device type>,<part number>/<serial number>,<firmware version>"

Example: `Rohde&Schwarz,FSWX3026,1348.0000K26/100005,1.30`

Usage: Query only

***IST?**

Individual status query

Returns the contents of the IST flag in decimal form. The IST flag is the status bit which is sent during a parallel poll.

Return values:
<ISTflag> 0 | 1

Usage: Query only

***OPC**

Operation complete

Sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request. The query writes a "1" into the output buffer when all preceding commands have been executed, which is useful for command synchronization.

***OPT?**

Option identification query

Queries the options included in the instrument. For a list of all available options and their description, refer to the specifications document.

Return values:

<Options> The query returns a list of all installed and activated options, separated by commas, where:
B<number> describes hardware options.
K<number> describes software options.

Usage: Query only

***PCB** <Address>

Pass control back

Indicates the controller address to which remote control is returned after termination of the triggered action.

Setting parameters:

<Address> Range: 0 to 30

Usage: Setting only

***PRE** <Value>

Parallel poll register enable

Sets parallel poll enable register to the indicated value. The query returns the contents of the parallel poll enable register in decimal form.

Parameters:

<Value> Range: 0 to 255

***PSC** <Action>

Power on status clear

Determines whether the contents of the `ENABle` registers are preserved or reset when the instrument is switched on. Thus a service request can be triggered when the instrument is switched on, if the status registers ESE and SRE are suitably configured. The query reads out the contents of the "power-on-status-clear" flag.

Parameters:

<Action> 0 | 1

0
The contents of the status registers are preserved.

1
Resets the status registers.

***RST**

Reset

Sets the instrument to a defined default status. The default settings are indicated in the description of commands.

The command is equivalent to `SYSTem:PRESet`.

Note that you can modify the factory set default values to user-defined settings (see `MMEMory:LOAD:STATe` on page 788). For more details on default values, see Section 4.10.2, "Restoring the default instrument configuration (preset)", on page 357.

Usage: Setting only

***SRE** <Contents>

Service request enable

Sets the service request enable register to the indicated value. This command determines under which conditions a service request is triggered.

Parameters:

<Contents> Contents of the service request enable register in decimal form. Bit 6 (MSS mask bit) is always 0.

Range: 0 to 255

***STB?**

Status byte query

Reads the contents of the status byte in decimal form.

Usage: Query only

***TRG**

Trigger

Triggers all actions waiting for a trigger event. In particular, *TRG generates a manual trigger signal. This common command complements the commands of the `TRIGger` subsystem.

`*TRG` corresponds to the `INITiate:IMMediate` command.

See `INITiate<n>[:IMMediate]` on page 647.

Usage: Event

***TST?**

Self-test query

Initiates self-tests of the instrument and returns an error code.

Note: If you start a self-test remotely, then select the "Local" softkey while the test is still running, the instrument only returns to the manual operation state after the test is completed. In this case, you cannot abort the self-test.

Return values:

<ErrorCode> **integer > 0 (in decimal format)**
An error occurred.
For details, see the Service Manual supplied with the instrument.

0
No errors occurred.

Usage: Query only

***WAI**

Wait to continue

Prevents servicing of the subsequent commands until all preceding commands have been executed and all signals have settled (see also command synchronization and *OPC).

Usage: Event

4.14.4 Performing measurements

The following commands are required to select the application and to configure a Sequencer in a remote environment.

The tasks for manual operation are described in Section 4.6, "Running measurements", on page 267.

- Selecting the applications 540
- Performing a sequence of measurements 544
- Programming example: performing a sequence of measurements 546

4.14.4.1 Selecting the applications

DISPlay:ATAB 541
INSTrument:CREate:DUPLicate 541
INSTrument:CREate[:NEW] 541
INSTrument:CREate:REPLace 542
INSTrument:DELete 543
INSTrument:LIST 543
INSTrument:REName 543
INSTrument[:SELect] 544

DISPlay:ATAB <State>

Switches between the MultiView tab and the most recently displayed application instance. If only one application instance is active, this command has no effect.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

INSTrument:CREate:DUPLicate

Duplicates the currently selected application instance, i.e. creates a new instance of the same type and with the identical measurement settings.

Example: `INST:CRE:DUPL`

Manual operation: See "Duplicate Current Application" on page 270

INSTrument:CREate[:NEW] <AppType>, <AppName>

Adds an application instance. The number of application instances that you can configure at the same time is only limited by the available memory on the instrument.

Parameters:

<AppType> <char_data>

Type of the new application instance.
For a list of available application types, see Table 4-54.

<AppName> String containing the name of the application instance.
Note that you cannot assign an existing application instance name to a new application instance. If you do, an error occurs.
Consider the naming conventions for Linux as described in "Filename restrictions" on page 361.
In particular, the name must not contain special characters.

Example: `INST:CRE SAN, 'Spectrum 2'`
Adds a "Spectrum" application instance named "Spectrum 2".

Manual operation: See "Spectrum" on page 106
See "I/Q Capture" on page 106
See "5G NR" on page 106
See "Amplifier" on page 106
See "AM/FM/PM Modulation Analysis" on page 107
See "I/Q Spectrum Analyzer" on page 107
See "Noise Figure" on page 107
See "OFDM Signal Analysis (OFDM VSA)" on page 107
See "Phase Noise" on page 107
See "Vector Signal Analysis (VSA)" on page 108
See "WLAN" on page 108
See "New application instance" on page 269

Table 4-54: Available application types and default application names

Application	<AppType> Parameter	Default application name*)
Spectrum	SANALYZER	Spectrum
5G NR	NR5G	5G NR
Amplifier Measurements	AMPL	Amplifier
AM/FM/PM Analog Demod	ADEM	Analog Demod
Fast Spur Search	SPUR	Spurious
I/Q Capture	IQC IQ (legacy)	IQ Capture
I/Q Spectrum Analyzer	IQSA	IQ Spectrum Analyzer
LTE	LTE	LTE
Noise Figure Measurements	NOISE	Noise
OFDM VSA	OFDMVSA	OFDM VSA
Phase Noise	PNOISE	Phase Noise
Pulse	PULSE	Pulse
Transient Analysis	TA	Transient Analysis
Vector Signal Analysis (VSA)	DDEM	VSA
WLAN	WLAN	WLAN
*) Note: the default application name is also listed in the table. If the specified name for a new application instance already exists, the default name, extended by a sequential number, is used for the new instance.		

INSTrument:CREate:REPLace <AppName1>, <AppType>, <AppName2>

Replaces an application instance with another one.

Parameters:

<AppName1> String containing the name of the application instance you want to replace.

<AppType> <char_data>
Type of the new application instance.
For a list of available application types, see Table 4-54.

<AppName2> String containing the name of the new application instance.
Note: If the specified name for a new application instance already exists, the default name, extended by a sequential number, is used for the new application instance (see Table 4-54).
Consider the naming conventions for Linux as described in "Filename restrictions" on page 361.
In particular, the name must not contain special characters.

Example: `INST:CRE:REPL 'IQCapture2',IQS,'IQCapture'`
Replaces the application instance named "IQCapture2" by a new application instance of type "IQ Capture" named "IQCapture".

Manual operation: See "Replace Current Application" on page 269

INSTrument:DELete <AppName>

Deletes an application instance.

Parameters:

<AppName> String containing the name of the application instance you want to delete.
An application instance must exist to delete it.

Example: `INST:DEL 'IQAnalyzer4'`
Deletes the application instance with the name 'IQAnalyzer4'.

INSTrument:LIST

Queries all active application instances. The query is useful to obtain the names of the existing application instances, which are required to replace or delete the application instances.

Return values:

<AppType>, <AppName> For each application instance, the command returns the application instance type and application instance name (see Table 4-54).
Tip: to change the application instance name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 3 application instances:
`'ADEM','Analog Demod','IQC','IQ Capture','IQC','IQ Capture2'`

INSTrument:REName <AppName1>, <AppName2>

Renames an application instance.

Parameters:

<AppName1> String containing the name of the application instance you want to rename.

<AppName2> String containing the new application instance name.
Note that you cannot assign an existing application instance name to a new application instance. If you do, an error occurs.
Consider the naming conventions for Linux as described in "File-name restrictions" on page 361.
In particular, the name must not contain special characters.

Example: `INST:REN 'IQAnalyzer2','IQAnalyzer3'`
Renames the application instance with the name 'IQAnalyzer2' to 'IQAnalyzer3'.

INSTrument[:SELect] <AppType>

Selects an application instance, for example before executing further commands for that application instance.

Parameters:

<AppType> For a list of available application types see Table 4-54.

Example: `INST IQC`
Activates an application instance for the I/Q Capture application.
`INST 'MyIQSpectrum'`
Selects the application instance named 'MyIQSpectrum' (for example before executing further commands for that application instance).

Manual operation: See "New application instance" on page 269

4.14.4.2 Performing a sequence of measurements

The following commands control the sequencer.

For details on the Sequencer see Section 4.1.1.2, "Running a sequence of measurements - the Sequencer concept", on page 103.

INITiate:SEQuencer:ABORt 544
INITiate:SEQuencer:IMMediate 545
INITiate:SEQuencer:MODE 545
SYSTem:SEQuencer 546

INITiate:SEQuencer:ABORt

Stops the currently active sequence of measurements.

You can start a new sequence any time using `INITiate:SEQuencer:IMMediate` on page 545.

Example: `INIT:SEQ:ABOR`

Usage: Event

Manual operation: See "Sequencer state" on page 270

INITiate:SEQuencer:IMMediate

Starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see`SYSTem:SEQuencer` on page 546).

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement is performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Manual operation: See "Sequencer state" on page 270

INITiate:SEQuencer:MODE <Mode>

Defines the capture mode for the entire measurement sequence and all measurement groups and application instances it contains.

Note: To synchronize to the end of a measurement sequence using `*OPC`, `*OPC?` or `*WAI`, use `SINGle` Sequencer mode.

Parameters:

<Mode> SINGle | CONTinuous | CONTinous | CDEFined

SINGle
Each measurement group is started one after the other in the order of definition. All application instances in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence is finished.

CONTinuous
Each measurement group is started one after the other in the order of definition. All application instances in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence restarts with the first one and continues until it is stopped explicitly.

*RST: CONTinuous

Example: `INIT:SEQ:MODE CONT`

SYSTem:SEQuencer <State>

Enables or disables the Sequencer. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error occurs.

For details on the "Sequencer", see Section 4.1.1.2, "Running a sequence of measurements - the Sequencer concept", on page 103.

A detailed programming example is provided in Section 4.14.4.3, "Programming example: performing a sequence of measurements", on page 546.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:

`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement is performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.
`SYST:SEQ OFF`

Manual operation: See "Sequencer state" on page 270

4.14.4.3 Programming example: performing a sequence of measurements

This example demonstrates how to perform several measurements in a sequence in a remote environment.

```
//2xSpectrumanalyzer + 2xIQ, start Sequencer at the end, test OPC?
// ----------------------------------------------------------------------


//------Preparing the instrument and first and second application instance -------
*RST
//Activate new IQ application instance
INSTrument:CREate:NEW IQ,'IQ 1'
//Set sweep count for new IQ application instance
SENS:SWEEP:COUNT 6
//Change trace modes for IQ application instance
DISP:TRAC1:MODE BLANK
DISP:TRAC2:MODE MAXH
```

```
DISP:TRAC3:MODE MINH
//Switch to single sweep mode
INIT:CONT OFF
//switch back to first (default) Spectrum application instance
INST:SEL 'Spectrum';*WAI
//Switch into SEM
SENSe:SWEep:MODE ESPectrum
//Load Sem standard file for W-CDMA
SENSe:ESPectrum:PRESet:STANdard 'WCDMA/3GPP/DL/3GPP_DL.xml'
//Set sweep count in Spectrum application instance
SENS:SWEEP:COUNT 5

//----------Creating a third application instance ----------------

//Create second IQ application instance
INSTrument:CREate:NEW IQ,'IQ 2'
//Set sweep count
SENS:SWEEP:COUNT 2
//Change trace modes
DISP:TRAC1:MODE MAXH
DISP:TRAC2:MODE MINH
//Create new Spectrum application instance
INSTrument:CREate:NEW SANalyzer,'Spectrum 2'
//Activate ACLR measurement in application instance 'Spectrum 2'
CALCulate:MARKer:FUNCtion:POWer:SELect ACPower
//Load W-CDMA Standard
CALCulate:MARKer:FUNCtion:POWer:PRESet FW3Gppcdma
//Change trace modes
DISP:TRAC2:MODE MAXH
DISP:TRAC1:MODE MINH

//--------Performing a sweep and retrieving results----------------

//Change sweep count
SENS:SWEep:COUNt 7
//Single Sweep mode
INIT:CONT OFF
//Switch back to first IQ application instance
INST:SEL 'IQ 1';*WAI
//Perform a measurement
INIT:IMM;*OPC?
//Retrieve results
CALC:MARK:Y?
//Activate Multiview
DISPlay:ATAB     ON

//---------Performing a sequence of measurements with the Sequencer------------
//Activate Sequencer
SYSTem:SEQuencer ON
//Start sweep in Sequencer
```

```
INITiate:SEQuencer:IMMediate;*OPC?
//Switch into first IQ application instance to get results
INST:SEL 'IQ 1';*WAI
CALCulate:MARKer:MAXimum
CALC:MARK:Y?
//Change sweep time in IQ
SENS:SWE:TIME 300us
//Switch to single Sequencer mode
INITiate:SEQuencer:MODE SINGle
//Sweep all application instances once, taking the sweep count in each application
//instance into account
INITiate:SEQuencer:IMMediate;*OPC?
//Set marker to maximum in IQ1 and query result
CALCulate:MARKer:MAXimum
CALC:MARK:Y?
//Switch to second IQ application instance and retrieve results
INST:SEL 'IQ 2';*WAI
CALCulate:MARKer:MIN
CALC:MARK:Y?
//Switch to first Spectrum application instance
INST:SEL 'Spectrum';*WAI
//Query one of the SEM results
CALCulate:MARKer:FUNCtion:POWer:RESult? CPOWer
//Switch to second Spectrum application instance
INST:SEL 'Spectrum 2';*WAI
//Query channel power result
CALCulate:MARKer:FUNCtion:POWer:RESult? ACPower
```

4.14.5 Configuring CrossACT measurements

The following commands are specific to "CrossACT" measurements in a remote environment.

The "Cross-Application Control and Triggering" functionality requires the CrossACT (R&S FSW3-KM135) license.

INSTrument:LINK<lg>....548
INSTrument:LINK<lg>:ADD....549
INSTrument:LINK<lg>:AOFF....549
INSTrument:LINK<lg>:DISPlay....550
INSTrument:LINK<lg>:LIST?....550
INSTrument:LINK<lg>:LIST:ACTive?....550
INSTrument:LINK<lg>:ORDer....550
INSTrument:LINK<lg>:REMove....551

INSTrument:LINK<lg> <AppName>...

Adds the specified application instances to the "CrossACT" group. If the group does not exist yet, the group is created if you specify at least two application instances.

Suffix:
<lg> "CrossACT" group, currently only 1

Setting parameters:
<AppName> List of application instance names

Example:
```
// Link the three application instances in "CrossACT" group 1
INSTrument:LINK1 'IQ Capture','IQ Capture 2', 'IQ Capture 3'
```

Usage: Setting only

Manual operation: See "Linked Applications" on page 273
See "Select Running Applications" on page 274
See "Select New Applications" on page 274

INSTrument:LINK<lg>:ADD <AppName>, <Position>,<AppName>

Adds the specified application instance to the "CrossACT" group, at the specified position.

Suffix:
<lg> "CrossACT" group, currently only 1

Setting parameters:
<AppName> Existing application instance name

Query parameters:
<Position> LEFT | RIGHt

Position the new application instance is added to the group, relative to the existing application instance.

Example: The "CrossACT" group consists of the application instances 'IQ-Cap1' and 'IQCap2'.
```
//To insert 'IQCap3' between the two:
INSTrument:LINK1:ADD 'IQCap1',RIGHt,'IQCap3'
//To insert 'IQCap4' at the beginning of the group:
INSTrument:LINK1:ADD 'IQCap1',LEFT,'IQCap4'
```

Usage: Setting only

Manual operation: See "Linked Applications" on page 273

INSTrument:LINK<lg>:AOFF

Dissolves the "CrossACT" group. Data capture is no longer linked between application instances.

Suffix:
<lg> "CrossACT" group, currently only 1

Example:
```
INSTrument:LINK:AOFF
```

Usage: Event

INSTrument:LINK<lg>:DISPlay

Selects the common result display for the "CrossACT" group.

Suffix:
<lg> "CrossACT" group, currently only 1

Example:
```
// Link the three application instances in "CrossACT" group 1
INSTrument:LINK1 'IQ Capture','IQ Capture 2', 'IQ Capture 3'
// Select the common display for the "CrossACT" application instances
INSTrument:LINK1:DISP
```

Usage: Event

INSTrument:LINK<lg>:LIST?

Lists all application instances in the "CrossACT" group.

Suffix:
<lg> "CrossACT" group, currently only 1

Example:
```
// Link the three application instances in "CrossACT" group 1
INSTrument:LINK1 'IQ Capture','IQ Capture 2', 'IQ Capture 3'
// Return the list of linked application instances in group 1
INSTrument:LINK1:LIST?
// 'IQCAP','IQ Capture','IQCAP','IQ Capture 2','IQCAP','IQ Capture 3'
```

Usage: Query only

Manual operation: See "Linked Applications" on page 273

INSTrument:LINK<lg>:LIST:ACTive?

Lists the active application instances in the "CrossACT" group. Application instances with conflicting parameters are excluded from the measurement and are not listed as active.

Suffix:
<lg> "CrossACT" group, currently only 1

Example:
```
// Link the three application instances in "CrossACT" group 1
INSTrument:LINK1 'IQ Capture','IQ Capture 2', 'IQ Capture 3'
// Return the list of linked application instances in group 1
INSTrument:LINK1:LIST:ACTive?
// 'IQCAP','IQ Capture','IQCAP','IQ Capture 2','IQCAP','IQ Capture 3'
```

Usage: Query only

INSTrument:LINK<lg>:ORDer <AppName>...

Orders the application instances in the "CrossACT" group.

Suffix:
<lg> "CrossACT" group, currently only 1

Setting parameters:

<AppName> List of application instance names, see Table 4-54

Example:

```
// Link the three application instances in "CrossACT" group 1
INSTrument:LINK 'IQ Capture','IQ Capture 2', 'IQ Capture 3'
// Reorder the whole "CrossACT" group
INSTrument:LINK:ORDer 'IQ Capture 3', 'IQ Capture', 'IQ Capture 2'
// Reorder partial "CrossACT" group
INSTrument:LINK:ORDer 'IQ Capture', 'IQ Capture 2'
// Set the left-most app
INSTrument:LINK:ORDer 'IQ Capture 2'
```

Usage: Setting only

INSTrument:LINK<lg>:REMove <AppName>...

Remove the specified application instances from the "CrossACT" group.

Suffix:

<lg> "CrossACT" group, currently only 1

Setting parameters:

<AppName> List of application instance names, see Table 4-54

Example:

```
// Link the three application instances in "CrossACT" group 1
INSTrument:LINK1 'IQ Capture','IQ Capture 2', 'IQ Capture 3'
// Return the list of linked application instances in group 1
INSTrument:LINK1:LIST?
// 'IQCAP','IQ Capture','IQCAP','IQ Capture 2','IQCAP','IQ Capture 3'
// Remove the two application instances. Only one remains,
// so the whole group is dissolved.
INSTrument:LINK:REMove 'IQ Capture 2', 'IQ Capture 3'
// The list of linked application instances is now empty
// as group is dissolved. Query returns error.
INSTrument:LINK1:LIST?
//
```

Usage: Setting only

Manual operation: See "Select Running Applications" on page 274

4.14.6 Configuring the data input and output

The following commands are required to configure data input and output.

- RF input....552
- Input from I/Q data files....560
- Programming example: Loading I/Q data files with multiple streams....564
- Remote commands for external frontend control....565
- Setting up probes....591
- Working with power sensors....596
- Configuring combined input....608

- Defining the frequency 612
- Configuring the amplitude 613
- Configuring I/Q data acquisition 622
- Configuring the outputs 624
- Configuring the trigger output 626

4.14.6.1 RF input

CALibration:PADJust[:STATe] 552
INPut<ip>:ATTenuation:AUTO:MODE 552
INPut<ip>:ATTenuation:PROTection:RESet 553
INPut<ip>:CONNector 553
INPut<ip>:COUPling 554
INPut<ip>:DPATh 554
INPut<ip>:FILTer:YIG[:STATe] 554
INPut<ip>:IMPedance 555
INPut<ip>:LPNoise[:STATe] 555
INPut<ip>:IMPedance:PTYPe 556
INPut:RF:COUNt? 556
INPut:RF:SELect? 556
INPut:RF:SOURce 557
INPut<ip>:RF:STATe 557
INPut:SELect 558
INPut:TYPE 559
INPut:UPORt:STATe 559
INPut:UPORt[:VALue] 560

CALibration:PADJust[:STATe] <State>

Activates or deactivates the preselector adjustment.

Prerequisite: Frequency sweep in the Spectrum application.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

INPut<ip>:ATTenuation:AUTO:MODE <OptMode>

Selects the priority for signal processing when determining the required RF attenuation.

Suffix:

<ip> Input

Parameters:

<OptMode> LDIStortion | LNOise

LNOise
Optimized for high sensitivity and low noise levels

LDIStortion
Optimized for low distortion by avoiding intermodulation

MANual
Define the attenuation manually using `INPut<ip>:ATTenuation` on page 616.

*RST: LDIStortion (WLAN application: LNOise)

Example: `INP:ATT:AUTO:MODE LNO`

Manual operation: See "Optimization" on page 182

INPut<ip>:ATTenuation:PROTection:RESet [<DeviceName>]

Resets the attenuator and reconnects the RF input with the input mixer for the FSWX after an overload condition occurred and the protection mechanism intervened. The error status bit (bit 3 in the `STAT:QUES:POW` status register) and the `INPUT OVLD` message in the status bar are cleared.

(See `STATus<ip>:QUEStionable:POWer[:EVENt]` on page 885 and "STATus<ip>:QUEStionable:POWer register" on page 501).

The command works only if the overload condition has been eliminated first.

For details on the protection mechanism, see "RF input protection" on page 115.

Suffix:
<ip> Input

Setting parameters:
<DeviceName>

Example: `INP:ATT:PROT:RES`

INPut<ip>:CONNector <ConnType>

Determines which connector the input for the measurement is taken from.

If an external frontend is active, the connector is automatically set to `RF`.

Suffix:
<ip> 1 | 2
Input

Parameters:
<ConnType> RF | AIQI | RFPRobe

RF
RF input connector

RFPRobe
Active RF probe

*RST: RF

Example: `INP:CONN RF`
Selects input from the RF input connector.

Manual operation: See "Input Connector" on page 187

INPut<ip>:COUPling <CouplingType>

Selects the coupling type of the RF input.

If an external frontend is active, the coupling is automatically set to `AC`.

Suffix:
<ip> Input

Parameters:
<CouplingType> AC | DC

AC
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Manual operation: See "Input Coupling" on page 186

INPut<ip>:DPATh <DirectPath>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

If an external frontend is active, the direct path is always used.

Suffix:
<ip> 1 | 2
Input

Parameters:
<DirectPath> AUTO | OFF

AUTO | 1
(Default) the direct path is used automatically for frequencies close to 0 Hz.

OFF | 0
The analog mixer path is always used.

Example: `INP:DPAT OFF`

Manual operation: See "Direct Path" on page 186

INPut<ip>:FILTer:YIG[:STATe] <State>

Enables or disables the YIG filter.

For details and restrictions, see Section 4.2.1.7, "Signal path settings", on page 184

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG Preselector" on page 187

INPut<ip>:IMPedance <Impedance>

Selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

Suffix:
<ip> Input

Parameters:
<Impedance> 50 | 75

numeric value
User-defined impedance from 50 Ohm to 100000000 Ohm (=100 MOhm)
User-defined values are only available for the "Spectrum" application and some optional applications.

*RST: 50 Ω
Default unit: Ohm

Example: `INP:IMP 75`

Manual operation: See "Impedance" on page 189

INPut<ip>:LPNoise[:STATe] <State>

Enables or disables a signal path that is optimized for a lower IF to improve phase noise for RF frequencies larger than 9 GHz. As a result, image rejection can be reduced.

This setting is only available in the "Spectrum" application and only for single RF input.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Manual operation: See "Low Phase Noise (Spectrum application only)" on page 186
See "Low Phase Noise (expert parameter)" on page 971

INPut<ip>:IMPedance:PTYPe <PadType>

Defines the type of matching pad used for impedance conversion for RF input.

Suffix:
<ip> Input

Parameters:
<PadType> SRESistor | MLPad

SRESistor
Series-R

MLPad
Minimum Loss Pad

*RST: SRESistor

Example:
```
INP:IMP 100
INP:IMP:PTYP MLP
```

Manual operation: See "Impedance" on page 189

INPut:RF:COUNt?

For multi-input instruments: Queries the number of active RF input connectors.

See Section 4.1.4.3, "Multi-input and combined input", on page 154.

Return values:
<RF count> Number of active connectors.

Range: 1 to 2

Example:
```
INP1:RF:STAT OFF
```
Deactivate RF input A.
```
INP2:RF:STAT ON
```
Activate RF input B.
```
INP:RF:COUN?
//Result: 1
```

Usage: Query only

INPut:RF:SELect?

For multi-input instruments: Queries the RF connectors providing input.

See also Section 4.1.4.3, "Multi-input and combined input", on page 154.

Return values:
<RF select> Comma-separated list of RF connectors providing input.

Example: `INP1:RF:STAT ON`
Activate RF input A.
`INP2:RF:STAT ON`
Activate RF input B.
`INP:RF:SEL?`

Example: Query list of active RF input connectors
`//Result: '1,2'`

Usage: Query only

INPut:RF:SOURce <Mode>

For multi-input instruments: Defines or queries how many of the input connectors are used for the measurement.

See also Section 4.1.4.3, "Multi-input and combined input", on page 154.

Parameters:
<Mode> SGL | MULTi

SGL
Only one of the input connectors is used.

MULTi
Input from multiple input connectors is measured.

Example: `INP1:RF:STAT ON`
Activate RF input A.
`INP2:RF:STAT ON`
Activate RF input B.
`INP:RF:SOUR MULT`
Enable the use of input from both RF connectors for the measurement.
`INP:RF:SEL?`
Query the RF connectors providing input.
`//Result: '1, 2'`

INPut<ip>:RF:STATe <State>

Determines which RF input provides the signal.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Deactivates the selected connector.

ON | 1
Activates the selected connector.

*RST: 0

Example: `INP2:RF:STAT OFF`
Deactivates "RF Input B".

Manual operation: See "Connector/ State" on page 173
See "Connector" on page 213

INPut:SELect <Source>

Selects which input connector provides the input signal for the application instance.

Parameters:

<Source> RF | AIQ | DIQ | FIQ | MIXer | EFRontend | MSOurce

RF
"RF A | B"

FIQ
File (I/Q) input

EFR
External frontend input

MSO
"Combined Input"
Configure the sources for the individual input signals of a "Combined Input" using `INPut<ip>:MSO:SELect?` on page 612.

*RST: RF

Manual operation: See "Activate RF Input / RF Input Activated" on page 173
See "Activate I/Q File Input / I/Q File Input Activated" on page 174
See "Activate External Frontend / External Frontend Activated" on page 213

Example

//Configure a "Combined Input" measurement

```
INP:SEL MSO
```

//Configure the first input signal from RF A

```
INP:MSO:ADD RF
```

```
INP1:MSO:RF:SEL RF1
```

//Query the input source of the first input signal

```
INP1:MSO:SEL?
```

//Result: RF

//Query the used input connector for the RF input signal

```
INP1:RF:SEL?
```

//Result: 1

//Add another RF input signal using RF B

```
INP:MSO:ADD RF
```

```
INP2:MSO:RF:SEL RF2
```

//Add 2 more input signals for the 2 streams in the IQInput file.

```
INP:MSO:ADD FIQ,
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/IQINPUT.iq.tar
1
INP:MSO:ADD FIQ,
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/IQINPUT.iq.tar',
2
```

//For demonstration purposes:

//delete the second input signal from RF B.

```
INP2:MSO:DEL
```

//Query the number of used input signals in the

//"Combined Input" measurement.

```
INP:MSO:COUN?
```

//Result: 3

INPut:TYPE <Input>

The command selects the input connector for multi-input instruments.

Parameters:

<Input>

INPUT1
Selects RF input 1.
1 mm [RF Input] connector

INPUT2
Selects RF input 2.

*RST: INPUT1

Example:

//Select input path
```
INP:TYPE INPUT1
```

INPut:UPORt:STATe <State>

Toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole D-Sub male connector is located on the rear panel of the FSWX.

See the FSWX Getting Started manual for details.

Parameters:

<State>

ON | 1
User port is switched to INPut.

OFF | 0
User port is switched to OUTPut.

*RST: 1

Example: `INP:UPOR:STAT ON`

INPut:UPORt[:VALue]

Queries the control lines of the user ports.

For details see `OUTPut:UPORt[:VALue]` on page 625.

Return values:

<Level> bit values in hexadecimal format
TTL type voltage levels (max. 5V)
Range: #B00000000 to #B00111111

Example:
```
INP:UPOR?
//Result: #B00100100
```
Pins 5 and 7 are active.

4.14.6.2 Input from I/Q data files

The input for measurements can be provided from I/Q data files. The commands required to configure the use of such files are described here.

For more information, see "I/Q data files" on page 127.

Useful commands for input from I/Q data files described elsewhere:

- `INPut:SELect` on page 558

Remote commands exclusive to input from I/Q data files:

INPut:CATalog? 560
INPut:FILE:ADD? 561
INPut:FILE<fi>:DELete 561
INPut:FILE<fi>:PATH? 561
INPut:FILE<fi>:PATH 561
INPut:FILE<fi>:REPetition:COUNt 562
INPut:FILE<fi>:STReam[:SELect]? 562
INPut:FILE<fi>:STReam[:SELect] 562
INPut:FILE:STReam:COUNt? 563
INPut:FILE<fi>:STReam:AUTO 563
INPut:FILE<fi>:STReam:LIST? 563

INPut:CATalog?

Queries the index and name of all loaded streams as a comma-separated list.

Return values:

<Stream number> integer
Input source index of the stream as indicated in the "Input Assistant". The lowest available index number is returned first.

<Stream name> String containing the name of the stream.

Example: INP:CAT?

Usage: Query only

```
//Result for 3 input streams:
1,'StreamA',2,'StreamC',3,'StreamB'
```

INPut:FILE:ADD? <File name>

Adds an input file. The assigned file suffix is returned as a result.

Query parameters:

<File name> String containing the path and name of the source file.
The file extension is `*.iq.tar`.

Return values:

<File number> integer
File suffix at which the new file is inserted in the list of input files.
The lowest available suffix number is assigned.

Example:
```
INP:FILE:ADD? 'file.iq.tar'
//Result:
//2
```

Usage: Query only

Manual operation: See "+ Add I/Q file" on page 175

INPut:FILE<fi>:DELete

Deletes the file at the specified file suffix. Subsequent file suffixes remain unchanged.

Suffix:

<fi> 1 to 99
Sequential number of a configured input file

Usage: Event

Manual operation: See "🗑 Remove I/Q file" on page 175

INPut:FILE<fi>:PATH?
INPut:FILE<fi>:PATH <FileName>

Queries the path and filename of the file at the defined file suffix, or adds an input file at the defined file suffix. The file must be in `.iq.tar` format.

You can only use a single data stream or channel as input, even if the file contains multiple streams or channels.

Suffix:

<fi> 1 to 99
Sequential number of a configured input file

Parameters:
<FileName> String containing the path and name of the data input file.

Example: //Add the specified file as the second file input source.

Manual operation: See "File" on page 175

```
INP:FILE2:PATH
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/data.iq.tar'
```

//Query the path and filename of the second input source.

```
INP:FILE2:PATH?
```

//Result:

```
//
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/data.iq.tar'
```

INPut:FILE<fi>:REPetition:COUNt <Repteition count>

Determines how often the file data is repeatedly copied in the I/Q data memory. If the available memory is not sufficient for the specified number of repetitions, the largest possible number of complete data streams is used.

Suffix:
<fi> 1 to 99
Sequential number of a configured input file

Parameters:
<Repteition count> integer

Manual operation: See "Repetitions" on page 175

INPut:FILE<fi>:STReam[:SELect]? <StreamName>
INPut:FILE<fi>:STReam[:SELect] <Stream name>

Prerequisites:

- File contains more than one data stream.
- Automatic mode is off (`INPut:FILE<fi>:STReam:AUTO` on page 563).

Selects a single data stream in a loaded file as input. The lowest available stream suffix is assigned to it. As a result, the assigned stream suffix is returned. `INPut:FILE<fi>:STReam:AUTO` on page 563 is disabled.

The query returns which stream suffix a specific data stream in a file has.

Suffix:
<fi> 1 to 99
Sequential number of a configured input file

Parameters:
<Stream name> string

Example:
```
INP:FILE2:STR 'StreamB'
//Result: 3
INP:FILE2:STR? 'StreamB'
//Result: 3
```

Manual operation: See "Streams" on page 175

INPut:FILE:STReam:COUNt?

Queries the total number of I/Q streams in all loaded files.

Return values:
<Count> integer

Usage: Query only

INPut:FILE<fi>:STReam:AUTO <Auto>

Prerequisite: File contains more than one data stream.

Automatically defines which data stream in the file is used as input.

Suffix:
<fi> 1 to 99
Sequential number of a configured input file

Parameters:
<Auto> ON | OFF | 0 | 1

OFF | 0
The data stream specified by `INPut:FILE<fi>:STReam[:SELect]` is used as input.

ON | 1
The first data stream in the file is used as input. Applications that support multiple data streams use the first data stream in the file for the first input stream, the second for the second stream etc. Each stream is assigned the lowest available <ip> suffix for the input source.
To determine the assigned input source indexes, use `INPut:CATalog?` on page 560.

*RST: 1

Manual operation: See "Streams" on page 175

INPut:FILE<fi>:STReam:LIST?

Returns a comma-separated list of all stream names in the file at the selected file suffix.

Suffix:
<fi> 1 to 99
Sequential number of a configured input file

Return values:
<Stream name> string

Example:
```
INP:FILE2:STR:LIST?
//Result: 'StreamA','StreamB','StreamC'
```

Usage: Query only

Manual operation: See "Streams" on page 175

4.14.6.3 Programming example: Loading I/Q data files with multiple streams

This example demonstrates how to load I/Q data files with multiple streams. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task.

Assume the following input files:

File 1 contains

- Stream A

File 2 contains

- Stream B
- Stream C

```
//Select file input
INP:SEL FIQ

//Load both input files
INP:FILE:ADD? 'File 1'
//Result(<fi>): 1
INP:FILE:ADD? 'File 2'
//Result(<fi>): 2

//Query the name of the file at suffix 2
INP:FILE2:PATH?
//Result: 'File 2'

//Query the list of available stream names for the file at suffix 2
INP:FILE2:STR:LIST?
//Result: 'Stream B','Stream C'

//Select all streams in File 2 as input
INP:FILE2:STR:AUTO ON
//Query the <ip> suffixes for each input stream
INP:FILE2:STR? 'Stream B'
//Result (<ip>): 2
INP:FILE2:STR? 'Stream C'
//Result (<ip>): 3
//Query the number of (selected) streams in all input sources
INP:FILE:STR:COUN?
//Result: 3 (Stream A, Stream B, Stream C)
```

```
//Select only Stream C in File 2 (-> deselect Stream B)
INP:FILE2:STR:AUTO OFF
INP:FILE2:STR 'Stream C'
//Result (<ip>): 2

//Set the sample rate for Stream C to 32 MHz
SENS2:IQ:SRAT 32MHZ

//Remove File 1
INP:FILE1:DEL
//Query the list of input streams with their suffixes
INP:CAT?
//Result: 2,'Stream C'
```

4.14.6.4 Remote commands for external frontend control

The following commands are available and required only if the external frontend control option (R&S FSW3-K553) is installed.

Further commands for external frontend control described elsewhere:

- `INPut:SELect EFR`; see `INPut:SELect` on page 558
- `[SENSe<ip>:]FREQuency:CENTer` on page 612
- `INPut<ip>:RF:STATe` on page 557
- `INPut<ip>:RLEVel` on page 614
- `INPut<ip>:ATTenuation:AUTO:MODE` on page 552
- `INPut<ip>:ATTenuation` on page 616
- `INPut<ip>:SANalyzer:ATTenuation` on page 619
- `INPut<ip>:SANalyzer:ATTenuation:AUTO` on page 620
- `SYSTem:ERRor[:NEXT]?` on page 861

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Commands for initial configuration

The following commands are required when you initially set up an external frontend.

[SENSe<ip>:]EFRontend:CONNection[:STATe]....566
[SENSe<ip>:]EFRontend:CONNection:CONFig....567
[SENSe<ip>:]EFRontend:CONNection:CSTate?....567
[SENSe<ip>:]EFRontend:FREQuency:BAND:COUNt?....568
[SENSe<ip>:]EFRontend:FREQuency:BAND<b>:LOWer?....568

[SENSe<ip>:]EFRontend:FREQuency:BAND<b>:UPPer?....568
[SENSe<ip>:]EFRontend:FREQuency:BCONfig:AUTO....569
[SENSe<ip>:]EFRontend:FREQuency:BCONfig:LIST?....569
[SENSe<ip>:]EFRontend:FREQuency:BCONfig:SELect....570
[SENSe<ip>:]EFRontend:FREQuency:IFRequency:MAXimum?....570
[SENSe<ip>:]EFRontend:FREQuency:IFRequency:MINimum?....570
[SENSe<ip>:]EFRontend:FREQuency:IFRequency:SIDeband?....571
[SENSe<ip>:]EFRontend:FREQuency:IFRequency[:VALue]?....571
[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:INPut:FREQuency?....571
[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:MODE....572
[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:OUTPut:FREQuency?....572
[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:OUTPut:STATe....573
[SENSe<ip>:]EFRontend:FREQuency:REFerence....573
[SENSe<ip>:]EFRontend:FREQuency:REFerence:LIST?....574
[SENSe:]EFRontend:IDN?....574
[SENSe<ip>:]EFRontend:NETWork....574

[SENSe<ip>:]EFRontend:CONNection[:STATe] <State>

Queries the external frontend connection state in the firmware.

Note: to query the physical connection state of the external frontend use `[SENSe<ip>:]EFRontend:CONNection:CSTate?` on page 567.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
The connection to the frontend is deactivated temporarily. The frontend is thus available for use elsewhere, for example by a signal generator. The measurement settings on the FSWX remain untouched.

ON | 1
Frontend connection enabled.
The frontend is reserved for exclusive use by the FSWX.

*RST: 0

Example:
```
//Global activation of external frontend
EFR ON
//Configure frontend
EFR:CONN:CONF "FE44S","123.456.789"
//Activate exclusive use of frontend by FSWX.
EFR:CONN ON
```

Manual operation: See "External frontend Connection State / Status" on page 214

[SENSe<ip>:]EFRontend:CONNection:CONFig <Type>, <IPAddress>[, <DeviceID>[, <SymbolicName>]]

Configures the connection to the external frontend.

Suffix:
<ip> Input

Parameters:
<Type> "FE170SR" | "FE110SR"
String in double quotes containing the type of frontend to be connected.

<IPAddress> string in double quotes
The IP address or computer name of the frontend connected to the FSWX via LAN. The IP address and computer name are indicated on the electronic ink display on the side panel of the frontend.

<DeviceID> string in double quotes
Unique device ID consisting of <type>-<serialnumber>
Not required or relevant for the FSWX.

<SymbolicName> string in double quotes
Symbolic name of the external frontend.
Not required or relevant for the FSWX.

Example:
```
//Global activation of external frontend
EFR ON
//Configure frontend
EFR:CONN:CONF "FE44S","123.456.789"
//Activate exclusive use of frontend by FSWX.
EFR:CONN ON
```

Manual operation: See "Frontend Type" on page 213
See "IP Address/ Host Name" on page 213

[SENSe<ip>:]EFRontend:CONNection:CSTate?

Queries the status of the physical connection to the external frontend.

Suffix:
<ip> Input

Return values:
<State> ON | OFF | 0 | 1
OFF | 0
Frontend not connected; connection error
ON | 1
Frontend connected

Usage: Query only

Manual operation: See "External frontend Connection State / Status" on page 214

[SENSe<ip>:]EFRontend:FREQuency:BAND:COUNt?

Queries the number of frequency bands provided by the selected frontend.

Suffix:
<ip> Input

Return values:
<NoBands> integer
Number of frequency bands

Example:
```
//Query number of frequency bands
EFR:FREQ:BAND:COUN?
//Result: 2
```

Usage: Query only

Manual operation: See "Frequency Band" on page 216

[SENSe<ip>:]EFRontend:FREQuency:BAND<b>:LOWer?

Queries the start of the frequency range supported by the selected frontend frequency band.

Suffix:
<ip> Input

<b> 1 to n
Band for multi-band frontends
Use `[SENSe<ip>:]EFRontend:FREQuency:BAND:COUNt?` to determine the number of available bands.

Return values:
<StartFreq> Start frequency of the specified band

Example:
```
//Query start frequency of second band
EFR:FREQ:BAND2:LOW?
//Result: 24000000000
```

Usage: Query only

Manual operation: See "Frequency Band" on page 216

[SENSe<ip>:]EFRontend:FREQuency:BAND<b>:UPPer?

Queries the end of the frequency range supported by the selected frontend frequency band.

Suffix:
<ip> Input

<b> 1 to n
Band for multi-band frontends
Use `[SENSe<ip>:]EFRontend:FREQuency:BAND:COUNt?` to determine the number of available bands.

Return values:
<StopFreq> End frequency of the specified band

Example:
```
//Query end frequency of second band
EFR:FREQ:BAND2:UPP?
//Result: 44000000000
```

Usage: Query only

Manual operation: See "Frequency Band" on page 216

[SENSe<ip>:]EFRontend:FREQuency:BCONfig:AUTO <State>

Determines whether the frequency band of the external frontend is configured automatically or manually.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Uses the frequency band configured by `[SENSe<ip>:]EFRontend:FREQuency:BCONfig:SELect` on page 570.

ON | 1
Configures the frequency band automatically.
Currently, auto mode always applies the "IF Low" range.

*RST: 1

Example:
```
//Configures the use of the IF high band manually.
EFR:FREQ:BCON:AUTO 0
EFR:FREQ:BCON:SEL "IF HIGH"
```

Manual operation: See "Frequency Band Configuration" on page 215

[SENSe<ip>:]EFRontend:FREQuency:BCONfig:LIST?

Returns the intermediate frequency (output) range of the external frontend.

Suffix:
<ip> Input

Return values:
<BandConfigs> string

"Spur Optimized"
The selected IF range avoids unwanted spurious effects.

"EVM Optimized"
(R&S FE170SR only)
The selected IF range provides an optimal EVM result.

Example:
```
EFR:FREQ:BCON:LIST?
//Result: "Spur Optimized"
EFR:FREQ:BCON:SEL "Spur Optimized"
```

Usage: Query only

Manual operation: See "Frequency Band Configuration" on page 215

[SENSe<ip>:]EFRontend:FREQuency:BCONfig:SELect <BandConfig>

Defines the intermediate frequency (output) range of the external frontend.

Suffix:
<ip> Input

Parameters:
<BandConfig>

"Spur Optimized"
(R&S FE170SR/R&S FE110SR only)
The selected IF range avoids unwanted spurious effects.

"EVM Optimized"
(R&S FE170SR only)
The selected IF range provides an optimal EVM result.

"Shared LO"
Ensures that multiple external frontends (R&S FE170SR/ R&S FE170ST or R&S FE110SR/R&S FE110ST) use the same LO frequencies for upconversion and downconversion.

Example:
```
EFR:FREQ:BCON:LIST?
//Result: "Spur Optimized"
EFR:FREQ:BCON:SEL "Spur Optimized"
```

Manual operation: See "Frequency Band Configuration" on page 215

[SENSe<ip>:]EFRontend:FREQuency:IFRequency:MAXimum?

Queries the maximum IF used for frequency conversion.

Suffix:
<ip> Input

Return values:
<IFFrequency>

Usage: Query only

[SENSe<ip>:]EFRontend:FREQuency:IFRequency:MINimum?

Queries the minimum IF used for frequency conversion.

Suffix:
<ip> Input

Return values:
<IFFrequency>

Usage: Query only

[SENSe<ip>:]EFRontend:FREQuency:IFRequency:SIDeband?

Queries the currently used sideband for frequency conversion.

Suffix:
<ip> Input

Return values:
<Sideband> "USB" | "LSB"

"USB"
Upper sideband

"LSB"
Lower sideband

Example:
```
EFR:FREQ:IFR?
EFR:FREQ:IFR:SID?
```

Usage: Query only

Manual operation: See "Intermediate Frequency" on page 216

[SENSe<ip>:]EFRontend:FREQuency:IFRequency[:VALue]?

Queries the currently used intermediate frequency (IF) for frequency conversion.

To query the maximum and minimum IF for the selected frequency range, use `[SENSe<ip>:]EFRontend:FREQuency:IFRequency:MAXimum?` on page 570 and `[SENSe<ip>:]EFRontend:FREQuency:IFRequency:MINimum?` on page 570.

Suffix:
<ip> Input

Return values:
<IFFrequency> numeric

Example:
```
EFR:FREQ:IFR?
```

Usage: Query only

Manual operation: See "Intermediate Frequency" on page 216

[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:INPut:FREQuency?

Queries the frequency of the LO input for `[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:MODE EXT`.

Suffix:
<ip> Input

Return values:
<LOInFreq> Default unit: Hz

Example: The external frontend uses the external LO provided at the "LO IN" connector.
```
EFR:FREQ:LOSC:MODE EXT
```
Query the frequency that the external LO must be provided at.
```
EFR:FREQ:LOSC:INP:FREQ?
//Result: 10615000000
```

Usage: Query only

Manual operation: See "Mandatory LO IN Frequency" on page 219

[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:MODE <Type>

Determines whether the external frontend uses its internal LO or an external LO.

Suffix:
<ip> Input

Parameters:
<Type> EXTernal | INTernal

EXTernal
Uses the external LO provided at the LO input connector of the external frontend. Query the frequency at which the LO must be input to the external frontend using `[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:INPut:FREQuency?` on page 571.

INTernal
Uses the internal LO.

*RST: EXTernal

Example:
```
EFR:FREQ:LOSC:MODE EXT
EFR:FREQ:LOSC:INP:FREQ?
//Result: 10615000000
```

Manual operation: See "LO Mode" on page 218

[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:OUTPut:FREQuency?

Queries the frequency of the LO output for `[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:OUTPut:STATe ON`.

Suffix:
<ip> Input

Return values:
<LOOutFreq> Default unit: Hz

Example: The external frontend uses the internal LO and provides it as output to the "LO OUT" connector.
```
EFR:FREQ:LOSC:MODE INT
EFR:FREQ:LOSC:OUTP:STAT ON
```
Query the frequency of the LO output.
```
EFR:FREQ:LOSC:OUTP:FREQ?
//Result: 10615000000
```

Usage: Query only

Manual operation: See "LO OUT Frequency" on page 219

[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:OUTPut:STATe <State>

Enables or disables output of the LO by the external frontend. The output frequency is returned by `[SENSe<ip>:]EFRontend:FREQuency:LOSCillator:OUTPut:STATe` on page 573.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: The external frontend provides the LO as output at the "LO OUT" connector.
```
EFR:FREQ:LOSC:OUTP:STAT ON
```
Query the frequency of the LO output.
```
EFR:FREQ:LOSC:OUTP:FREQ?
//Result: 10615000000
```

Manual operation: See "LO Out State" on page 219

[SENSe<ip>:]EFRontend:FREQuency:REFerence <Frequency>

Sets the reference frequency that is used for frequency conversion on the frontend. Depending on the connected type of frontend, different values are available. To determine which reference levels are available, use `[SENSe<ip>:]EFRontend:FREQuency:REFerence:LIST?` on page 574.

Suffix:
<ip> Input

Parameters:
<Frequency> Default unit: Hz

Example:
```
//Query the available reference levels
EFR:FREQ:REF:LIST?
//Result: 10000000,640000000,1000000000
//Use 640 MHz reference
EFR:FREQ:REF 640000000
```

Manual operation: See "Reference Frequency" on page 216

[SENSe<ip>:]EFRontend:FREQuency:REFerence:LIST?

Queries the available reference signals for the connected frontend type.

Suffix:
<ip> Input

Return values:
<References> 10000000 | 640000000 | 1000000000

Example:
```
//Query the available reference levels
EFR:FREQ:REF:LIST?
//Result: 10000000,640000000,1000000000
//Use 640 MHz reference
EFR:FREQ:REF 640000000
```

Usage: Query only

Manual operation: See "Reference Frequency" on page 216

[SENSe:]EFRontend:IDN?

Queries the device identification information (`*IDN?`) of the frontend.

Return values:
<DevInfo> string without quotes

Rohde&Schwarz,<device type>,<part number>/<serial number>,<firmware version>

Example:
```
EFR:IDN?
//Result:
Rohde&Schwarz,FE44S,1234.5678K00/123456,0.8.0
```

Usage: Query only

[SENSe<ip>:]EFRontend:NETWork <IPAddress>, <Subnet>, <DHCP State>

Sets or queries the network information for the frontend.

This information is also indicated on the electronic paper display on the side panel of the device.

Beware that if you change the network setting to DHCP = ON, the connection is aborted and you must re-establish a connection to the frontend (see `[SENSe<ip>:]EFRontend:CONNection[:STATe]` on page 566).

Suffix:
<ip> Input

Parameters:
<IPAddress> string in double quotes
IP address of the frontend

<Subnet> string in double quotes
Subnet mask of the frontend

<DHCP State> ON | OFF | 0 | 1
Indicates whether a DHCP server is used.
OFF | 0
DHCP off
ON | 1
DHCP on
*RST: 0

Example:
```
EFR:NETW?
//Result: "123.456.78.90","255.255.255.0",ON
```

Manual operation: See "IP Address" on page 222
See "Subnet Mask" on page 222
See "DHCP" on page 222
See "Apply Network Settings" on page 222

Commands for test, alignment, and diagnosis

The following commands are required to test and optimize the connection after it has initially been set up.

[SENSe<ip>:]EFRontend:ALIGnment<ch>? 575
[SENSe<ip>:]EFRontend:ALIGnment<ch>:DATE? 576
[SENSe<ip>:]EFRontend:ALIGnment<ch>:FILE 576
[SENSe<ip>:]EFRontend:ALIGnment<ch>:STATe 576
[SENSe<ip>:]EFRontend:ALIGnment<ch>:TYPE 577
[SENSe<ip>:]EFRontend:ALIGnment<ch>:VALid? 577
[SENSe<ip>:]EFRontend:FWUPdate 578
[SENSe:]EFRontend<f>:SELFtest? 578
[SENSe:]EFRontend<f>:SELFtest:RESult? 578

[SENSe<ip>:]EFRontend:ALIGnment<ch>?

Starts a self-alignment on the IF cable to the frontend and returns the result.

Suffix:
<ip> Input

<ch> Channel, for future use

Return values:
<Result> **0**
No error

>0
Error

*RST: 0

Usage: Query only

[SENSe<ip>:]EFRontend:ALIGnment<ch>:DATE?

Queries the date of the last alignment of the IF cable to the frontend.

Suffix:
<ip> Input

<ch> Channel, for future use

Return values:
<Date> "YYYY-MM-DD"
Date of last alignment

Example:
```
EFR:ALIG:DATE?
//Result: "2020-12-16"
```

Usage: Query only

[SENSe<ip>:]EFRontend:ALIGnment<ch>:FILE <File>

Selects or queries the touchstone file that contains correction data to compensate for signal losses in the cable occurring at different IF signal frequencies.

Suffix:
<ip> Input

<ch> Channel, for future use

Parameters:
<File> string in double quotes
Path and filename of the correction data file. The file must be in `s2p` format.
If the specified file is not found or does not have the correct format, an error message is returned (`-256, "File name not found", -150, "String data error"`).

Example:
```
EFR:ALIG:FILE "FE44S.s2p"
```

Manual operation: See "Load Cable Correction File" on page 217

[SENSe<ip>:]EFRontend:ALIGnment<ch>:STATe <State>

Activates correction of the IF signal due to cable loss from the frontend to the analyzer. Specify the file with correction data using `[SENSe<ip>:]EFRontend:ALIGnment<ch>:FILE` on page 576.

Suffix:
<ip> Input

<ch> Channel, for future use

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Manual operation: See "Cable Correction State" on page 216

[SENSe<ip>:]EFRontend:ALIGnment<ch>:TYPE <Type>

Selects the type of frequency correction for the IF cable from the frontend to the analyzer.

Suffix:
<ip> Input

<ch> Channel, for future use

Parameters:
<Type> FILE | ADJustment

FILE
Frequency correction using the file specified with `[SENSe<ip>:]EFRontend:ALIGnment<ch>:FILE` on page 576.

ADJustment
Frequency correction using self-alignment data, see `[SENSe<ip>:]EFRontend:ALIGnment<ch>?` on page 575.

[SENSe<ip>:]EFRontend:ALIGnment<ch>:VALid?

Queries whether the correction data file is valid.

Suffix:
<ip> Input

<ch> Channel, for future use

Return values:
<Result> 0 | 1

0
The file is not valid.
For `.s2p` file correction: format incorrect or current IF-frequency (of ext. FE) + demodulation bandwidth is not covered in frequency range of `.s2p` file.
For self-alignment correction: self-alignment failed or has not been performed.

1
The file is valid.

Example:
```
EFR:ALIG:FILE "FE44S.s2p"
EFR:ALIG:VAL?
```

Usage: Query only

[SENSe<ip>:]EFRontend:FWUPdate

Updates the firmware on the external frontend. Note that this process can take some time.

Suffix:
<ip> Input

Usage: Event

Manual operation: See "FW Update" on page 214

[SENSe:]EFRontend<f>:SELFtest?

Performs a self-test on the frontend to compare the current performance and characteristic values with the specified values for the frontend.

As a result, the success is returned.

Suffix:
<f> 1
RF input connector 1 | 2

Return values:
<Result> **0**
No error
>0
Error
*RST: 0

Example:
```
EFR:SELF?
//Result: 0
```

Usage: Query only

Manual operation: See "Start Selftest" on page 220

[SENSe:]EFRontend<f>:SELFtest:RESult?

Queries the results of the self-test on the frontend.

Suffix:
<f> 1
RF input connector 1 | 2

Return values:
<Result> String containing xml data in double quotes

Example: `EFR:SELF:RES?`
For details, see "Format of self-test result file" on page 583.

Usage: Query only

Manual operation: See "Selftest Results" on page 221

Commands for external devices

You can insert additional external devices in the signal path between the DUT and the external frontend, such as preamplifiers or filters. The external frontend must then consider the additional gain or correction values.

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:FILE....579
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:STATe....580
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?....580
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:LIST?....580
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:REFResh....581
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MAXimum?....581
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MINimum?....582
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?....582
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:NAME?....583
[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:TYPE?....583

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:FILE
<File>

Defines the correction file to compensate for signal losses by the external devices occurring at different IF signal frequencies.

To query whether the loaded file is valid or not, use `[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?` on page 580.

Suffix:
<ip> Input

<ch> Channel, for future use

<di> External device 1 | 2

Parameters:
<File>

Example:
```
SENS:EFR:CHAN:EXTD:CORR:FILE 'ExtDev_Corr.s2p'
SENS:EFR:CHAN:EXTD:CORR:STAT ON
SENS:EFR:CHAN:EXTD:CORR:FILE:VAL?
```

Manual operation: See "Load S2P File" on page 225

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:STATe
<State>

Enables or disables the use of a correction file for the connected external devices. The file is defined by `[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:FILE` on page 579.

Suffix:
<ip> Input
<ch> Channel, for future use
<di> External device 1 | 2

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on
*RST: 0

Example:
```
SENS:EFR:CHAN:EXTD:CORR:FILE 'ExtDev_Corr.s2p'
SENS:EFR:CHAN:EXTD:CORR:STAT ON
```

Manual operation: See "Correction State" on page 224

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:CORRection:VALid?

Queries whether the loaded correction file for an external device is valid or not.

Suffix:
<ip> Input
<ch> Channel, for future use
<di> External device 1 | 2

Return values:
<Result> ON | OFF | 0 | 1
OFF | 0
File is valid.
ON | 1
File is not valid.

Usage: Query only

Manual operation: See "Load S2P File" on page 225

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:LIST?

Queries the names of all detected connected devices at the external frontend.

Suffix:
<ip> Input
<ch> Channel, for future use
<di> External device 1 | 2

Return values:
<Devices> Comma-separated list of the names of the devices.

Example:
```
:SENSe1:EFRontend1:CHANnel1:EXTDevice1:LIST?
//Result:
//"fe170_z50","fe170_z01"
```

Usage: Query only

Manual operation: See "Name" on page 224

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:REFResh

Scans the ports of the external frontend and refreshes the display with detected information on connected devices. This function is useful after connecting a new device to the frontend.

Suffix:
<ip> Input
<ch> Channel, for future use
<di> External device 1 | 2

Example:
```
SENSe1:EFRontend1:CHANnel:EXTDevice1:REFResh
```

Usage: Event

Manual operation: See "Refresh External Devices" on page 223

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MAXimum?

Queries the upper limit of the supported frequency range of the connected device.

Suffix:
<ip> Input
<ch> 1..n
Channel, for future use
<di> 1..n

Return values:
<RFFrequency> numeric value
Maximum frequency
Default unit: Hz

Example:
```
SENS:EFR:EXTD1:FREQ:MAX?
//Result:
170000000000
```

Usage: Query only

Manual operation: See "Frequency Range" on page 224

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:FREQuency:MINimum?

Queries the lower limit of the supported frequency range of the connected device.

Suffix:

<ip> Input

<ch> 1..n
Channel, for future use

<di> 1..n

Return values:

<RFFrequency> numeric value
Minimum frequency
Default unit: Hz

Example:
```
SENS:EFR:EXTD1:FREQ:MIN?
//Result:
110000000000
```

Usage: Query only

Manual operation: See "Frequency Range" on page 224

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:GAIN?

Queries the gain provided by a connected external amplifier.

Suffix:

<ip> Input

<ch> 1..n
Channel, for future use

<di> 1..n

Return values:

<Gain> numeric value
Default unit: dB

Example:
```
SENSe1:EFRontend1:CHANnel1:EXTDevice1:GAIN?
//Result:
//10
```

Usage: Query only

Manual operation: See "Gain" on page 224

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:NAME?

Queries the name of the external device for reference.

Suffix:
<ip> Input

<ch> 1..n
Channel, for future use

<di> 1..n

Return values:
<Type> string

Example:
```
SENS:EFR:CHAN:EXTD1:NAME?
//Result:
//'fe170_z50'
```

Usage: Query only

Manual operation: See "Name" on page 224

[SENSe<ip>:]EFRontend[:CHANnel<ch>]:EXTDevice<di>:TYPE?

Queries the type of the detected device for reference.

Suffix:
<ip> Input

<ch> 1..n
Channel, for future use

<di> 1..n

Return values:
<Type> 'Amplifier' | 'Filter'

Example:
```
SENSe1:EFRontend1:CHANnel1:EXTDevice1:TYPE?
//Result:
//'Filter'
```

Usage: Query only

Manual operation: See "Type" on page 224

Format of self-test result file

As a result of the self-test, an XML file with test details is created. It contains the following information in the specified order. Mandatory elements and attributes are indicated in bold font.

Element	Attributes	Description
<Sequence>		Main element
	Name	="Self-test"

Element	Attributes	Description
	Description	Optional description of the test process
	FirmwareVersion	Firmware version of the controlling instrument (FSWX)
	FrontendLibrary-Version	Version of the `control.dll` with the format `x.y.z`
	FrontendServerVer-sion	Version of the RRH server with the format `x.y.z` (FE44A only)
	Date	Date the self-test was performed, with the format `dd/mm/yyyy`
	Time	Time the self-test was performed, with the format `hh:mm:ss`
	State	Test result state, combined result of all <SequenceCate-gory>s: `"PASSED"`/ `"FAILED"`
	Version	For internal use.
	Comment	Optional comment on the test process
<SequenceCate-gory>		Set of test steps
	Name	Name of the test sequence, e.g. "Frontend voltages"
	Description	Optional description of the test sequence
	State	Test sequence result state, combined result of all <Sequence-Step>s: `"PASSED"`/ `"FAILED"`
	Version	For internal use.
	Comment	Optional comment on the test sequence
<SequenceStep>		Subelement of **<SequenceCategory>** for an individual test step
	Name	Name of the individual test step, e.g. FE1_3V3
	Description	Optional description of the test step
	LimitLow	Optional: lower limit to be checked
	LimitHigh	Optional: upper limit to be checked
	MeasValue	Optional: measured value
	Unit	Optional: unit of the measured value
	State	Test step result state:`"PASSED"`/ `"FAILED"`
	Version	For internal use.
	Comment	Optional comment on the test step

Example for self-test result XML file

```
<?xml version="1.0" encoding="UTF-8"?>
<Sequence xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
          xsi:noNamespaceSchemaLocation="SelfTest_Schema.xsd">
 <Name>DeviceCheck</Name>
 <FirmwareVersion>1.50-21.1.1.0 Beta</FirmwareVersion>
```

```
<FrontendLibraryVersion>0.8.0</FrontendLibraryVersion>
<Date>15/01/2021</Date>
<Time>08:51:35</Time>
<State>FAILED</State>
<Version>1.0.0</Version>
<SequenceCategory>
 <Name>Frontend Voltages</Name>
 <Description>test description</Description>
 <State>FAILED</State>
 <Version>1.0.0</Version>
 <Type>Diagnose</Type>
 <SequenceStep>
  <Name>FE1_3V3</Name>
  <LimitLow>3.000</LimitLow>
  <LimitHigh>3.600</LimitHigh>
  <MeasValue>3.311</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>FE1_5V</Name>
  <LimitLow>4.250</LimitLow>
  <LimitHigh>5.750</LimitHigh>
  <MeasValue>5.027</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>FE1_6V5</Name>
  <LimitLow>6.000</LimitLow>
  <LimitHigh>7.000</LimitHigh>
  <MeasValue>5.893</MeasValue>
  <State>FAILED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>FE1_M3V3</Name>
  <LimitLow>-3.600</LimitLow>
  <LimitHigh>-3.000</LimitHigh>
  <MeasValue>3.347</MeasValue>
  <State>FAILED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
</SequenceCategory>
<SequenceCategory>
 <Name>Frontend Temperature</Name>
 <Description>test description</Description>
 <State>PASSED</State>
 <Version>1.0.0</Version>
 <Type>Diagnose</Type>
```

```
 <SequenceStep>
  <Name>TEMP_FE1</Name>
  <LimitLow>0.000</LimitLow>
  <LimitHigh>60.000</LimitHigh>
  <MeasValue>39.300</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
</SequenceCategory>
<SequenceCategory>
 <Name>Synthesizer Voltage</Name>
 <Description>test description</Description>
 <State>PASSED</State>
 <Version>1.0.0</Version>
 <Type>Diagnose</Type>
 <SequenceStep>
  <Name>SYNTH_3V4</Name>
  <LimitLow>3.200</LimitLow>
  <LimitHigh>3.910</LimitHigh>
  <MeasValue>3.576</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>SYNTH_5V4_SYN</Name>
  <LimitLow>4.860</LimitLow>
  <LimitHigh>5.940</LimitHigh>
  <MeasValue>5.405</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>SYNTH_5V4_YIG</Name>
  <LimitLow>4.860</LimitLow>
  <LimitHigh>5.940</LimitHigh>
  <MeasValue>5.438</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>SYNTH_M5V</Name>
  <LimitLow>-5.500</LimitLow>
  <LimitHigh>-4.500</LimitHigh>
  <MeasValue>-4.948</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>SYNTH_REF5V</Name>
  <LimitLow>4.500</LimitLow>
```

```
  <LimitHigh>5.500</LimitHigh>
  <MeasValue>5.031</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
</SequenceCategory>
<SequenceCategory>
 <Name>Supply Voltage</Name>
 <Description>test description</Description>
 <State>PASSED</State>
 <Version>1.0.0</Version>
 <Type>Diagnose</Type>
 <SequenceStep>
  <Name>SUPPLY_12V</Name>
  <LimitLow>10.800</LimitLow>
  <LimitHigh>13.200</LimitHigh>
  <MeasValue>11.909</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>SUPPLY_3V3D</Name>
  <LimitLow>2.970</LimitLow>
  <LimitHigh>3.630</LimitHigh>
  <MeasValue>3.318</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>SUPPLY_4V</Name>
  <LimitLow>3.650</LimitLow>
  <LimitHigh>4.460</LimitHigh>
  <MeasValue>4.053</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>SUPPLY_6V</Name>
  <LimitLow>5.400</LimitLow>
  <LimitHigh>6.600</LimitHigh>
  <MeasValue>6.076</MeasValue>
  <State>PASSED</State>
  <Version>1.0.0</Version>
 </SequenceStep>
 <SequenceStep>
  <Name>SUPPLY_M5V</Name>
  <LimitLow>-6.050</LimitLow>
  <LimitHigh>-4.950</LimitHigh>
  <MeasValue>-5.507</MeasValue>
  <State>PASSED</State>
```

```
   <Version>1.0.0</Version>
  </SequenceStep>
 </SequenceCategory>
</Sequence>
```

Programming example: Configuring an external frontend

The following example describes how to configure RF frontend settings in remote operation.

```
// Prepare the instrument
// Preset
*RST
// Create new IQ-Analyzer channel
:INST:SEL IQ
// Enable 640MHz Reference
:ROSC:O640 ON

//Enable general use of external frontend
SENSe:EFRontend:STATe ON
//Configure connection to ext. FE named "FE44S-1000826"
SENSe:EFRontend:CONNection:CONFig "FE44S","FE44S-1000826"
//Activate exclusive use of frontend by FSWX.
SENSe:EFRontend:CONNection:STATe ON

//For demonstration purposes only: assign a static IP address
SENSe:EFRontend:NETWork "123.456.7.8", "255.255.255.00", OFF

// Query information about the connected RF frontend.
SENSe:EFRontend:CONNection:CSTAte?
// Response: 1 (connected)
SENSe:EFRontend:IDN?
////Result: Rohde&Schwarz,FE44S,1234.5678K00/123456,0.8.0

// Specify frontend settings
//Query available intermediate frequency bands
SENSe:EFRontend:FREQuency:BCONfig:LIST?
//Result: "IF HIGH", "IF LOW"
//Use high IF
SENSe:EFRontend:FREQuency:BCONfig:SELect "IF HIGH"
//Query used intermediate frequency
SENSe:EFRontend:FREQuency:IFRequency?
//Result: 8.595000000

//Query available reference frequencies
SENSe:EFRontend:FREQuency:REFerence:LIST?
//Result: 10000000,640000000,1000000000
//Use 640 MHz reference
SENSe:EFRontend:FREQuency:REFerence 640000000

// Query ranges of the operating frequency band.
SENSe:EFRontend:FREQuency:BAND1:LOWer?
```

```
// Response in Hz: "24000000000" (= 24 GHz)
SENSe:EFRontend:FREQuency:BAND1:UPPer?
// Response in Hz: "44000000000" (= 44 GHz)

// Add cable correction data by loading an *.s2p file.
SENSe:EFRontend:ALIGnment:FILE "C:/R_S/Instr/user/external_frontends/FE44S/
touchstonefiles/if_default_cable_1347_7552_00.s2p"
SENSe:EFRontend:ALIGnment:STATe ON

//Update FW version on frontend (only available if external frontend firmware
//is incompatible to FSWX firmware)
SENSe:EFRontend:FWUPdate
//Perform a selftest on the frontend and query results
SENSe:EFRontend:SELFtest?
//Result: 0 (no errors)
SENSe:EFRontend:SELFtest:RESult?
//Result: "<?xml version="1.0" encoding="UTF-8"?>
//<Sequence xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
//xsi:noNamespaceSchemaLocation="
//<Name>DeviceCheck</Name>
//<FirmwareVersion>1.50-21.1.1.0 Beta</FirmwareVersion>
//..."
```

Programming example 2: Configuring an external frontend with a connected amplifier

The following example demonstrates how to configure an R&S FE170SR external frontend with a connected amplifier.

Some commands may not be necessary as they reflect the default settings. However, they are included to demonstrate the command usage.

```
// Prepare the instrument
// Preset
*RST
// Create new IQ-Analyzer channel
:INST:SEL IQ
// Enable 640MHz Reference
:ROSC:O640 ON

//Enable general use of external frontend
SENSe:EFRontend:STATe ON
//Configure connection to ext. FE named "FE170SR-123456"
SENSe:EFRontend:CONNection:CONFig "FE170SR","FE170SR-123456"
//Activate exclusive use of frontend by FSWX.
SENSe:EFRontend:CONNection:STATe ON

// Query information about the connected RF frontend.
SENSe:EFRontend:CONNection:CSTAte?
// Response: 1 (connected)
SENSe:EFRontend:IDN?
////Result: Rohde&Schwarz,FE170SR,1234.5678K00/123456,0.8.0
```

```
// Specify frontend settings
//Query available intermediate frequency bands
SENSe:EFRontend:FREQuency:BCONfig:LIST?
//Result: "Spur Optimized","EVM Optimized"
//Use spur optimized
SENSe:EFRontend:FREQuency:BCONfig:SELect "Spur Optimized"
//Query used intermediate frequency
SENSe:EFRontend:FREQuency:IFRequency?
//Result: 9940000000

//Query available reference frequencies
SENSe:EFRontend:FREQuency:REFerence:LIST?
//Result: 10000000,640000000,1000000000
//Use 1 GHz reference
SENSe:EFRontend:FREQuency:REFerence 1000000000

// Query ranges of the operating frequency band.
SENSe:EFRontend:FREQuency:BAND1:LOWer?
// Response in Hz: "110000000000" (= 110 GHz)
SENSe:EFRontend:FREQuency:BAND1:UPPer?
// Response in Hz: "170000000000" (= 170 GHz)

// Add cable correction data by loading an *.s2p file.
SENSe:EFRontend:ALIGnment:FILE "C:/R_S/Instr/user/external_frontends/FE170SR/
touchstonefiles/if_default_cable_1348_3850_00.s2p"
SENSe:EFRontend:ALIGnment:STATe ON

//Configure external amplifier named "fe170_z50" connected to frontend
//Refresh and query the list of detected external devices
SENSe:EFRontend:EXTDevice:REFResh
SENSe:EFRontend:EXTDevice:LIST?
//Result:
//"fe170_z50"
//Query the type of the external device
SENSe:EFRontend:EXTDevice:TYPE?
//Result:
//'Amplifier'
//Query the supported frequency range of the amplifier
SENSe:EFRontend:EXTDevice1:FREQuency:MINimum?
//Result:
//110000000000
SENSe:EFRontend:EXTDevice1:FREQuency:MAXimum?
//Result:
//170000000000
//Query the gain of the amplifier
SENSe:EFRontend:EXTDevice1:GAIN?
//Result:
//10
//Only for demonstration purposes:
//Load and enable a correction file for the amplifier.
//The correction file is automatically considered if the IX cable is used to connect
```

```
//the external device to the frontend.
SENSe:EFRontend:EXTDevice1:CORRection:FILE 'C:/temp/ExtDev_Corr.s2p'
SENSe:EFRontend:EXTDevice1:CORRection:STATe ON
//Check if the loaded file is valid
SENSe:EFRontend:EXTDevice1:CORRection:VALid?
```

4.14.6.5 Setting up probes

Modular probes can be connected to any of the RF input connectors of the FSWX.

For details see Section 4.2.4.1, "Basics on probes", on page 201.

Useful commands for setting up probes described elsewhere:

- `INPut<ip>:CONNector` on page 553

Remote commands exclusive to setting up probes:

[SENSe:]PROBe<pb>:ID:PARTnumber? 591
[SENSe:]PROBe<pb>:ID:SRNumber? 591
[SENSe:]PROBe<pb>:SETup:ATTRatio 592
[SENSe:]PROBe<pb>:SETup:CMOFfset 592
[SENSe:]PROBe<pb>:SETup:DMOFfset 593
[SENSe:]PROBe<pb>:SETup:MODE 593
[SENSe:]PROBe<pb>:SETup:NAME? 594
[SENSe:]PROBe<pb>:SETup:NMOFfset 594
[SENSe:]PROBe<pb>:SETup:PMODe 594
[SENSe:]PROBe<pb>:SETup:PMOFfset 595
[SENSe:]PROBe<pb>:SETup:STATe? 596
[SENSe:]PROBe<pb>:SETup:TYPE? 596

[SENSe:]PROBe<pb>:ID:PARTnumber?

Queries the Rohde & Schwarz part number of the probe.

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Return values:
<PartNumber>

Example: //Query part number
`PROB3:ID:PART?`

Usage: Query only

Manual operation: See "Part Number" on page 204

[SENSe:]PROBe<pb>:ID:SRNumber?

Queries the serial number of the probe.

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Return values:
<SerialNo>

Example: //Query serial number
`PROB3:ID:SRN?`

Usage: Query only

Manual operation: See "Serial Number" on page 204

[SENSe:]PROBe<pb>:SETup:ATTRatio <AttenuationRatio>

Prerequisite: modular probe

Defines the attenuation applied to the input at the probe.

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Parameters:
<AttenuationRatio> **10**
Attenuation by 20 dB (ratio= 10:1)
2
Attenuation by 6 dB (ratio= 2:1)
*RST: 10
Default unit: dB

Example: `SENS:PROB:SET:ATTR 10`

Manual operation: See "Attenuation" on page 205

[SENSe:]PROBe<pb>:SETup:CMOFfset <CMOffset>

Prerequisite: A differential probe in CM-mode is connected to the FSWX. Sets the common mode offset.

If the probe is disconnected, the common mode offset of the probe is reset to 0.0 V.

Note that if the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

For details see the FSWX User Manual.

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Parameters:

<CMOffset> Offset of the mean voltage between the positive and negative input terminal vs. ground

Range: -16 V to +16 V
Default unit: V

Example: `SENS:PROB:SET:CMOF 1`

Manual operation: See "Common Mode Offset/ Diff. Mode Offset / P Offset / N Offset /" on page 205

[SENSe:]PROBe<pb>:SETup:DMOFfset <DMOffset>

Prerequisite: A modular probe in DM-mode is connected to the FSWX. Sets the DM-mode offset.

If the probe is disconnected, the DM-mode offset of the probe is reset to 0.0 V.

Note that if the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

For details see the FSWX User Manual.

Suffix:

<pb> 1..n
Selects the connector:
3 = RF

Parameters:

<DMOffset> Voltage offset between the positive and negative input terminal

Default unit: V

Example: `SENS:PROB:SET:DMOF 0.1`

Manual operation: See "Common Mode Offset/ Diff. Mode Offset / P Offset / N Offset /" on page 205

[SENSe:]PROBe<pb>:SETup:MODE <Mode>

Active Rohde & Schwarz probes (except for R&S RT-ZS10E) have a configurable microbutton on the probe head.

Suffix:

<pb> 1..n
Selects the connector:
3 = RF

Parameters:

<Mode> RSINgle | NOACtion

RSINgle
Run single: starts one data acquisition.

NOACtion
Nothing is started on pressing the micro button.

Example: `SENS:PROB:SET:MODE NOAC`

Manual operation: See "Microbutton Action" on page 205

[SENSe:]PROBe<pb>:SETup:NAME?

Queries the name of the probe.

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Return values:
<Name> String containing the name of the probe.

Example: //Query name of the probe
`PROB3:SET:NAME?`

Usage: Query only

Manual operation: See "Name" on page 204

[SENSe:]PROBe<pb>:SETup:NMOFfset <NMOffset>

Prerequisite: A modular probe in N-mode is connected to the FSWX. Sets the N-mode offset. The maximum voltage difference between the positive and negative input terminals is 16 V.

If the probe is disconnected, the N-mode offset of the probe is reset to 0.0 V.

Note that if the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

For details, see Section 4.2.4.1, "Basics on probes", on page 201.

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Parameters:
<NMOffset> The voltage offset between the negative input terminal and ground.
Default unit: V

Example: `SENS:PROB:SET:NMOF 0.1`

Manual operation: See "Common Mode Offset/ Diff. Mode Offset / P Offset / N Offset /" on page 205

[SENSe:]PROBe<pb>:SETup:PMODe <Mode>

Determines the mode of a multimode modular probe.

For details see Section 4.2.4.1, "Basics on probes", on page 201.

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Parameters:
<Mode> CM | DM | PM | NM

DM
Voltage between the positive and negative input terminal

CM
Mean voltage between the positive and negative input terminal vs. ground

PM
Voltage between the positive input terminal and ground

NM
Voltage between the negative input terminal and ground

Example: `SENS:PROB:SETU:PMOD PM`
Sets the probe to P-mode.

Manual operation: See "Mode" on page 205

[SENSe:]PROBe<pb>:SETup:PMOFfset <PMOffset>

Prerequisite: A modular probe in P-mode is connected to the FSWX. Sets the P-mode offset. The maximum voltage difference between the positive and negative input terminals is 16 V.

If the probe is disconnected, the P-mode offset of the probe is reset to 0.0 V.

Note that if the offset for DM-mode or CM-mode is changed, the offsets for the P-mode and N-mode are adapted accordingly, and vice versa.

For details, see "Multimode function and offset compensation for modular RF probes" on page 202.

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Parameters:
<PMOffset> The voltage offset between the positive input terminal and ground.

Default unit: V

Example: `SENS:PROB:SET:PMOF 0.1`

Manual operation: See "Common Mode Offset/ Diff. Mode Offset / P Offset / N Offset /" on page 205

[SENSe:]PROBe<pb>:SETup:STATe?

Queries if the probe at the specified connector is active (detected) or not active (not detected).

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Return values:
<State> DETected | NDETected

Example: //Query connector state
`PROB3:SET:STAT?`

Usage: Query only

[SENSe:]PROBe<pb>:SETup:TYPE?

Queries the type of the probe.

Suffix:
<pb> 1..n
Selects the connector:
3 = RF

Return values:
<Type> String containing one of the following values:
–"None" (no probe detected)
– "active differential"
– "active single-ended"
– "active modular"

Example: //Query probe type
`PROB3:SET:TYPE?`

Usage: Query only

Manual operation: See "Type" on page 205

4.14.6.6 Working with power sensors

The following commands describe how to work with power sensors.

These commands require the use of a Rohde & Schwarz power sensor. For a list of supported sensors, see the specifications document.

- Configuring power sensors 597
- Configuring power sensor measurements 598
- Configuring power sensor math 605
- Triggering with power sensors 606

Configuring power sensors

SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe] 597
SYSTem:COMMunicate:RDEVice:PMETer<p>:COUNt? 597
SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine 597

SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe] <State>

Enables or disables automatic assignment of a power sensor to the power sensor index.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `SYST:COMM:RDEV:PMET:CONF:AUTO OFF`

Manual operation: See "Select" on page 195

SYSTem:COMMunicate:RDEVice:PMETer<p>:COUNt?

Queries the number of power sensors currently connected to the FSWX.

Suffix:
<p> Power sensor index

Return values:
<NumberSensors> Number of connected power sensors.

Example: `SYST:COMM:RDEV:PMET:COUN?`

Usage: Query only

Manual operation: See "Select" on page 195

SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine <Placeholder>, <Type>, <Interface>, <SerialNo>

Assigns the power sensor with the specified serial number to the selected power sensor index (configuration).

The query returns the power sensor type and serial number of the sensor assigned to the specified index.

Suffix:
<p> Power sensor index

Parameters:
<Placeholder> Currently not used

<Type> Detected power sensor type, e.g. "NRP-Z81".

<Interface> Interface the power sensor is connected to; always "USB"

<SerialNo> Serial number of the power sensor assigned to the specified index

Example:
```
SYST:COMM:RDEV:PMET2:DEF
'','NRP-Z81','','123456'
```
Assigns the power sensor with the serial number '123456' to the configuration "Power Sensor 2".
```
SYST:COMM:RDEV:PMET2:DEF?
```
Queries the sensor assigned to "Power Sensor 2".
Result:
```
'','NRP-Z81','USB','123456'
```
The NRP-Z81 power sensor with the serial number '123456' is assigned to the "Power Sensor 2".

Manual operation: See "Select" on page 195

Configuring power sensor measurements

CALibration:PMETer<p>:ZERO:AUTO ONCE 598
CALCulate<n>:PMETer<p>:RELative[:MAGNitude] 599
CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE 599
CALCulate<n>:PMETer<p>:RELative:STATe 599
FETCh:PMETer<p>? 600
READ:PMETer<p>? 600
[SENSe:]PMETer<p>:DCYCle[:STATe] 600
[SENSe:]PMETer<p>:DCYCle:VALue 600
[SENSe:]PMETer<p>:FREQuency 601
[SENSe:]PMETer<p>:FREQuency:LINK 601
[SENSe:]PMETer<p>:MTIMe 602
[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt 602
[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] 602
[SENSe:]PMETer<p>:ROFFset[:STATe] 603
[SENSe:]PMETer<p>:SOFFset 603
[SENSe:]PMETer<p>[:STATe] 603
[SENSe:]PMETer<p>:UPDate[:STATe] 604
UNIT<n>:PMETer<p>:POWer 604
UNIT<n>:PMETer<p>:POWer:RATio 604

CALibration:PMETer<p>:ZERO:AUTO ONCE

Zeroes the power sensor.

Note that you have to disconnect the signals from the power sensor input before you start to zero the power sensor. Otherwise, the results are invalid.

Suffix:
<p> Power sensor index

Example:
```
CAL:PMET2:ZERO:AUTO ONCE;*WAI
```
Starts zeroing the power sensor 2 and delays the execution of further commands until zeroing is concluded.

Usage: Event

Manual operation: See "Zeroing Power Sensor" on page 195

CALCulate<n>:PMETer<p>:RELative[:MAGNitude] <RefValue>

Defines the reference value for relative measurements.

Suffix:
<n> Window 1 to 16

<p> Power sensor index

Parameters:
<RefValue> Range: -200 dBm to 200 dBm
*RST: 0
Default unit: dBm

Example: `CALC:PMET2:REL -30`
Sets the reference value for relative measurements to -30 dBm for power sensor 2.

Manual operation: See "Reference Value" on page 196

CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE

Sets the current measurement result as the reference level for relative measurements.

Suffix:
<n> Window 1 to 16

<p> Power sensor index

Example: `CALC:PMET2:REL:AUTO ONCE`
Takes the current measurement value as reference value for relative measurements for power sensor 2.

Usage: Event

Manual operation: See "Obtaining the reference level from the measurement (Meas -> Ref)" on page 196

CALCulate<n>:PMETer<p>:RELative:STATe <State>

Enables or disables relative power sensor measurements.

Suffix:
<n> Window 1 to 16

<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:PMET2:REL:STAT ON`
Activates the relative display of the measured value for power sensor 2.

FETCh:PMETer<p>?

Queries the results of power sensor measurements.

Suffix:
<p> Power sensor index

Example: `FETC:PMET?`

Usage: Query only

READ:PMETer<p>?

Initiates a power sensor measurement and queries the results.

Suffix:
<p> Power sensor index

Example: `READ:PMET?`

Usage: Query only

[SENSe:]PMETer<p>:DCYCle[:STATe] <State>

Enables or disables the duty cycle correction.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:DCYC:STAT ON`

Manual operation: See "Duty Cycle" on page 197

[SENSe:]PMETer<p>:DCYCle:VALue <Percentage>

Defines the duty cycle for the correction of pulse signals.

The power sensor uses the duty cycle in combination with the mean power to calculate the power of the pulse.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<Percentage> Range: 0.001 to 99.999
*RST: 99.999
Default unit: %

Example: `PMET2:DCYC:STAT ON`
Activates the duty cycle correction.
`PMET2:DCYC:VAL 0.5`
Sets the correction value to 0.5%.

Manual operation: See "Duty Cycle" on page 197

[SENSe:]PMETer<p>:FREQuency <Frequency>

Defines the frequency of the power sensor.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<Frequency> The available value range is defined in the specifications document of the power sensor in use.
*RST: 50 MHz
Default unit: Hz

Example: `PMET2:FREQ 1GHZ`
Sets the frequency of the power sensor to 1 GHz.

Manual operation: See "Frequency Manual" on page 195

[SENSe:]PMETer<p>:FREQuency:LINK <Coupling>

Selects the frequency coupling for power sensor measurements.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<Coupling> CENTer | MARKer1 | OFF

CENTer
Couples the frequency to the center frequency of the analyzer

MARKer1
Couples the frequency to the position of marker 1

OFF
Switches the frequency coupling off

*RST: CENTer

Example: `PMET2:FREQ:LINK CENT`
Couples the frequency to the center frequency of the analyzer

Manual operation: See "Frequency Coupling" on page 195

[SENSe:]PMETer<p>:MTIMe <Duration>

Selects the duration of power sensor measurements.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<Duration> SHORt | NORMal | LONG
*RST: NORMal

Example: `PMET2:MTIM SHOR`
Sets a short measurement duration for measurements of stationary high power signals for the selected power sensor.

Manual operation: See "Meas Time / Average" on page 196

[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt <NumberReadings>

Sets the number of power readings included in the averaging process of power sensor measurements.

Extended averaging yields more stable results for power sensor measurements, especially for measurements on signals with a low power, because it minimizes the effects of noise.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<NumberReadings> An average count of 0 or 1 performs one power reading.
Range: 0 to 256
Increment: binary steps (1, 2, 4, 8, ...)

Example: `PMET2:MTIM:AVER ON`
Activates manual averaging.
`PMET2:MTIM:AVER:COUN 8`
Sets the number of readings to 8.

Manual operation: See "Average count" on page 197

[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] <State>

Enables or disables averaging for power sensor measurements.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:MTIM:AVER ON`
Activates manual averaging.

Manual operation: See "Meas Time / Average" on page 196

[SENSe:]PMETer<p>:ROFFset[:STATe] <State>

Includes or excludes the reference level offset of the analyzer for power sensor measurements.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:ROFF OFF`
Takes no offset into account for the measured power.

Manual operation: See "Use Ref Level Offset" on page 196

[SENSe:]PMETer<p>:SOFFset <SensorOffset>

Prerequisite: `[SENSe:]PMETer<p>:ROFFset[:STATe]` is disabled. Considers the specified offset for the measured power.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<SensorOffset> Default unit: dB

Example: `PMET2:SOFF 0.001`

Manual operation: See "Sensor Level Offset" on page 196

[SENSe:]PMETer<p>[:STATe] <State>

Enables or disables a power sensor.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET1 ON`
Switches the power sensor measurements on.

Manual operation: See "Select" on page 195

[SENSe:]PMETer<p>:UPDate[:STATe] <State>

Enables or disables continuous update of power sensor measurements.

If on, the results are updated even if a single sweep is complete.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET1:UPD ON`
The data from power sensor 1 is updated continuously.

Manual operation: See "Continuous Update" on page 195

UNIT<n>:PMETer<p>:POWer <Unit>

Selects the unit for absolute power sensor measurements.

Suffix:
<n> Window 1 to 16

<p> Power sensor index

Parameters:
<Unit> DBM | WATT | W | DB | PCT

*RST: DBM

Example: `UNIT:PMET:POW DBM`

Manual operation: See "Unit/Scale" on page 196

UNIT<n>:PMETer<p>:POWer:RATio <Unit>

Selects the unit for relative power sensor measurements.

Suffix:
<n> Window 1 to 16

<p> Power sensor index

Parameters:

<Unit> DB | PCT

*RST: DB

Example:
```
UNIT:PMET:POW:RAT DB
```

Manual operation: See "Unit/Scale" on page 196

Configuring power sensor math

You can determine the difference between results from multiple power sensors in one measurement using the power sensor math function.

[SENSe:]PMETer:MATH[:STATe] 605
[SENSe:]PMETer:MATH:MINuend 605
[SENSe:]PMETer:MATH:SUBTrahend 606
[SENSe:]PMETer:MATH:RESult? 606

[SENSe:]PMETer:MATH[:STATe] <State>

Enables or disables the math function for the power sensor results.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
PMET:MATH:STAT ON
//Subtract the value for power sensor 2 from power sensor 1.
PMET:MATH:MIN 1
PMET:MATH:SUBT 2
PMET:MATH:RES?
```

Manual operation: See "Math State" on page 199

[SENSe:]PMETer:MATH:MINuend <Minuend>

Defines the minuend for power sensor math (<Sensor A> in <Sensor A> - <SensorB>).

Parameters:

<Minuend> 1 | 2 | 3 | 4

Manual operation: See "Math Result" on page 199

[SENSe:]PMETer:MATH:SUBTrahend <Subtrahend>

Defines the subtrahend for power sensor math (<Sensor B> in <Sensor A> - <SensorB>).

Parameters:
<Subtrahend> 1 | 2 | 3 | 4

Manual operation: See "Math Result" on page 199

[SENSe:]PMETer:MATH:RESult?

Returns the difference between results from multiple power sensors (<Sensor A> - <SensorB>).

Return values:
<MathResult>

Usage: Query only

Triggering with power sensors

[SENSe:]PMETer<p>:TRIGger:DTIMe....606
[SENSe:]PMETer<p>:TRIGger:HOLDoff....606
[SENSe:]PMETer<p>:TRIGger:HYSTeresis....607
[SENSe:]PMETer<p>:TRIGger:LEVel....607
[SENSe:]PMETer<p>:TRIGger:SLOPe....608
[SENSe:]PMETer<p>:TRIGger[:STATe]....608

[SENSe:]PMETer<p>:TRIGger:DTIMe <Time>

Defines the time period that the input signal has to stay below the IF power trigger level before the measurement starts.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<Time> Range: 0 s to 1 s
Increment: 100 ns
*RST: 100 µs
Default unit: s

Example:
```
PMET2:TRIG:DTIMe 0.001
```

[SENSe:]PMETer<p>:TRIGger:HOLDoff <Holdoff>

Defines the trigger holdoff for external power triggers.

Suffix:
<p> Power sensor 1 to 4

Parameters:

<Holdoff> Time period that has to pass between the trigger event and the start of the measurement, in case another trigger event occurs.

Range: 0 s to 1 s
Increment: 100 ns
*RST: 0 s
Default unit: s

Example: `PMET2:TRIG:HOLD 0.1`
Sets the holdoff time of the trigger to 100 ms

Manual operation: See "Holdoff Time" on page 198

[SENSe:]PMETer<p>:TRIGger:HYSTeresis <Hysteresis>

Defines the trigger hysteresis for external power triggers.

The hysteresis in dB is the value that the input signal must stay below the IF power trigger level to allow a trigger to start the measurement.

Suffix:

<p> Power sensor 1 to 4

Parameters:

<Hysteresis>
Range: 3 dB to 50 dB
Increment: 1 dB
*RST: 0 dB
Default unit: dB

Example: `PMET2:TRIG:HYST 10`
Sets the hysteresis of the trigger to 10 dB.

Manual operation: See "Hysteresis" on page 197

[SENSe:]PMETer<p>:TRIGger:LEVel <Level>

Defines the trigger level for external power triggers.

Suffix:

<p> Power sensor 1 to 4

Parameters:

<Level> -20 to +20 dBm

Range: -20 dBm to 20 dBm
*RST: -10 dBm
Default unit: dBm

Example: `PMET2:TRIG:LEV -10 dBm`
Sets the level of the trigger

Manual operation: See "External Trigger Level" on page 197

[SENSe:]PMETer<p>:TRIGger:SLOPe <Edge>

Selects the trigger condition for external power triggers.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<Edge> POSitive | NEGative

POSitive
The measurement starts in case the trigger signal shows a positive edge.

NEGative
The measurement starts in case the trigger signal shows a negative edge.

*RST: POSitive

Example: `PMET2:TRIG:SLOP NEG`

Manual operation: See "Slope" on page 198

[SENSe:]PMETer<p>:TRIGger[:STATe] <State>

Enables or disables the external power trigger.

Suffix:
<p> Power sensor 1 to 4

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:TRIG ON`
Switches the external power trigger on

Manual operation: See "External Power Trigger" on page 197

4.14.6.7 Configuring combined input

Some applications can combine multiple signals in one result ("Combined Input"). In this case, you configure multiple input sources for one application.

The "Spectrum" application does not support "Combined Input" measurements.

Useful commands for combined input described elsewhere:

- `INPut:SELect` on page 558

Remote commands exclusive to combined input:

DISPlay[:WINDow<n>]:INPut 609
DISPlay[:WINDow<n>]:LAYout 609
DISPlay[:WINDow<n>]:TRACe<t>:INPut 609
DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect 610
DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect 610
INPut:MSO:ADD? 610
INPut:MSO:COPY 611
INPut:MSO:COUNt? 611
INPut<ip>:MSO:DELete 611
INPut<ip>:MSO:RF:SELect 611
INPut<ip>:MSO:SELect? 612

DISPlay[:WINDow<n>]:INPut <input>

Suffix:
<n> Window 1 to 16

Parameters:
<input>

DISPlay[:WINDow<n>]:LAYout <Mode>

Prerequisite: Multiple input sources enabled.

This command sets and queries the window layout for multi-result displays.

Suffix:
<n> Window 1 to 16

Parameters:
<Mode> CUSTom | TABBed

CUSTom
The results are combined in one display. The display contains multiple traces, one for each source.

TABBed
Each trace from each input source is displayed in a separate tab of the window. In addition, an overview tab displays all traces in one window.

*RST: CUSTom

Example: `DISPlay:WINDow2:LAYout TABB`

Manual operation: See "Custom View / Tabbed View" on page 1454

DISPlay[:WINDow<n>]:TRACe<t>:INPut <input>

Defines which input source provides the data for the trace in a multi-input setup.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:

<input> integer
Index of the input source

Example: `DISPlay:WINDow2:TRAC4:INPut 3`

Manual operation: See "Input Source" on page 1462

DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect

Sets the focus on the selected result display window.

This window is then the active window.

For measurements with multiple results in subwindows, the command also selects the subwindow. Use this command to select the (sub)window before querying trace data.

Suffix:

<n> Window 1 to 16

<w> subwindow
Not supported by all applications

Example: //Put the focus on window 1
`DISP:WIND1:SEL`

Example: //Put the focus on subwindow 2 in window 1
`DISP:WIND1:SUBW2:SEL`

DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect

Suffix:

<n> 1..n

<w> 1..n

INPut:MSO:ADD? <Source>[, <FilePath>]

Inserts an input signal for "Combined Input" measurements.

For I/Q file input, you can configure the path to the file directly via a parameter for this command.

For any other input source, see the description in Section 4.14.6, "Configuring the data input and output", on page 551.

Query parameters:

<Source> RF | AIQ | DIQ | FIQ | MIXer | EFRontend | MSOurce

RF
"RF A | B"

FIQ
File (I/Q) input

EFR
External frontend input

MSO
"Combined Input"
Configure the sources for the individual input signals of a "Combined Input" using `INPut<ip>:MSO:SELect?` on page 612.

*RST: RF

<FilePath> For I/Q file input only: the path and filename of the input file.

Return values:
<Stream number> For multi-stream I/Q file input only: the data stream to use as the input signal.

Usage: Query only

INPut:MSO:COPY

Usage: Event

INPut:MSO:COUNt?

Queries the number of active input signals for "Combined Input" measurements.

Return values:
<Stream count>

Usage: Query only

INPut<ip>:MSO:DELete

Removes the selected input signal for "Combined Input".

Suffix:
<ip> Input

Usage: Event

INPut<ip>:MSO:RF:SELect <RF input>

Defines which RF connector provides the input signal for "Combined Input".

Suffix:
<ip> Input

Parameters:
<RF input> RFA | RFB
RF connector

INPut<ip>:MSO:SELect?

Queries the input source used by the selected input signal in a "Combined Input" measurement.

Suffix:
<ip> Input

Return values:
<Source> RF | FIQ | MIX | EFR | MSO

RF
RF connector

FIQ
I/Q file input (single stream)

EFR
External frontend input

Usage: Query only

4.14.6.8 Defining the frequency

[SENSe<ip>:]FREQuency:CENTer <Frequency>

Defines the center frequency of the signal in Hertz.

Suffix:
<ip> Input

Parameters:
<Frequency> For the allowed range and f_{max}, refer to the specifications document.

*RST: fmax/2
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Manual operation: See "Center Frequency" on page 178
See "Center Frequency" on page 959
See "Frequency Analyzer" on page 1180

[SENSe<ip>:]FREQuency:OFFSet <Frequency>

Defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" are corrected for this shift numerically by the application.

Suffix:
<ip> Input

Parameters:
<Frequency> Range: -1 THz to 1 THz
*RST: 0 Hz
Default unit: Hz

Example: `FREQ:OFFS 1GHZ`

Manual operation: See "Frequency Offset" on page 179
See "Frequency Offset" on page 959

4.14.6.9 Configuring the amplitude

The following commands are required to configure the amplitude in a remote environment.

- Amplitude settings....613
- Configuring the attenuation....615
- Configuring a preamplifier....620

Amplitude settings

The settings for manual configuration are described in Section 4.2.1.6, "Amplitude settings", on page 179.

Useful commands for amplitude configuration described elsewhere:

- `[SENSe<ip>:]ADJust:LEVel` on page 644

Remote commands exclusive to amplitude configuration:

CALCulate<n>:MARKer<m>:FUNCtion:REFerence....613
UNIT<n>:POWer....614
CALCulate<n>:UNIT:POWer....614
[SENSe:]POWer:NCORrection....614
INPut<ip>:RLEVel....614
INPut<ip>:RLEVel:OFFSet....615

CALCulate<n>:MARKer<m>:FUNCtion:REFerence

Matches the reference level to the power level of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK2:FUNC:REF`
Sets the reference level to the level of marker 2.

Manual operation: See "Set Ref Level to Marker Level" on page 1193

UNIT<n>:POWer <Unit>
CALCulate<n>:UNIT:POWer <Unit>

Selects the unit of the y-axis.

The unit applies to all power-based measurement windows with absolute values.

Suffix:
<n> Window 1 to 16

Parameters:
<Unit> DBM | V | A | W | DB | PCT | UNITless | DBPW | WATT | DBPT | DBUV | DBMV | VOLT | DBUA | AMPere | DBM_mhz | DBM_hz | DBUV_mhz | DBMV_mhz | DBUa_mhz | DBUV_m | DBUa_m | DBPW_mhz | DBPT_mhz | DBUa_mmhz | DBUV_mmhz | DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | DBM_mhz | DBM_hz | DBUa_mhz | DBUV_mhz | DBmV_mhz | DBpW_mhz

(Units based on 1 MHz require installed R&S FSW3-K54 (EMI measurements) option.)

*RST: dBm

Example: `CALC:UNIT:POW DBM`
Sets the power unit to dBm.

Manual operation: See "Power Level Unit" on page 184

[SENSe:]POWer:NCORrection <State>

Enables or disables noise cancellation.

If noise cancellation is on, the FSWX performs a reference measurement to determine its inherent noise and subtracts the result from the channel power measurement result (first active trace only).

For more information see "Noise Cancellation" on page 184.

Parameters:
<State> ON | OFF | 1 | 0

*RST: 0

Example: `POW:NCOR ON`

Manual operation: See "Noise Cancellation" on page 184
See "Noise Cancellation" on page 1102

INPut<ip>:RLEVel <RefLevel>

Defines the reference level (for all traces in all windows).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset. See INPut<ip>:RLEVel:OFFSet on page 615.

Suffix:
<ip> Input

Parameters:
<RefLevel> The unit is variable.
Range: See specifications document
*RST: 0 dBm
Default unit: dBm

Example: INP:RLEV 10

Example: See Section 5.5.3.1, "Programming example: performing a basic frequency sweep", on page 1432.

Manual operation: See "Reference Level" on page 181

INPut<ip>:RLEVel:OFFSet <RefLevelOffset>

Defines a reference level offset (for all traces in all windows).

Suffix:
<ip> Input

Parameters:
<RefLevelOffset> Range: -200 dB to 200 dB
*RST: 0dB
Default unit: dB

Example:
```
INP:RLEV 10
INP:RLEV:OFFS -10DB
```

Example: See Section 5.5.3.1, "Programming example: performing a basic frequency sweep", on page 1432.

Manual operation: See "Shifting the display (Reference Level Offset)" on page 181
See "Shifting the Display (Reference Level Offset)" on page 1020

Configuring the attenuation

Useful commands for configuring attenuation described elsewhere:

- INPut<ip>:ATTenuation:AUTO:MODE on page 552

Remote commands exclusive to configuring attenuation:

INPut<ip>:ATTenuation 616
INPut<ip>:ATTenuation:AUTO 616
INPut<ip>:ATTenuation:IF 617
INPut<ip>:ATTenuation:IF:AUTO 617
INPut<ip>:ATT:MECH 618
INPut<ip>:ATT:MECH:AUTO 618

INPut<ip>:ATTenuation:PROTection[:STATe]....618
INPut<ip>:EATT:RANGing....619
INPut<ip>:SANalyzer:ATTenuation....619
INPut<ip>:SANalyzer:ATTenuation:AUTO....620

INPut<ip>:ATTenuation <Attenuation>

Prerequisite: `INPut<ip>:ATTenuation:AUTO OFF`

Defines or indicates the overall attenuation applied to the RF input of the FSWX.

If an external frontend is active (`INP:SEL EFR`, see `INPut:SELect` on page 558), you can configure the attenuation of the external frontend and the analyzer separately. See also `INPut<ip>:SANalyzer:ATTenuation` on page 619 and `INPut<ip>:SANalyzer:ATTenuation:AUTO` on page 620.

Suffix:
<ip> Input

Parameters:
<Attenuation> Range: see specifications document
*RST: 10 dB (AUTO is set to ON)
Default unit: dB

Example:
```
INP:ATT:AUTO OFF
INP:ATT 30dB
```
Defines a 30 dB attenuation.

Manual operation: See "RF Attenuation Overall" on page 182
See "External Frontend Attenuation" on page 183
See "RF Attenuation Overall" on page 1043
See "External Frontend Attenuation" on page 1044

INPut<ip>:ATTenuation:AUTO <State>

Couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the FSWX determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

If an external frontend is active (see `INP:SEL EFR`, see `INPut:SELect` on page 558), you can configure the attenuation of the external frontend and the analyzer separately. See also `INPut<ip>:SANalyzer:ATTenuation` on page 619 and `INPut<ip>:SANalyzer:ATTenuation:AUTO` on page 620.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
The overall RF attenuation is defined by `INPut<ip>:ATTenuation` on page 616.

ON | 1
Attenuation is automatically optimized for low distortion by avoiding intermodulation, depending on the reference level.

*RST: 1

Example:
```
INP:ATT:AUTO OFF
INP:ATT 5DB
```
Defines a manual attenuation value of 5 dB.

Manual operation: See "Optimization" on page 182
See "External Frontend Attenuation" on page 183
See "Optimization" on page 1043
See "External Frontend Attenuation" on page 1044

INPut<ip>:ATTenuation:IF <Value>

Prerequisites:

- I/Q-based application
- `INPut<ip>:ATTenuation:IF:AUTO OFF`

Defines the IF attenuation before the A/D converter.

Suffix:
<ip> Input

Parameters:
<Value> Default unit: dB

Example:
```
INP:ATT:IF:AUTO OFF
INP:ATT:IF 10
```

Manual operation: See "IF Attenuation (expert parameter)" on page 183

INPut<ip>:ATTenuation:IF:AUTO <Auto>

Determines how the IF attenuation between the preamplifier and the A/D converter is defined. This setting is only available for I/Q data capture.

Suffix:
<ip> Input

Parameters:
<Auto> ON | OFF | 0 | 1

OFF | 0
Determined by `INPut<ip>:ATTenuation:IF` on page 617.

ON | 1
Determined automatically by the FSWX.

*RST: 0

Example:
```
INP:ATT:IF:AUTO OFF
INP:ATT:IF 10
```

Manual operation: See "IF Attenuation (expert parameter)" on page 183

INPut<ip>:ATT:MECH <Attenuation>

Prerequisite: Manual mechanical attenuation mode, see INPut<ip>:ATT:MECH:AUTO on page 618.

Defines the mechanical attenuation value. You can switch off mechanical attenuation entirely, or set it to 20 dB.

Suffix:
<ip> Input

Parameters:
<Attenuation> Default unit: dB

Example:
```
INP:ATT:MECH:AUTO OFF
INP:ATT:MECH 0
```

Manual operation: See "RF Attenuation Mechanical" on page 182

INPut<ip>:ATT:MECH:AUTO <State>

Determines how the mechanical RF attenuation is defined.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Define the value using INPut<ip>:ATT:MECH on page 618.

ON | 1
The FSWX uses the electronic attenuator for attenuation levels up to 19 dB. For higher levels, the FSWX enables the mechanical attenuator for 20 dB attenuation, and covers the remaining level by electronic attenuation.

*RST: 1

Example:
```
INP:ATT:MECH:AUTO OFF
INP:ATT:MECH 0
```

Manual operation: See "RF Attenuation Mechanical" on page 182

INPut<ip>:ATTenuation:PROTection[:STATe] <State>

Turns the availability of attenuation levels of 10 dB or less on and off.

Suffix:
<ip> 1 | 2
Input

Parameters:
<State> ON | OFF | 1 | 0

ON | 1
Attenuation levels of 10 dB or less are not allowed to protect the RF input connectors of the FSWX.

OFF | 0
Attenuation levels of 10 dB or less are not blocked. Provide appropriate protection for the RF input connectors of the FSWX yourself.

*RST: 1

Example: `INP:ATT:PROT ON`
Turns on the input protection.

INPut<ip>:EATT:RANGing <Enhanced>

Enables or disables the enhanced electronic attenuator.

For more information, see "Electronic vs mechanical attenuation" on page 240.

Suffix:
<ip> 1 | 2
Input

Parameters:
<Enhanced> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Manual operation: See "Enhanced Electronic Ranging" on page 183

INPut<ip>:SANalyzer:ATTenuation <Attenuation>

Configures attenuation at the analyzer input for an active external frontend manually.

Suffix:
<ip> 1 | 2
Input

Parameters:
<Attenuation> Range: see specifications document
Increment: 1 dB
Default unit: dB

Example: `INP:SAN:ATT 5`

Manual operation: See "RF Attenuation Overall" on page 182

INPut<ip>:SANalyzer:ATTenuation:AUTO <State>

Enables or disables automatic configuration of attenuation at the analyzer input for an active external frontend.

By default, the attenuation settings are applied at the input of the external frontend, see INPut<ip>:ATTenuation:AUTO on page 616 and INPut<ip>:ATTenuation on page 616.

Suffix:
<ip> 1 | 2
Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Auto mode for analyzer attenuation is disabled. Allows you to configure attenuation at the analyzer using INPut<ip>:SANalyzer:ATTenuation on page 619.

ON | 1
Auto mode for analyzer attenuation is enabled. No attenuation is configured at the analyzer.

*RST: 0

Example:

```
//Enable external frontend
EFR ON
//Query the currently configured RF attenuation
INP:ATT?
//Result: 10 dB
//Disable auto mode for analyzer attenuation
INP:SAN:ATT:AUTO OFF
//Configure 10 dB attenuation at the analyzer
INP:SAN:ATT 10
//Query the currently configured RF attenuation at the ext. FE
INP:ATT?
//Result: 0 dB
```

Configuring a preamplifier

INPut<ip>:EGAin[:STATe] 620
INPut<ip>:GAIN:STATe 621
INPut<ip>:GAIN[:VALue] 621

INPut<ip>:EGAin[:STATe] <State>

Before this command can be used, the external preamplifier must be connected to the FSWX. See the preamplifier's documentation for details.

When activated, the FSWX automatically compensates the magnitude and phase characteristics of the external preamplifier in the measurement results.

Note that when an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

For multi-input instruments, you must enable correction from the external preamplifier for each input individually. Correction cannot be enabled for multiple inputs at the same time.

When deactivated, no compensation is performed even if an external preamplifier remains connected.

Suffix:
<ip> 1 | 2
Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
No data correction is performed based on the external preamplifier

ON | 1
Performs data corrections based on the external preamplifier

*RST: 0

Example: `INP:EGA ON`

INPut<ip>:GAIN:STATe <State>

Turns the internal preamplifier on and off. It requires the optional preamplifier hardware.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the preamplifier off

ON | 1
The signal is preamplified by 20 dB
If an optional splitter is active, the preamplifier amplifies the input signal in each signal path by 10 dB.

*RST: 0

Example: `INP:GAIN:STAT ON`
Switches on 20 dB preamplification.

Manual operation: See "Preamplifier" on page 183

INPut<ip>:GAIN[:VALue] <Gain>

Selects the "gain" if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut<ip>:GAIN:STATe` on page 621).

The command requires the additional preamplifier hardware option.

Suffix:
<ip> Input

Parameters:
<Gain> The following settings are available:
15 dB and 30 dB
All other values are rounded to the nearest of these two.
Default unit: dB

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 30
```
Switches on 30 dB preamplification.

4.14.6.10 Configuring I/Q data acquisition

[SENSe<ip>:]IQ:BWIDth 622
[SENSe<ip>:]IQ:CAPTure:OFFSet 622
[SENSe<ip>:]IQ:CLENgth 623
[SENSe<ip>:]IQ:CTIMe 623
[SENSe<ip>:]IQ:SRATe 623
[SENSe<ip>:]SWAPiq 623

[SENSe<ip>:]IQ:BWIDth <Bandwidth>

Defines or queries the flat, usable bandwidth of the final I/Q data. This value depends on the defined sample rate.

Suffix:
<ip> Input

Parameters:
<Bandwidth> Default unit: Hz

Example:
```
SENS:IQ:BWID 20MHZ
```

Manual operation: See "Analysis Bandwidth (expert parameter)" on page 177

[SENSe<ip>:]IQ:CAPTure:OFFSet <Offset>

Defines or queries an offset between the start of data capturing and the start of the analysis range in the application, similar to a trigger offset.

Suffix:
<ip> Input

Parameters:
<Offset> Default unit: s

Example:
```
SENS2:IQ:CAPT:OFFS 1 s
```

Manual operation: See "Capture Offset (expert parameter)" on page 177

[SENSe<ip>:]IQ:CLENgth <CaptureLength>

Defines or queries the capture length for the specified input source.

Suffix:
<ip> Input

Parameters:
<CaptureLength> integer
The number of I/Q samples to capture.

Example: `SENS:IQ:CLEN 200`

Manual operation: See "Capture Length (expert parameter)" on page 177

[SENSe<ip>:]IQ:CTIMe <CaptureTime>

Defeins or queries the data acquisition time.

Suffix:
<ip> Input

Parameters:
<CaptureTime> Default unit: s

Example: `SENS2:IQ:CTIMe 1 S`

Manual operation: See "Capture Time" on page 177

[SENSe<ip>:]IQ:SRATe <SampleRate>

Sets the final user sample rate for the acquired I/Q data. Thus, you can change the user sample rate without affecting the actual data capturing settings on the FSWX.

Note: The smaller the user sample rate, the smaller the usable I/Q bandwidth.

For details, see "Sample rate and maximum usable I/Q bandwidth for RF input" on page 123.

Suffix:
<ip> Input

Parameters:
<SampleRate> Sample rate
*RST: 32 MHz
Default unit: Hz

Manual operation: See "Sample Rate" on page 176

[SENSe<ip>:]SWAPiq <State>

Defines whether the recorded I/Q pairs are swapped (I<->Q) before the application processes them. Swapping I and Q inverts the sideband.

Swapping is useful if the DUT interchanged the I and Q parts of the signal. Then the FSWX can do the same to compensate for it.

Suffix:
<ip> Input

Parameters:
<State> **ON | 1**
I and Q signals are interchanged
Inverted sideband, Q+j*I

OFF | 0
I and Q signals are not interchanged
Normal sideband, I+j*Q

*RST: 0

Manual operation: See "Swap I/Q (expert parameter)" on page 177

4.14.6.11 Configuring the outputs

The following commands are required to provide output from the FSWX.

Configuring trigger input/output is described in Section 4.14.6.12, "Configuring the trigger output", on page 626.

DIAGnostic:SERVice:NSOurce 624
OUTPut:UPORt:STATe 625
OUTPut:UPORt[:VALue] 625
SYSTem:SPEaker:MAXVolume 625
SYSTem:SPEaker[:STATe] 626
SYSTem:SPEaker:VOLume 626

DIAGnostic:SERVice:NSOurce <State>

Enables or disables the 28 V supply of the BNC connector labeled [noise source control] on the FSWX.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
DIAG:SERV:NSO ON
```

Manual operation: See "Noise Source control" on page 232

OUTPut:UPORt:STATe <State>

Toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole D-Sub male connector is located on the rear panel of the FSWX.

For the FSWX, this command is maintained for compatibility reasons only. The **AUX PORT** connector only supports output.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
User port is switched to INPut

ON | 1
User port is switched to OUTPut

Example: `OUTP:UPOR:STAT ON`

OUTPut:UPORt[:VALue] <Value>

Sets the control lines of the user ports.

The assignment of the pin numbers to the bits is as follows:

Bit	7	6	5	4	3	2	1	0
Pin	N/A	N/A	5	3	4	7	6	2

Bits 7 and 6 are not assigned to pins and must always be 0.

The user port is written to with the given binary pattern.

If the user port is programmed to input instead of output (see `INPut:UPORt:STATe` on page 559), the output value is temporarily stored.

Parameters:

<Value> bit values in hexadecimal format

TTL type voltage levels (max. 5V)

Range: #B00000000 to #B00111111

Example: `OUTP:UPOR #B00100100`
Sets pins 5 and 7 to 5 V.

SYSTem:SPEaker:MAXVolume <Volume>

Defines the maximum volume to be output as a percentage of the maximum possible volume. This setting is maintained for all applications.

Parameters:

<Volume> percentage

Example: `SYST:SPE:MAXV 50`

Manual operation: See "Max Instrument Volume" on page 1214

SYSTem:SPEaker[:STATe] <State>

Prerequisites:

- Time domain in "Spectrum" application
- "AM/FM/PM Analog Demod"

Switches the built-in loudspeaker on or off for demodulated signals. This setting applies only to the current application.

To set the volume, use the `SYSTem:SPEaker:VOLume` command.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
SYST:SPE ON
SYST:SPE:VOL 0.5
```
Sets the loudspeaker to half the full volume.

Manual operation: See "Audio" on page 232

SYSTem:SPEaker:VOLume <Volume>

Defines the volume of the built-in loudspeaker for demodulated signals. This setting only applies to the currently active application.

The command is available in the time domain in "Spectrum" mode and in "AM/FM/PM Analog Demod" mode.

Parameters:

<Volume> Percentage of the maximum volume.

Range: 0 to 1
*RST: 0.5

Example:
```
SYST:SPE:VOL 0
```
Switches the loudspeaker to mute.

Manual operation: See "Audio" on page 232
See "Volume" on page 1214

4.14.6.12 Configuring the trigger output

The following commands are required to send the trigger signal to one of the variable "TRIGGER INPUT/OUTPUT" connectors on the FSWX.

OUTPut:TRIGger<tp>:DIRection....627
OUTPut:TRIGger<tp>[:UDEFined]:LEVel....627
OUTPut:TRIGger<tp>:OTYPe....627
OUTPut:TRIGger<tp>[:UDEFined]:PULSe:IMMediate....628
OUTPut:TRIGger<tp>[:UDEFined]:PULSe:LENGth....628

OUTPut:TRIGger<tp>:DIRection <Direction>

Selects the trigger direction for trigger connectors that serve as an input as well as an output.

Suffix:
<tp> Selects the trigger connector.
2 = "Trigger 2 In / Out"
4 = "Trigger 4 In / Out"

Parameters:
<Direction> INPut | OUTPut

INPut
Connector works as an input.

OUTPut
Connector works as an output.

*RST: INPut

Example: `OUTP:TRIG2:DIR INP`

Manual operation: See "Trigger Connector Direction" on page 235

OUTPut:TRIGger<tp>[:UDEFined]:LEVel <Level>

Defines the level of the (TTL compatible) signal generated at the trigger output.

Works only if you have selected a user-defined output with `OUTPut:TRIGger<tp>:OTYPe`.

Suffix:
<tp> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
4 = trigger port 4 (rear)

Parameters:
<Level> LOW | HIGH

HIGH
5 V

LOW
0 V

*RST: LOW

Example: `OUTP:TRIG2:LEV HIGH`

Manual operation: See "Constant signal Level" on page 235

OUTPut:TRIGger<tp>:OTYPe <OutputType>

Selects the type of signal generated at the trigger output.

Suffix:
<tp> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
4 = trigger port 4 (rear)

Parameters:
<OutputType> DEVice | NMEasurement | TARMed | UDEFined | TOFF | FOLLow

DEVice
Sends a trigger signal when the FSWX has triggered internally.

TARMed
Sends a trigger signal when the trigger is armed and ready for an external trigger event.

UDEFined
Sends a user-defined trigger signal. For more information, see `OUTPut:TRIGger<tp>[:UDEFined]:LEVel`.

*RST: DEVice

Example: `OUT:TRIG2:OTYP TOFF`

Manual operation: See "Output Type" on page 235

OUTPut:TRIGger<tp>[:UDEFined]:PULSe:IMMediate

Generates a pulse at the trigger output.

Suffix:
<tp> 1..n

Example: `OUT:TRIG:PULS:IMM`

Manual operation: See "Send Trigger" on page 236

OUTPut:TRIGger<tp>[:UDEFined]:PULSe:LENGth <Length>

Defines the length of the pulse generated at the trigger output.

Suffix:
<tp> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:
<Length> Pulse length in seconds.
Default unit: S

Example: `OUTP:TRIG2:PULS:LENG 0.02`

Manual operation: See "Pulse Length" on page 235

4.14.7 Configuring triggered and gated measurements

The commands required to configure a triggered or gated measurement in a remote environment are described here.

The commands required for trigger output are described in Section 4.14.6.12, "Configuring the trigger output", on page 626.

*OPC should be used after requesting data. This will hold off any subsequent changes to the selected trigger source, until after the sweep is completed and the data is returned.

- Configuring the triggering conditions....629
- Configuring gated measurements....635
- Programming example: continuous gating....640

4.14.7.1 Configuring the triggering conditions

The following commands are required to configure a triggered measurement.

Configuring trigger output is described in Section 4.14.6.12, "Configuring the trigger output", on page 626.

Remote commands exclusive to configuring triggers:

TRIGger[:SEQuence]:CTPis....629
TRIGger[:SEQuence]:DTIMe....630
TRIGger[:SEQuence]:HOLDoff....630
TRIGger[:SEQuence]:INPut[:SELect]....631
TRIGger[:SEQuence]:LEVel[:EXTernal<tp>]....631
TRIGger<ip>[:SEQuence]:LEVel:POWer....632
TRIGger[:SEQuence]:LEVel:VIDeo....632
TRIGger[:SEQuence]:POWer:HOLDoff....632
TRIGger<ip>[:SEQuence]:POWer:HYSTeresis....633
TRIGger[:SEQuence]:SLOPe....633
TRIGger[:SEQuence]:SOURce....633
TRIGger[:SEQuence]:TIME:RINTerval....635

TRIGger[:SEQuence]:CTPis <State>

The trigger event is set to the actual trigger point within the sample (TPIS).

This setting is available for all trigger sources except "Free Run".

This setting only becomes effective for the next new measurement.

TPIS correction is not supported if user frequency response correction (R&S FSW3-K544) is active. If you activate frequency response correction, TPIS correction is automatically deactivated in all channels.

For more information, see Section 4.11.4, "User-defined frequency response correction", on page 411.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:

```
//    Query the current trigger offset within the sample
TRAC:IQ:TPIS?
//Result: 0.000002
//Correct the trigger event
TRIG:CTP ON
//Start a new measurement
INIT:IMM; *WAI
//Query the trigger offset within the sample again
TRAC:IQ:TPIS?
//Result: 0.000000
```

Manual operation: See "Correct TPIS" on page 262

TRIGger[:SEQuence]:DTIMe <Time>

Defines the time that the input signal must stay below the trigger level before a trigger is detected again.

Parameters:

<Time> Dropout time of the trigger.

Range: 0 s to 10.0 s
*RST: 0 s
Default unit: s

Example:

```
TRIG:SEQ:DTIM 1
```

Manual operation: See "Drop-Out Time" on page 262

TRIGger[:SEQuence]:HOLDoff <Offset>

Defines the time offset between the trigger event and the start of the sweep.

A negative offset is possible for time domain measurements.

For the trigger sources "External" or "Power", a common input signal is used for both trigger and gate. Therefore, changes to the gate delay also affect the trigger offset.

Parameters:

<Offset> For measurements in the frequency domain, the range is 0 s to 30 s.
For measurements in the time domain, the range is the negative sweep time to 30 s.

*RST: 0 s
Default unit: s

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Offset" on page 261

TRIGger[:SEQuence]:INPut[:SELect] <input>

Prerequisites:

- Multi-input I/Q-based application
- Power trigger

Selects the input port used for power trigger input.

For single-input applications, the input port is selected by `INPut<ip>:RF:STATe` on page 557.

Parameters:

<input> 1 | 2

input connector ("RF A | B")

Example:
```
TRIG:SEQ:SOUR POW
TRIG:SEQ:INP:SEL 2
```

TRIGger[:SEQuence]:LEVel[:EXTernal<tp>] <Level>

Defines the level the external signal must exceed to cause a trigger event.

Prerequisite: the variable "Trigger 2 In / Out" / "Trigger 4 In / Out" connectors are configured for input.

See `OUTPut:TRIGger<tp>:DIRection` on page 627.

In the "Spectrum" application, only `EXTernal1` is supported.

For more information, see Section 4.3.4.1, "Initiating a measurement: trigger source", on page 247.

Suffix:

<tp> Selects the trigger connector.
1 = "Trigger 1 Input"
2 = "Trigger 2 In / Out"
3 = "Trigger 3 Input"
4 = "Trigger 4 In / Out"

Parameters:

<Level>
Range: 0.5 V to 3.5 V
*RST: 1.4 V
Default unit: V

Example: `TRIG:LEV 2V`

Manual operation: See "Trigger Level" on page 261

TRIGger<ip>[:SEQuence]:LEVel:POWer <TriggerLevel>

Defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event.

Note that the FSWX considers any RF attenuation or preamplification when it analyzes the trigger level. If defined, a reference level offset is also considered.

Suffix:

<ip> Input

Parameters:

<TriggerLevel>
For details on available trigger levels and trigger bandwidths, see the specifications document.
*RST: -20 dBm
Default unit: dBm

Example: `TRIG:LEV:POW -30DBM`

Manual operation: See "Trigger Level" on page 261

TRIGger[:SEQuence]:LEVel:VIDeo <Level>

Defines the level the video signal must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:

<Level>
Range: 0 PCT to 100 PCT
*RST: 50 PCT
Default unit: percent

Example: `TRIG:LEV:VID 50PCT`

Manual operation: See "Trigger Level" on page 261

TRIGger[:SEQuence]:POWer:HOLDoff <Time>

Defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just "Power" (despite the legacy keyword).

Note: If you perform gated measurements in combination with the "Power" trigger, the FSWX ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q data measurements.

Parameters:

<Time>
Range: 0 s to 10 s
*RST: 0 s
Default unit: s

Example:
```
TRIG:SOUR EXT
```
Sets an external trigger source.
```
TRIG:POW:HOLD 200 ns
```
Sets the holding time to 200 ns.

Manual operation: See "Trigger Holdoff" on page 262

TRIGger<ip>[:SEQuence]:POWer:HYSTeresis <Hysteresis>

Prerequisite: "Power" trigger source

Defines the trigger hysteresis.

Suffix:

<ip> Input

Parameters:

<Hysteresis>
Range: 3 dB to 50 dB
*RST: 3 dB
Default unit: dB

Example:
```
TRIG:SOUR POW
```
Sets the "Power" trigger source.
```
TRIG:POW:HYST 10DB
```
Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 262

TRIGger[:SEQuence]:SLOPe <Slope>

For all trigger sources except time, you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Parameters:

<Slope> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example:
```
TRIG:SLOP NEG
```

Manual operation: See "Slope" on page 261

TRIGger[:SEQuence]:SOURce <Source>

Selects the trigger source.

Using a trigger or gated measurements turns the squelch off (see [SENSe:]DEMod:SQUelch[:STATe] on page 749 [SENSe:]DEMod:SQUelch[:STATe] on page 749).

For more information, see Section 4.3.4.1, "Initiating a measurement: trigger source", on page 247.

Note on external triggers:

If you configure a measurement to wait for an external trigger signal in a remote control program, remote control is blocked until the program receives a trigger and can continue. Make sure that your remote control programs avoid this situation.

For more information, see Section 7.2, "Error messages in remote control mode", on page 1474.

Parameters:

<Source>

IMMediate
Free Run

EXTernal
Trigger signal from the "Trigger Input" connector.

EXT2
Trigger signal from the "Trigger Input/Output" connector.
Note: Connector must be configured for "Input".

EXT3
Trigger signal from the "TRIGGER 3 INPUT/ OUTPUT" connector.
Note: Connector must be configured for "Input".

POWer
Second intermediate frequency

EPOW
The power level from a separate RF input signal with a user-defined frequency and bandwidth triggers the measurement.

TIME
Time interval

VIDeo
Video mode is available in the time domain and only in the Spectrum application.

PSEN
External power sensor

*RST: IMMediate

Example:
```
TRIG:SOUR EXT
```
Selects the external trigger input as source of the trigger signal

Example: For an example, see Section 5.5.3.1, "Programming example: performing a basic frequency sweep", on page 1432.

Manual operation: See "Trigger Source" on page 1457

TRIGger[:SEQuence]:TIME:RINTerval <Interval>

Defines the repetition interval for the time trigger.

Parameters:

<Interval> numeric value

Range: 2 ms to 5000 s
*RST: 1.0 s
Default unit: s

Example: `TRIG:SOUR TIME`
Selects the time trigger input for triggering.
`TRIG:TIME:RINT 5`
The sweep starts every 5 s.

Manual operation: See "Repetition Interval" on page 261

4.14.7.2 Configuring gated measurements

[SENSe:]SWEep:EGATe....635
[SENSe:]SWEep:EGATe:AUTO....636
[SENSe:]SWEep:EGATe:CONTinuous:PCOunt....636
[SENSe:]SWEep:EGATe:CONTinuous:PLENgth....637
[SENSe:]SWEep:EGATe:CONTinuous[:STATe]....637
[SENSe:]SWEep:EGATe:HOLDoff....637
[SENSe:]SWEep:EGATe:LENGth....637
[SENSe:]SWEep:EGATe:LEVel[:EXTernal<tp>]....638
[SENSe:]SWEep:EGATe:LEVel:POWer....638
[SENSe:]SWEep:EGATe:POLarity....639
[SENSe:]SWEep:EGATe:SOURce....639
[SENSe:]SWEep:EGATe:TYPE....639

[SENSe:]SWEep:EGATe <State>

Enables or disables gated measurements.

For measurements with an external trigger gate, the measured values are recorded as long as the gate is opened. During a sweep, the gate can be opened and closed several times. The synchronization mechanisms with *OPC, *OPC? and *WAI remain completely unaffected.

The measurement ends when a particular number of measurement points has been recorded.

(See `[SENSe:]SWEep[:WINDow<n>]:POINts` on page 1426).

Performing gated measurements turns the squelch off.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
SWE:EGAT ON
```
Switches on the gate mode.
```
SWE:EGAT:TYPE EDGE
```
Switches on the edge-triggered mode.
```
SWE:EGAT:HOLD 100US
```
Sets the gate delay to 100 µs.
```
SWE:EGAT:LEN 500US
```
Sets the gate opening time to 500 µs.
```
INIT;*WAI
```
Starts a sweep and waits for its end.

Manual operation: See "Gated Trigger" on page 1016

[SENSe:]SWEep:EGATe:AUTO <State>

Determines whether the same or different triggers are used for general measurement and gating.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
The gate is opened by the gating source, but only after a trigger from the general trigger source occurs.

ON | 1
(Default:) The trigger source is used both for the general measurement trigger and the gating trigger.

*RST: 1

Example:
```
SENS:SWE:EGAT:AUTO MAN
SENS:SWE:EGAT:SOUR EXT2
SENS:SWE:EGAT:LEV:EXT2 1V
```
Sets the gating trigger to a level of 1 V at trigger port 2.

[SENSe:]SWEep:EGATe:CONTinuous:PCOunt <Amount>

Defines the number of gate periods to be measured after a single trigger event.

Parameters:

<Amount> integer

Range: 1 to 65535
Increment: 1
*RST: 100

Example:
```
SWE:EGAT:CONT:PCO 50
```

[SENSe:]SWEep:EGATe:CONTinuous:PLENgth <Time>

Defines the length in seconds of a single gate period in continuous gating. The length is determined from the beginning of one gate measurement to the beginning of the next one.

Parameters:

<Time> Range: 125 ns to 30 s
*RST: 5 ms
Default unit: s

Example: `SWE:EGAT:CONT:PLEN 10`

[SENSe:]SWEep:EGATe:CONTinuous[:STATe] <State>

Prerequisite: `[SENSe:]SWEep:EGATe` is "On".

Activates or deactivates continuous gating.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `SWE:EGAT ON`
Activate gating
`SWE:EGAT:CONT:STAT ON`
Activate continuous gating

[SENSe:]SWEep:EGATe:HOLDoff <DelayTime>

Defines the delay time between the gate signal and the continuation of the measurement.

Note: If you perform gated measurements in combination with the IF Power trigger, the FSWX ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

Parameters:

<DelayTime> Range: 0 s to 30 s
*RST: 0 s
Default unit: s

Example: `SWE:EGAT:HOLD 100us`

[SENSe:]SWEep:EGATe:LENGth <GateLength>

Defines the gate length.

Parameters:

<GateLength> Range: 125 ns to 30 s
*RST: 400µs
Default unit: s

Example: `SWE:EGAT:LENG 10ms`

[SENSe:]SWEep:EGATe:LEVel[:EXTernal<tp>] <GateLevel>

Prerequisites:

- Triggered gated measurement (`[SENSe:]SWEep:EGATe:AUTO MAN`).
- **Prerequisite:**: the variable "Trigger 2 In / Out" / "Trigger 4 In / Out" connectors are configured for input.
  See `OUTPut:TRIGger<tp>:DIRection` on page 627.

Defines the gate level for which the gate is open.

Suffix:

<tp> Selects the trigger connector.
1 = "Trigger 1 Input"
2 = "Trigger 2 In / Out"
3 = "Trigger 3 Input"
4 = "Trigger 4 In / Out"

Parameters:

<GateLevel> numeric value

Range: 0.5 V to 3.5 V
*RST: 1.4 V
Default unit: V

Example:

```
SENS:SWE:EGAT:AUTO MAN
SENS:SWE:EGAT:SOUR EXT2
SENS:SWE:EGAT:LEV:EXT2 1V
```

Sets the gating trigger to a level of 1 V at trigger port 2.

[SENSe:]SWEep:EGATe:LEVel:POWer <GateLevel>

Prerequisite: triggered gated measurement (`[SENSe:]SWEep:EGATe:AUTOMAN`).

Defines the the power level at the third intermediate frequency that must be exceeded for the gate to be open.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Parameters:

<GateLevel> For details on available trigger levels and trigger bandwidths see the specifications document.

*RST: -10 dBm
Default unit: dBm

Example:
```
SENS:SWE:EGAT:AUTO MAN
SENS:SWE:EGAT:SOUR POW
SENS:SWE:EGAT:LEV:POW 0
```
Sets the gating trigger to a level of 0 dBm at the third IF.

[SENSe:]SWEep:EGATe:POLarity <Polarity>

Selects the polarity of an external gate signal.

The setting applies both to the edge of an edge-triggered signal and the level of a level-triggered signal.

Parameters:
<Polarity> POSitive | NEGative
*RST: POSitive

Example:
```
SWE:EGAT:POL POS
```

[SENSe:]SWEep:EGATe:SOURce <Source>

Selects the signal source for gated measurements.

If an IF power signal is used, the gate is opened as soon as a signal at > -20 dBm is detected within the IF path bandwidth (10 MHz).

For more information, see Section 4.3.4.8, "Selective data capture: gated measurements", on page 252.

For triggered gated measurements,only the following gate trigger sources are supported:

- External trigger
- Power sensor

Parameters:
<Source> EXTernal | EXT2 | EXT3 | POWer | IQPower | VIDeo | PSEN
*RST: POWer

Example:
```
SWE:EGAT:SOUR POW
```
Switches the gate source to power.

[SENSe:]SWEep:EGATe:TYPE <Type>

Selects the way gated measurements are triggered.

Parameters:
<Type> LEVel | EDGE

LEVel
The trigger event for the gate to open is a particular power level.
After the gate signal has been detected, the gate remains open until the signal disappears.
Note: If you perform gated measurements in combination with the IF Power trigger, the FSWX ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

EDGE
The trigger event for the gate to open is the detection of the signal edge.
After the gate signal has been detected, the gate remains open until the gate length is over.

*RST: EDGE

Example: `SWE:EGAT:TYPE EDGE`

4.14.7.3 Programming example: continuous gating

This example demonstrates how to perform a measurement with continuous gating in a remote environment.

```
//-----------Configuring the measurement ------------
*RST

//ACLR LTE TDD with 51 MHz Span
CALC:MARK:FUNC:POW:PRES EUTRa
FREQ:CENT 1GHZ
SWE:EGAT ON
SWE:EGAT:SOUR EXT
SWE:EGAT:TYPE EDGE
SWE:EGAT:HOLD 9.25MS
SWE:EGAT:LENG 1.25MS
SWE:EGAT:CONTinuous:STAT?
//0
SWE:EGAT:CONTinuous:STAT ON
SWE:EGAT:CONTinuous:STAT?
//1
SWE:EGAT:CONTinuous:PLENgth?
//0.005
SWE:EGAT:CONTinuous:PLENgth 4MS
SWE:EGAT:CONTinuous:PLENgth?
//0.004
SWE:EGAT:CONTinuous:PCOunt?
//100
SWE:EGAT:CONTinuous:PCOunt 80
SWE:EGAT:CONTinuous:PCOunt?
//80

//--------------Performing the Measurement-----
```

```
INIT:CONT OFF
INIT
// Sweep duration is less than 1 second
```

4.14.8 Adjusting settings automatically

The commands required to adjust settings automatically in a remote environment are described here.

The functions for manual operation are described in Section 4.5, "Adjusting settings automatically", on page 265.

[SENSe<ip>:]ADJust:ALL....641
[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation....641
[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation:MODE....642
[SENSe<ip>:]ADJust:CONFigure:HYSTeresis:LOWer....642
[SENSe<ip>:]ADJust:CONFigure:HYSTeresis:UPPer....643
[SENSe<ip>:]ADJust:CONFigure:TRIGger....643
[SENSe<ip>:]ADJust:FREQuency....644
[SENSe<ip>:]ADJust:LEVel....644
[SENSe<ip>:]ADJust:PTIMe....644

[SENSe<ip>:]ADJust:ALL

Initiates a measurement to determine and set the ideal settings for the current task automatically (only once for the current measurement).

This includes:

- Center frequency
- Reference level

Suffix:
<ip> Input

Example: `ADJ:ALL`

Manual operation: See "Adjusting all determinable settings automatically (Perform Auto All)" on page 266

[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation <Duration>

To determine the ideal reference level, the FSWX performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation:MODE` is set to `MANual`.

Suffix:
<ip> Input

Parameters:

<Duration> Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example: `ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

Manual operation: See "Measurement Time Mode / Measurement Time" on page 266

[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation:MODE <Mode>

To determine the ideal reference level, the FSWX performs a measurement on the current input data. This command selects the way the FSWX determines the length of the measurement.

Suffix:

<ip> Input

Parameters:

<Mode> AUTO | MANual

AUTO
The FSWX determines the measurement length automatically according to the current input data.

MANual
The FSWX uses the measurement length defined by `[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation` on page 641.

*RST: AUTO

Example: `SENS:ADJ:CONF:LEV:DUR:MODE AUTO`

Manual operation: See "Measurement Time Mode / Measurement Time" on page 266

[SENSe<ip>:]ADJust:CONFigure:HYSTeresis:LOWer <Threshold>

When the reference level is adjusted automatically using the `[SENSe<ip>:]ADJust:LEVel` on page 644 command, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Suffix:

<ip> Input

Parameters:

<Threshold> Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:LOW 2`
For an input signal level of currently 20 dBm, the reference level is only adjusted when the signal level falls below 18 dBm.

Manual operation: See "Upper Level / Lower Level Hysteresis" on page 267

[SENSe<ip>:]ADJust:CONFigure:HYSTeresis:UPPer <Threshold>

When the reference level is adjusted automatically using the `[SENSe<ip>:]ADJust:LEVel` on page 644 command, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Suffix:

<ip> Input

Parameters:

<Threshold> Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:UPP 2`

Manual operation: See "Upper Level / Lower Level Hysteresis" on page 267

[SENSe<ip>:]ADJust:CONFigure:TRIGger <State>

Defines the behavior of a triggered measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example).

Suffix:

<ip> Input

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
(default:) The measurement for adjustment waits for the next trigger.
To abort the measurement, use `ABORt` on page 645.

OFF | 0
The measurement for adjustment is performed without waiting for a trigger (corresponds to "Continue" in manual operation).

*RST: 0

Example: `SENS:ADJ:CONF:TRIG ON`

[SENSe<ip>:]ADJust:FREQuency

Sets the center frequency to the frequency with the highest signal level in the current frequency range.

At the same time, the optimal reference level is also set (see `[SENSe<ip>:]ADJust:LEVel` on page 644).

Suffix:
<ip> Input

Example: `ADJ:FREQ`

Manual operation: See "Adjusting the center frequency automatically (Perform Auto Frequency)" on page 266

[SENSe<ip>:]ADJust:LEVel

Initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. Thus, the settings of the RF attenuation and the reference level are optimized for the signal level. The FSWX is not overloaded and the dynamic range is not limited by an S/N ratio that is too small.

Suffix:
<ip> Input

Example: `ADJ:LEV`

Manual operation: See "Setting the Reference Level Automatically (Auto Level Once)" on page 181
See "Setting the reference level automatically (Perform Auto Level)" on page 266

[SENSe<ip>:]ADJust:PTIMe

Prerequisites:

- Multi-input application
- Successful self-alignment of instrument

Aligns the signals at all RF inputs in phase and time to enable phase-aligned or time-aligned measurements on multiple signal paths.

Suffix:
<ip> irrelevant

Usage: Event

Manual operation: See "Perform Phase & Time Self-Alignment" on page 267

4.14.9 Performing measurements

ABORt 645
INITiate<n>:CONMeas 645
INITiate<n>:CONTinuous 646
INITiate<n>[:IMMediate] 647

ABORt

Aborts the measurement in the current application instance and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details on overlapping execution, see the Remote control via SCPI document.

To abort a sequence of measurements by the Sequencer, use the `INITiate:SEQuencer:ABORt` command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program never finishes. The remote channel to the FSWX is blocked for further commands. In this case, you must interrupt processing on the remote channel first to abort the measurement.

To do so, send a `Device Clear` command from the control instrument to the FSWX on a parallel channel. The command clears all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: //Abort the current measurement and immediately start a new one.
```
ABOR;:INIT:IMM
```

Example: //Abort the current measurement and start a new one once abortion has been completed.
```
ABOR;*WAI
INIT:IMM
```

INITiate<n>:CONMeas

Restarts a (single) measurement that has been stopped (using `ABORt`) or finished in single sweep mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

As opposed to `INITiate<n>[:IMMediate]` on page 647, this command does not reset traces in "Max Hold", "Min Hold" or "Average" mode. Therefore it can be used to continue measurements using "Max Hold" or "Average" functions.

Suffix:
<n> Window 1 to 16

Example:
```
//Switch to single sweep mode.
INIT:CONT OFF
//Switch on trace averaging.
DISP:WIND:TRAC:MODE AVER
//Set the sweep counter to 20 sweeps.
SWE:COUN 20
//Start the measurement and wait for the end of the 20 sweeps.
INIT;*WAI
//Continue the measurement (next 20 sweeps) and wait for the end.
INIT:CONM;*WAI
```
Result: Averaging is performed over 40 sweeps.

Usage: Asynchronous command

Manual operation: See "Continue Single Sweep" on page 268

INITiate<n>:CONTinuous <State>

Controls the sweep mode for an individual application instance.

Note that in single sweep mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous sweep mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous sweep mode in remote control, as results like trace data or markers are only valid after a single sweep end synchronization.

For details on synchronization see Remote control via SCPI.

If the sweep mode is changed for an application instance while the Sequencer is active (see `INITiate:SEQuencer:IMMediate` on page 545), the mode is only considered the next time the measurement in that application instance is activated by the Sequencer.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous sweep

OFF | 0
Single sweep

*RST: 1 (some applications can differ)

Example: //Switch the sweep mode to single sweep.
```
INIT:CONT OFF
```
//Switch the sweep mode to continuous sweep.
```
INIT:CONT ON
```

Manual operation: See "[Run Cont] / Continuous Sweep" on page 268
See "Frequency Sweep" on page 987
See "Zero Span" on page 987

INITiate<n>[:IMMediate]

Starts a (single) new measurement.

With sweep count or average count > 0, this means a restart of the corresponding number of measurements. With trace mode MAXHold, MINHold and AVERage, the previous results are reset on restarting the measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization, see Remote control via SCPI on the Rohde & Schwarz website.

Suffix:
<n> Window 1 to 16

Example: //Switch to single sweep mode.
```
INIT:CONT OFF
```
//Switch on trace averaging.
```
DISP:WIND:TRAC:MODE AVER
```
//Set the sweep counter to 20 sweeps.
```
SWE:COUN 20
```
//Start the measurement and wait for the end of the 20 sweeps.
```
INIT;*WAI
```

Usage: Asynchronous command

Manual operation: See "[RUN SINGLE] / Run Single Sweep" on page 267
See "Frequency Sweep" on page 987
See "Zero Span" on page 987

4.14.10 Configuring the result display

The commands required to configure the screen display in a remote environment are described here.

- General window commands....648
- Working with windows in the display....649
- Examples: configuring the result display....662

4.14.10.1 General window commands

The following commands are required to configure general window layout, independent of the application.

Note that the suffix <n> always refers to the window *in the currently selected application instance* (see `INSTrument[:SELect]` on page 544).

DISPlay:FORMat 648
DISPlay[:WINDow<n>]:SIZE 648

DISPlay:FORMat <Format>

Determines which tab is displayed.

Parameters:

<Format> SINGle | SPLit

SPLit
Displays the "MultiView" tab with an overview of all active application instances.
For more information, see "MultiView tab" on page 69.

SINGle
Displays the application instance that was previously focused.

*RST: SING

Example: `DISP:FORM SPL`

DISPlay[:WINDow<n>]:SIZE <Size>

Maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 659).

Suffix:

<n> Window 1 to 16

Parameters:

<Size> LARGe | SMALl

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example: `DISP:WIND2:SIZE LARG`

4.14.10.2 Working with windows in the display

The following commands are required to change the result display and rearrange the screen layout for an application instance . Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected application instance.

Note that the suffix <n> always refers to the window *in the currently selected application instance*.

See`INSTrument[:SELect]` on page 544.

Application-specific <WindowType> parameter values

Table 4-55: <WindowType> parameter values for the Spectrum application

Parameter value	Window type
DIAGram	"Diagram"
MTABle	"Marker table"
PEAKlist	"Marker peak list"
RSUMmary	"Result summary"
SGRam	"Spectrogram"

Table 4-56: <WindowType> parameter values for the I/Q Capture application

Parameter value	Window type
FREQ	"Spectrum"
MAGN	"Magnitude"

Table 4-57: <WindowType> parameter values for the I/Q Spectrum Analyzer application

Parameter value	Window type
Basic I/Q measurement:	
FREQ	"Frequency sweep"
IQVector VECTor	"I/Q Vector"
MAGN	"Magnitude"
MTABle	"Marker table"
RIMAG	"Real/Imag (I/Q)"
RF measurements:	
ACLR	Adjacent channel power
APD	"APD"
CCDF	"CCDF"
OBW	"Occupied bandwidth"

Parameter value	Window type
PVT	"Phase vs Time"
SPEC	"FFT Spectrum"
TDP	"Time domain power"
TOI	"TOI" (Third-order intercept)
ZSPan	"Zero span"

Table 4-58: <WindowType> parameter values for the Display application

Parameter value	Window type
CARTesian	"Cartesian" diagram
POLar	"Polar" diagram
MTABle	"Marker table"

Table 4-59: <WindowType> parameter values for the Pulse application

Parameter value	Window type
CPMagnitude	"Correlated Pulse Magnitude"*
CMCapture	"Correlated Magnitude Capture"*
MCAPture	"Magnitude Capture Buffer"
MTABle	"Marker Table"
PDIStribution	"Parameter Distribution"
PFERror	"Pulse Frequency Error"*
PFRequency	"Pulse Frequency"
PIAQ	"Pulse I and Q"
PMAGnitude	"Pulse Magnitude"
PPERor	"Pulse Phase Error"*
PPHase	"Pulse Phase"
PPSPectrum	"Pulse-Pulse Spectrum"
PPWrapped	"Pulse phase, wrapped"
PRESults	"Pulse Results"
PSPectrum	"Parameter Spectrum"
PSTatistics	"Pulse Statistics"
PTRend	"Parameter Trend"
RRSPectrum	"Result Range Spectrum"
*) Result displays marked with an asterisk require both the "Pulse" and the additional "Time Sidelobe" option.	

Table 4-60: <WindowType> parameter values for the AM/FM/PM Analog Demod application

Parameter value	Window type
MTABle	"Marker table"
PEAKlist	"Marker peak list"
RSUMmary	"Result summary"
'XTIM:AM'	"RF Time Domain" (= RF power)
'XTIM:AM:RELative'	"AM Time Domain"
'XTIM:AM:RELative:AFSPec-trum'	"AM Spectrum"
'XTIM:FM'	"FM Time Domain"
'XTIM:FM:AFSPectrum'	"FM Spectrum"
'XTIM:PM'	"PM Time Domain"
'XTIM:PM:AFSPectrum'	"PM Spectrum"
'XTIM:SPECtrum'	"RF Spectrum"

Table 4-61: <WindowType> parameter values for the Amplifier application

Parameter value	Window type
ACP	"Adjacent Channel Power" (Table)
AMAM	"AM/AM"
AMEVm	"EVM" vs Power
AMPM	"Phase Deviation vs Input Power"("AM/PM")
DDPD	"DDPD Results"
GCOMpression	"Gain Compression"
GDEL	"Group Delay"
GDVTime	"Gain Deviation vs Time"
IMAGnitude	"Magnitude Capture" I
ICCPower	"Icc vs Power"
ISPectrum	"Spectrum FFT" I
MDPD	"Memory DPD Coefficients"
MRES	"Channel Response Magnitude"
MTABle	"Marker Table"
PAEI	"PAE Input Power"
PAEO	"PAE Output Power"
PAETime	"PAE Time"
PRES	"Channel Response Phase"
PSWeep	"Parameter Sweep" (Diagram)

Parameter value	Window type
PTABle	"Parameter Sweep" (Table)
PDVTime	"Phase Deviation vs Time"
PVTime	"Power vs. Time (I x Q)"
QMAGnitude	"Magnitude Capture" Q
QSPectrum	"Spectrum FFT" Q
REVM	Raw "EVM"
RFMagnitude	"Magnitude Capture" RF
RFSPectrum	"Spectrum FFT"
RTABle	"Result Summary" (Table)
SEVM	Spectrum "EVM"
STAB	"Statistics Table"
TDOMain	"Time Domain"
VCCPower	"Vcc vs Power"
VICC	"Vcc vs. Icc"

Table 4-62: <WindowType> parameter values for Phase Noise

Parameter value	Window type
FDRift	Frequency drift
MTABle	Marker table
PNOise	Phase noise diagram
RNOise	Residual noise table
SNOise	Spot noise table
SPECtrum	Spectrum monitor
SPURs	Spur list
SRESults	Sweep result list
STABility	Frequency and level stability indicator

Table 4-63: <WindowType> parameter values for Noise Figure

Parameter value	Window type
CPCold	"Cal Level (Cold)"
CPHot	"Cal Level (Hot)"
CYFactor	"Cal Y-Factor"
DPC	"P Cold"
DPH	"P Hot"

Parameter value	Window type
ENR	"ENR Measured"
GAIN	"Gain"
MTABle	"Marker table"
NOISe	"Noise figure"
PCOLd	"Level (cold)"
PHOT	"Level (hot)"
RESults	"Result table"
TEMPerature	"Temperature"
YFACtor	"Y-Factor"

Table 4-64: <WindowType> parameter values for Transient Analysis

Parameter value	Window type
SGR	"Spectrogram"
RFPTime	RF Power "Time Domain"
FMTime	"FM Time Domain"
IQTime	I/Q "Time Domain"
FDEViation	Frequency Deviation "Time Domain"[1)]
FDSG	Frequency Deviation Spectrogram[2)]
FDSP	Frequency Deviation Spectrum[2)]
PDEViation	Phase Deviation "Time Domain"[1)]
PDIStribution	Parameter Distribution
PDSG	Phase Deviation Spectrogram[2)]
PDSP	Phase Deviation Spectrum[2)]
PMTime	"PM Time Domain"
PMWRapped	"PM Time Domain" (Wrapped)
PNO	Phase Noise[2)]
PTRend	Parameter Trend
RFSPectrum	"RF Spectrum"
CRTime	Chirp Rate "Time Domain"[1)]
MTABle	Marker table
RTABle	Results table[1)]
STABle	Statistics table[1)]
[1)] requires additional option FSWX-K60C/-K60H [2)] requires additional option FSWX-K60P	

Table 4-65: <WindowType> parameter values for the VSA application

Parameter value	Data source (+ default result display)
CBUFfer	Capture buffer ("Magnitude absolute")
MEAS	Meas & Ref ("Magnitude relative")
REF	
EQUalizer	"Equalizer"
EVECtor	Error vector ("EVM")
MACCuracy	Modulation Accuracy ("Result Summary")
MCOMbination	Multi Source ("Spec (Meas+Error)")
MERRor	Modulation Errors ("Magnitude error")
SYMB	"Symbols (Hexadecimal)"

Table 4-66: <WindowType> parameter values for 5G NR measurement application

Parameter value	Window type
I/Q measurements	
AISC	"Allocation ID vs. Symbol X Carrier"
ASUM	"Allocation Summary"
BSUM	"Beamforming Summary"
BSTR	"Bitstream"
CBUF	"Capture Buffer"
CCDF	"CCDF"
CDEC	"Channel Decoder"
CONS	"Constellation Diagram"
EVCA	"EVM vs. Carrier"
EVRB	"EVM vs. RB"
EVSC	"EVM vs. Symbol X Carrier"
EVSY	"EVM vs. Symbol"
FEVS	"Frequency Error vs Symbol"
FLAT	"Channel Flatness"
FVSU	"Frequency Error vs Subframe"
MTAB	"Marker Table"
PSPE	"Power Spectrum"
PVSC	"Power vs. Symbol X Carrier"
RSUM	"Result Summary"
RSMA	"RS Magnitude"

Parameter value	Window type
RSPD	"RS Phase Difference"
RSWP	"RS Phase"
Time alignment error	
CBUF	"Capture Buffer"
MTAB	"Marker Table"
PSPE	"Power Spectrum"
TAL	"Time Alignment Error"
ACLR and **SEM** measurements	
DIAG	"Diagram"
PEAK	"Peak List"
MTAB	"Marker Table"
RSUM	"Result Summary"

Table 4-67: <WindowType> parameter values for 5G NR measurement application

Parameter value	Window type
I/Q measurements	
AISC	"Allocation ID vs. Symbol X Carrier"
ASUM	"Allocation Summary"
BSTR	"Bitstream"
CBUF	"Capture Buffer"
CCDF	"CCDF"
CONS	"Constellation Diagram"
EVCA	"EVM vs. Carrier"
EVRB	"EVM vs. RB"
EVSC	"EVM vs. Symbol X Carrier"
EVSY	"EVM vs. Symbol"
FEVS	"Frequency Error vs Symbol"
FVSU	"Frequency Error vs Subframe"
IE	"Inband Emissions"
IEA	"Inband Emissions All"
IESummary	"Inband Emissions Summary"
MTAB	"Marker Table"
PSPE	"Power Spectrum"
PVSC	"Power vs. Symbol X Carrier"

Parameter value	Window type
RSUM	"Result Summary"
SFL	"Spectrum Flatness"
PRACH analysis	
ASUM	"PRACH Allocation Summary"
CBUF	"Capture Buffer"
CONS	"Constellation Diagram"
MTAB	"Marker Table"
PSPE	"Power Spectrum"
RSUM	"Result Summary"
SFL	"Spectrum Flatness"
ACLR and **SEM** measurements	
DIAG	"Diagram"
PEAK	"Peak List"
MTAB	"Marker Table"
RSUM	"Result Summary"

LAYout:ADD[:WINDow]?....656
LAYout:CATalog[:WINDow]?....657
LAYout:IDENtify[:WINDow]?....658
LAYout:MOVE[:WINDow]....658
LAYout:REMove[:WINDow]....658
LAYout:REPLace[:WINDow]....659
LAYout:SPLitter....659
LAYout:WINDow<n>:ADD?....661
LAYout:WINDow<n>:REMove....661
LAYout:WINDow<n>:REPLace....662
LAYout:WINDow<n>:TYPE....662

LAYout:ADD[:WINDow]? <WindowName>, <Direction>, <WindowType>

Adds a window to the display in the active application instance.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Query parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index.
To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

<WindowType> text value or string
Type of result display (evaluation method) you want to add.
See "Application-specific <WindowType> parameter values" on page 649 for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
```
LAY:ADD? '1',LEFT,MTAB
```
Result:
```
'2'
```
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation: See "Diagram" on page 80
See "Result Summary" on page 81
See "Spectrogram" on page 81
See "Magnitude" on page 1454
See "FFT Spectrum" on page 1454

LAYout:CATalog[:WINDow]?

Queries the name and index of all active windows in the active application instance from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string
Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example:
```
LAY:CAT?
```
Result:
```
'2',2,'1',1
```
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

Queries the **index** of a particular display window in the active application instance.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:IDEN:WIND? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:MOVE[:WINDow] <WindowName>, <WindowName>, <Direction>

Moves a window to another position on the screen.

Setting parameters:

<WindowName> String containing the name of an existing window that is to be moved.
By default, the name of a window is the same as its index.
To determine the name and index of all active windows in the active application instance, use the `LAYout:CATalog[:WINDow]?` query.

<WindowName> String containing the name of an existing window the selected window is placed next to or replaces.
By default, the name of a window is the same as its index.
To determine the name and index of all active windows in the active application instance, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow | REPLace

Destination the selected window is moved to, relative to the reference window.

Example: `LAY:MOVE '4','1',LEFT`
Moves the window named '4' to the left of window 1.

Example: `LAY:MOVE '1','3',REPL`
Replaces the window named '3' by window 1. Window 3 is deleted.

Usage: Setting only

LAYout:REMove[:WINDow] <WindowName>

Removes a window from the display in the active application instance.

Setting parameters:

<WindowName> String containing the name of the window. In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Setting only

LAYout:REPLace[:WINDow] <WindowName>, <WindowType>

Replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active application instance while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Setting parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index.
To determine the name and index of all active windows in the active application instance, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 656 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

Usage: Setting only

LAYout:SPLitter <Index1>, <Index2>, <Position>

Changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 648 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command does not work, but does not return an error.

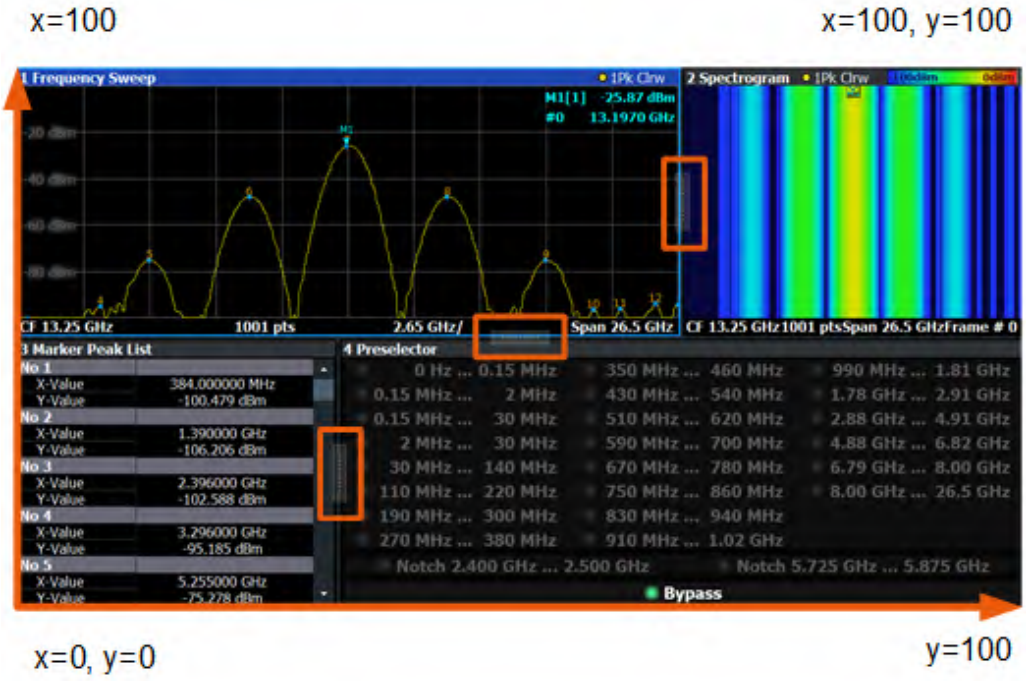


Figure 4-60: Window coordinates for remote control of the splitters

Setting parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without application info panel, status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 4-60.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('"Marker Table"') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('"Marker Peak List"') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
`LAY:SPL 3,2,70`
`LAY:SPL 4,1,70`
`LAY:SPL 2,1,70`

Usage: Setting only

LAYout:WINDow<n>:ADD? <Direction>, <WindowType>

Adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added. Unlike `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

Is always used as a query so that you immediately obtain the name of the new window as a result.

Suffix:
<n> Window 1 to 16

Query parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 656 for a list of available window types.

Return values:
<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:REMove

Removes the window specified by the suffix <n> from the display in the active application instance.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Suffix:
<n> Window 1 to 16

Example: LAY:WIND2:REM
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

Changes the window type of an existing window (specified by the suffix <n>) in the active application instance.

The effect of this command is identical to the LAYout:REPLace[:WINDow] command.

To add a new window, use the LAYout:WINDow<n>:ADD? command.

Suffix:
<n> Window 1 to 16

Setting parameters:
<WindowType> Type of measurement window you want to replace another one with.
See LAYout:ADD[:WINDow]? on page 656 for a list of available window types.

Example: LAY:WIND2:REPL MTAB
Replaces the result display in window 2 with a marker table.

Usage: Setting only

LAYout:WINDow<n>:TYPE <WindowType>

Queries or defines the window type of the window specified by the index <n>. The window type determines which results are displayed. For a list of possible window types, see LAYout:ADD[:WINDow]? on page 656.

Note that this command is not available in all applications and measurements.

Suffix:
<n> Window 1 to 16

Parameters:
<WindowType>

Example: LAY:WIND2:TYPE?

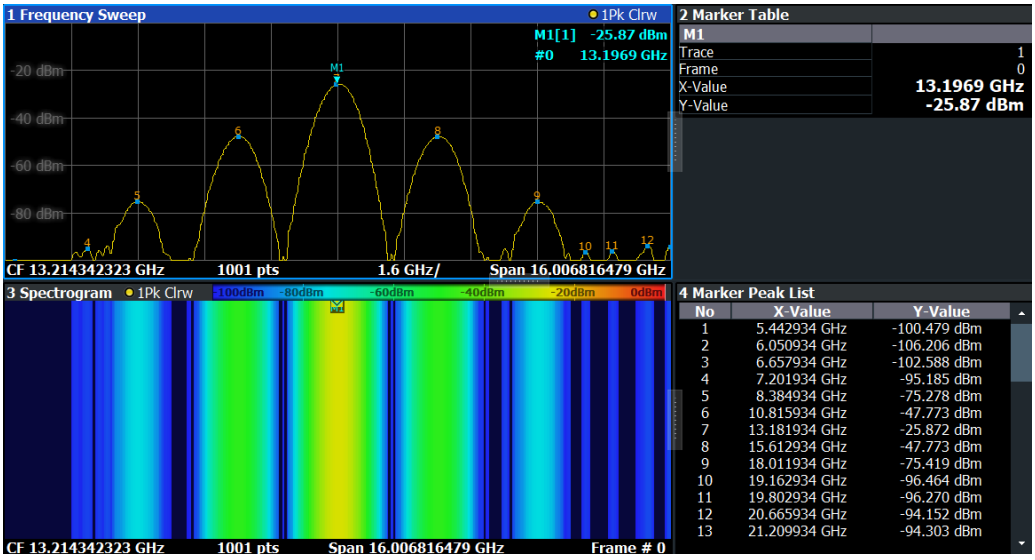
4.14.10.3 Examples: configuring the result display

The following example demonstrates how to configure result displays in a remote environment.

Example 1: adding and arranging windows

Starting from the default initial display in the "Spectrum" application ("Frequency Sweep"), this example configures the following result displays:

1 Frequency Sweep	3 "Marker Table"
2 Spectrogram	4 "Marker Peak List"




```
//--------------Resetting the instrument -----------
*RST
//--------------- Adding new windows --------------------
//Add a Spectrogram window beneath the Frequency Sweep window
LAY:ADD? '1',BEL,SGR
//Result: window number: '2'
//Add a Marker Table window to the right of the Frequency Sweep window
LAY:ADD? '1',RIGH,MTAB
//Result: window number: '3'
//Add a Marker Peak List window to the right of the Spectrogram window
LAY:WIND2:ADD? RIGH,PEAK
//Result: window number: '4'

//--------------- Changing the size of individual windows -------------
//Move the splitter between the Frequency Sweep window and the Marker Table
//window to enlarge the spectrum display to 60% of the entire width.
LAY:SPL 1,3,60
//Move the splitter between the Spectrogram window and the Marker Peak List
//window to enlarge the Spectrogram display to 60% of the entire width.
LAY:SPL 2,4,60

//--------------- Querying all displayed windows ------------------
//Query the name and number of all displayed windows
//(from top left to bottom right)
LAY:CAT?
//Result : '1',1,'2',2,'3',3,'4',4

//------------- Maximizing a Window ------------------
//Maximize the window "2 Spectrogram"
```

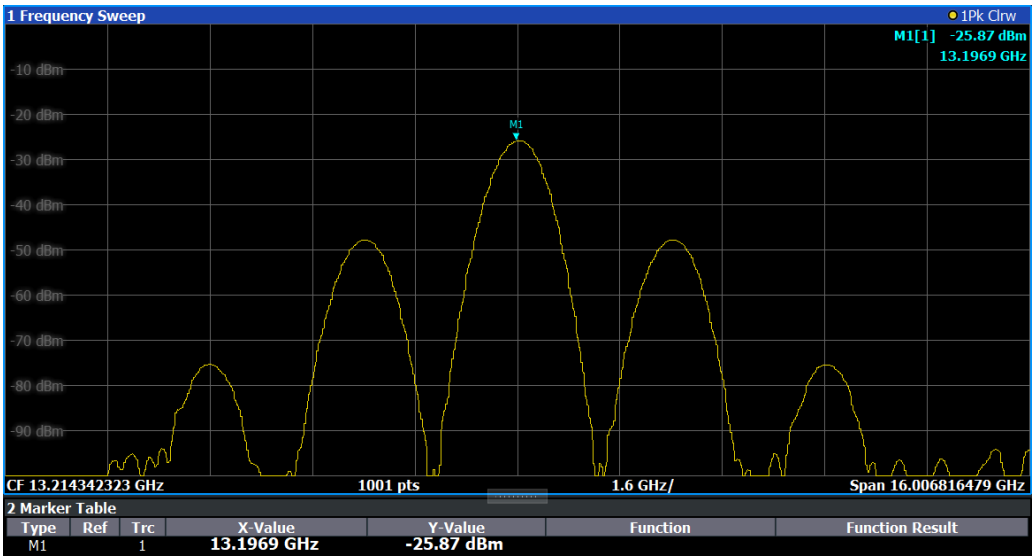
```
DISP:WIND2:SIZE LARG

//-------------Restore multiple window display -----------
DISP:WIND2:SIZE SMAL
```

Example 2: replacing and removing windows

Starting from the display configured in Example 1: adding and arranging windows, this example removes and replaces result displays to obtain the following configuration:

1 Frequency Sweep
4 "Marker Table"




```
//-------------- Preparing the configuration from example 1 -----------
*RST
LAY:ADD? '1',BEL,SGR
LAY:ADD? '1',RIGH,MTAB
LAY:WIND2:ADD? RIGH,PEAK
LAY:CAT?
//Result : '1',1,'2',2,'3',3,'4',4
//Remove Spectrogram
LAY:WIND2:REM //Remove Marker Table window
LAY:REM '3'
//Replace Marker Peak List window by Marker Table
LAY:REPL '4',MTAB

//--------------- Querying all displayed windows ------------------
//Query the name and number of all displayed windows (from top left to bottom right)
LAY:CAT?
```

```
//Result : '1',1,'4',4

//--------------- Changing the size of individual windows -------------
//Move the splitter between the Frequency Sweep window and the Marker Table window
//to enlarge the spectrum display to 80% of the entire height.
LAY:SPL 1,4,80
```

4.14.11 Result evaluation commands

The following commands allow you to evaluate the results of most RF and many other measurements.

- Zooming into the display 665
- Configuring the trace display and retrieving trace data 668
- Working with markers 695
- Configuring display lines 758
- Defining limit checks 761

4.14.11.1 Zooming into the display

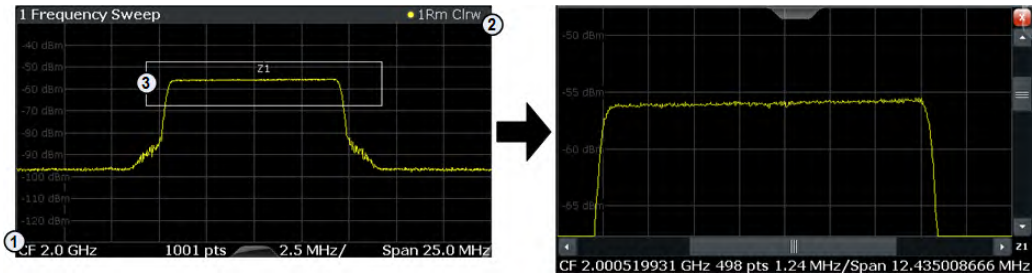
Using the single zoom

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA 665
DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe] 666

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA <x1>, <y1>, <x2>, <y2>

Defines the zoom area.

To define a zoom area, you first have to turn on the zoom.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

<n> Window 1 to 16

<w> subwindow
Not supported by all applications

Parameters:

<x1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of the coordinate system. The upper right corner is the endpoint of the system.
Range: 0 to 100
Default unit: PCT

<y1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of the coordinate system. The upper right corner is the endpoint of the system.
Range: 0 to 100
Default unit: PCT

<x2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of the coordinate system. The upper right corner is the endpoint of the system.
Range: 0 to 100
Default unit: PCT

<y2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of the coordinate system. The upper right corner is the endpoint of the system.
Range: 0 to 100
Default unit: PCT

Manual operation: See "Single Zoom" on page 336

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe] <State>

Enables or disables the zoom.

Suffix:

<n> Window 1 to 16

<w> subwindow
Not supported by all applications

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP:ZOOM ON`
Activates the zoom mode.

Manual operation: See "Single Zoom" on page 336
See "Zoom Off (Restore original display)" on page 337

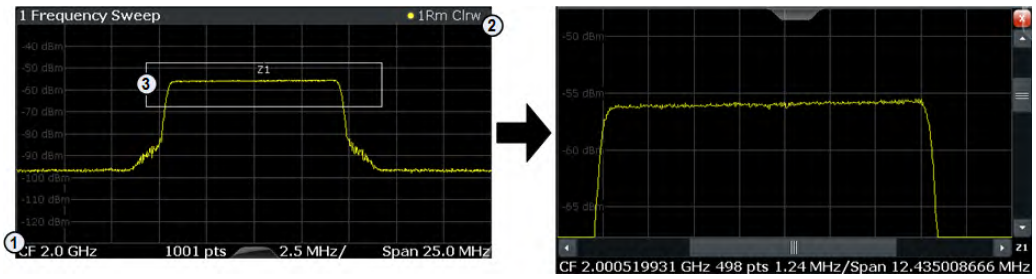
Using the multiple zoom

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA.....667
DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe]..... 668

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA <x1>, <y1>, <x2>, <y2>

Defines the zoom area for a multiple zoom.

To define a zoom area, you first have to turn on the zoom.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

<n> Window 1 to 16

<w> subwindow
Not supported by all applications

<zn> Selects the zoom window.

Parameters:

<x1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of the coordinate system. The upper right corner is the endpoint of the system.

Range: 0 to 100
Default unit: PCT

<y1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of the coordinate system. The upper right corner is the endpoint of the system.

Range: 0 to 100
Default unit: PCT

<x2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of the coordinate system. The upper right corner is the endpoint of the system.

Range: 0 to 100
Default unit: PCT

<y2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of the coordinate system. The upper right corner is the endpoint of the system.

Range: 0 to 100
Default unit: PCT

Example:
```
DISP:WIND:SUBW:ZOOM:MULT:AREA 10,10,90,90
```

Manual operation: See "Multi-Zoom" on page 336

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe] <State>

Enables or disables the multiple zoom.

Suffix:

<n> Window 1 to 16

<w> subwindow
Not supported by all applications

<zn> Selects the zoom window.
If you turn off one of the zoom windows, all subsequent zoom windows move up one position.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
DISP:WIND:SUBW:ZOOM:MULT:STAT OFF
```

Manual operation: See "Multi-Zoom" on page 336
See "Zoom Off (Restore original display)" on page 337

4.14.11.2 Configuring the trace display and retrieving trace data

The commands required to work with traces are described here.

- Configuring standard traces....669
- Configuring spectrograms....678
- Using trace mathematics....686

- Retrieving trace results 688
- Importing and exporting traces 690
- Programming example: configuring a spectrogram 693

Configuring standard traces

Useful commands for trace configuration described elsewhere

- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing` on page 1431
- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]` on page 1429

Remote commands exclusive to trace configuration

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe] 669
DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe] 670
DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT 670
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE 671
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous 672
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:PRESet 672
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:PERSistence[:STATe] 673
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture 673
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe] 674
[SENSe<ip>:]AVERage<n>:AUTO 674
[SENSe<ip>:]AVERage<n>:COUNt 675
[SENSe<ip>:]AVERage<n>[:STATe<t>] 675
[SENSe<ip>:]AVERage<n>:TYPE 676
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] 676
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO 677
TRACe<n>:COPY 677

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe] <State>

Turns a trace on and off.

The measurement continues in the background.

Suffix:

<n> Trace 1 to 6

<w> subwindow
Not supported by all applications

<t> Trace 1 to 6

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: DISP:TRAC3 ON

Manual operation: See "Trace State" on page 973
See "Add Trace / Trace<x>" on page 1216
See "Trace State" on page 1217

DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe] <State>

Turns on the display of a descriptive label for the specified trace instead of the default "Trace <x>" label.

Define the label using the DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT command.

You can only configure labels for active traces and for traces whose "State" is enabled.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<State> **OFF**
Switch the function off
ON
Switch the function on
*RST: OFF

Example:
```
DISP:WIND2:TRAC1:LAB ON
DISP:WIND2:TRAC1:LAB:TEXT 'MaxTrace'
```

Manual operation: See "Label" on page 1219

DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT <Text>

Defines a descriptive label for the specified trace instead of the default "Trace <x>" label.

Enable the label using the DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe] command.

You can only configure labels for active traces and for traces whose "State" is enabled.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<Text> String containing the trace label.

Example:
```
DISP:WIND2:TRAC1:LAB ON
DISP:WIND2:TRAC1:LAB:TEXT 'MaxTrace'
```

Manual operation: See "Label" on page 1219

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE <Mode>

Selects the trace mode. If necessary, the selected trace is also activated.

For max hold, min hold or average trace mode, you must set the number of single measurements.

See `[SENSe<ip>:]SWEep:COUNt` on page 1425.

Note that synchronization to the end of the measurement is possible only in single sweep mode.

For more information, see "Analyzing several traces - trace mode" on page 285.

Suffix:

<n> Window 1 to 16

<w> subwindow
Not supported by all applications

<t> Trace 1 to 6

Parameters:

<Mode> WRITe | AVERage | MAXimum | MINimum | REAL | IMAGinary | BLANk

WRITe
(default:) Overwrite mode: the trace is overwritten by each sweep.

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

MAXHold
The maximum value is determined over several sweeps and displayed. The FSWX saves the sweep result in the trace memory only if the new value is greater than the previous one.

MINHold
The minimum value is determined from several measurements and displayed. The FSWX saves the sweep result in the trace memory only if the new value is lower than the previous one.

VIEW
The current contents of the trace memory are frozen and displayed.

BLANk
Hides the selected trace.

*RST: Trace 1: WRITe, Trace 2-6: BLANk

Example: `INIT:CONT OFF`
Switching to single sweep mode.
`SWE:COUN 16`
Sets the number of measurements to 16.
`DISP:TRAC3:MODE WRIT`
Selects clear/write mode for trace 3.
`INIT;*WAI`
Starts the measurement and waits for the end of the measurement.

Manual operation: See "Trace Mode" on page 1217

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous <State>

Enables or disables automatic trace reset after a parameter has changed.

The reset works for trace modes min hold, max hold and average.

Note that the command has no effect if critical parameters like the span have been changed to avoid invalid measurement results

Suffix:
<n> Window 1 to 16
<w> subwindow
<t> Trace 1 to 6

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off.
ON | 1
Switches the function on.

Example: `DISP:WIND:TRAC3:MODE:HCON ON`
Switches off the reset function.

Manual operation: See "Hold" on page 1218

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:PRESet <ResultType>

Applies predefined, commonly required trace settings to the selected window.

Suffix:
<n> Window 1 to 16
<w> subwindow
<t> Trace 1 to 6

Parameters:
<ResultType> **ALL**
Preset All Traces

MAM
Max | Avg | Min

MCM
Max | ClrWrite | Min

Example: `DISP:WIND3:TRAC:PRES MCM`
In window 3, the traces are set to the following modes:
Trace 1: Max Hold
Trace 2: Clear Write
Trace 3: Min Hold

Manual operation: See "Predefined Trace Settings - Quick Config" on page 1219

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:PERSistence[:STATe]
<State>

Enables or disables persistence in the persistence spectrum. The persistency duration depends on the sweep count. See `[SENSe<ip>:]SWEep:COUNt` on page 1425.

For a sweep count = 0, the persistence duration is infinite, that is: each trace remains visible until you start a new sweep.

Suffix:
<n> Window 1 to 16
<w> subwindow
<t> Trace 1 to 6

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP:WIND2:SUBW2:TRAC:PERS:STAT OFF`

Manual operation: See "Persistence" on page 1218

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture
<Aperture>

Defines the degree (aperture) of the trace smoothing, if `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]TRUE`.

Suffix:
<n> Window 1 to 16
<w> subwindow
<t> Trace 1 to 6

Parameters:

<Aperture>
Range: 1 to 50
*RST: 2
Default unit: PCT

Example: `DISP3:TRAC2:SMO:APER 5`
Defines an aperture of 5% for trace 2 in window 3

Manual operation: See "Smoothing" on page 1218

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe] <State>

Enables or disables trace smoothing for a particular trace.

If enabled, the trace is smoothed by the value specified using `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture` on page 673.

For more information, see "Removing anomalies: Trace smoothing" on page 288.

Suffix:

<n> Window 1 to 16

<w> subwindow

<t> Trace 1 to 6

Parameters:

<State>
ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP3:TRAC2:SMO ON`
Turns on trace smoothing for trace 2 in window 3

Manual operation: See "Smoothing" on page 1218

[SENSe<ip>:]AVERage<n>:AUTO <State>

Defines whether the trace mode is defined automatically or manually.

For more information, see "How trace data is averaged - the averaging mode" on page 287.

Suffix:

<ip> Input

<n> Window 1 to 16

Parameters:

<State>
ON | OFF | 0 | 1

OFF | 0
You define the trade mode manually using `[SENSe<ip>:]AVERage<n>:TYPE` on page 676.

ON | 1
(Default:) The FSWX determines the optimal averaging mode automatically according to the selected trace detector.

*RST: 1

Example: `AVER:AUTO OFF`
Disables automatic average mode.
`AVER:TYPE LIN`
Switches to linear average calculation.

Manual operation: See "Average Mode" on page 1220

[SENSe<ip>:]AVERage<n>:COUNt <AverageCount>

Defines the number of sweeps that the application uses to average traces.

During calibration measurements, the phase and amplitude values are averaged over the defined number of sweeps.

In continuous sweep mode, the application calculates the moving average over the average count.

In single sweep mode, the application stops the measurement and calculates the average after the average count has been reached.

Suffix:
<ip> Input

<n> irrelevant

Parameters:
<AverageCount> If you set an average count of 0 or 1, the application performs one single sweep in single sweep mode.
In continuous sweep mode, if the average count is set to 0, a moving average over 10 sweeps is performed.

Range: 0 to 200000
*RST: 0

Example: `SENS:AVER:COUN 10`

Manual operation: See "Sweep Count" on page 969
See "Average Count" on page 1220

[SENSe<ip>:]AVERage<n>[:STATe<t>] <State>

Enables or disables averaging for a particular trace in a particular window.

Suffix:
<ip> Input

<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<State> ON | OFF | 1 | 0

Example: `SENS:AVER2:STAT2 OFF`

[SENSe<ip>:]AVERage<n>:TYPE <Mode>

Selects the trace averaging mode for `[SENSe<ip>:]AVERage<n>:AUTO OFF`.

Suffix:
<ip> Input

<n> Window 1 to 16

Parameters:
<Mode>

LOGarithmic
The logarithmic power values are averaged.

LINear
The power values are averaged before they are converted to logarithmic values.

POWer
The power level values are converted into unit Watt before averaging. After the averaging, the data is converted back into its original unit.

Example: `AVER:AUTO OFF`
Disables automatic average mode.
`AVER:TYPE LIN`
Switches to linear average calculation.

Manual operation: See "Average Type" on page 1220

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] <Detector>

Defines the trace detector to be used for trace analysis.

For more information, see "Mapping samples to sweep points with the trace detector" on page 278.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<Detector>

APEak
Autopeak

NEGative
Negative peak

POSitive
Positive peak

QPEak
Quasipeak (CISPR filter only)

SAMPle
First value detected per trace point

RMS
RMS value

AVERage
Average

CAVerage
CISPR Average (CISPR filter only)

CRMS
CISPR RMS (CISPR filter only)

XRMS
RMSXCorr

*RST: APEak

Example: `DET POS`
Sets the detector to "positive peak".

Manual operation: See "X-Corr Detector" on page 973
See "Type" on page 1218

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO <State>

Couples and decouples the detector to the trace mode.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<State> ON | OFF | 0 | 1

*RST: 1

Example: `DET:AUTO OFF`
The selection of the detector is not coupled to the trace mode.

Manual operation: See "Detector" on page 1217

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

Copies data from one trace to another.

Suffix:
<n> Window 1 to 16

Parameters:
<TraceNumber> **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**
The first parameter is the destination trace, the second parameter is the source.
(Note the 'e' in the parameter is required!)

Example: `TRAC:COPY TRACE1,TRACE2`
Copies the data from trace 2 to trace 1.

Manual operation: See "Copy Trace" on page 1221

Configuring spectrograms

In addition to the standard "level versus frequency" or "level versus time" spectrum traces, the FSWX also provides a spectrogram display of the measured data. A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. The commands required to configure spectrograms in a remote environment are described here. For details and manual operation see Section 5.4.4.3, "Spectrogram settings", on page 1223.

When configuring spectrograms, the window suffix is irrelevant. The settings are always applied to the spectrogram window, or to all spectrogram windows, if several are active for the same application instance.

For commands to set markers in spectrograms, see "Configuring spectrograms" on page 678.

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Configuring a spectrogram measurement

CALCulate<n>:SGRam:CLEar[:IMMediate]....679
CALCulate<n>:SPECtrogram:CLEar[:IMMediate]....679
CALCulate<n>:SGRam:CONTinuous....679
CALCulate<n>:SPECtrogram:CONTinuous....679
CALCulate<n>:SGRam:FRAMe:COUNt....679
CALCulate<n>:SPECtrogram:FRAMe:COUNt....679
CALCulate<n>:SGRam:FRAMe:SELect....680
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CALCulate<n>:SPECtrogram:TSTamp[:STATe]....683

CALCulate<n>:SGRam:CLEar[:IMMediate]
CALCulate<n>:SPECtrogram:CLEar[:IMMediate]

Resets the spectrogram and clears the history buffer.

Suffix:
<n> Window 1 to 16

Example: //Reset the result display and clear the memory
`CALC:SGR:CLE`

Manual operation: See "Clear Spectrogram" on page 1225
See "Clear Spectrogram" on page 1227

CALCulate<n>:SGRam:CONTinuous <State>
CALCulate<n>:SPECtrogram:CONTinuous <State>

Determines whether the results of the last measurement are deleted before starting a new measurement in single sweep mode.

This setting applies to all spectrograms in the application instance.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `INIT:CONT OFF`
Selects single sweep mode.
`INIT;*WAI`
Starts the sweep and waits for the end of the sweep.
`CALC:SGR:CONT ON`
Repeats the single sweep measurement without deleting the results of the last measurement.

Manual operation: See "Continue Frame" on page 1226

CALCulate<n>:SGRam:FRAMe:COUNt <Frames>
CALCulate<n>:SPECtrogram:FRAMe:COUNt <Frames>

Defines the number of frames to be recorded in a single sweep.

This value applies to all spectrograms in the application instance.

Suffix:
<n> Window 1 to 16

Parameters:

<Frames> The maximum number of frames depends on the history depth.

Range: 1 to history depth
Increment: 1
*RST: 1

Example: //Select single sweep mode
`INIT:CONT OFF`
//Set the number of frames to 200
`CALC:SGR:FRAM:COUN 200`

Manual operation: See "Frame Count" on page 1227

CALCulate<n>:SGRam:FRAMe:SELect <Frame>
CALCulate<n>:SPECtrogram:FRAMe:SELect <Frame> | <Time>

Selects a specific frame for further analysis.

The command is available if no measurement is running or after a single sweep has ended.

Suffix:

<n> Window 1 to 16

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

Default unit: S

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example: `INIT:CONT OFF`
Stop the continuous sweep.
`CALC:SGR:FRAM:SEL -25`
Selects frame number -25.

Manual operation: See "Select Frame" on page 1226

CALCulate<n>:SGRam:HDEPth <History>
CALCulate<n>:SPECtrogram:HDEPth <History>

Defines the number of frames to be stored in the FSWX memory.

Suffix:

<n> Window 1 to 16

Parameters:

<History> The maximum number of frames depends on the number of sweep points.

Range: 781 to 20000
Increment: 1
*RST: 3000

Example: `CALC:SPEC:HDEP 1500`
Sets the history depth to 1500.

Manual operation: See "History Depth" on page 1225

CALCulate<n>:SGRam:LAYout <State>
CALCulate<n>:SPECtrogram:LAYout <State>

Selects the state and size of spectrograms.

The command is available for result displays that support spectrograms.

Suffix:

<n> Window 1 to 16

Parameters:

<State>

FULL
Only the spectrogram is displayed, the trace diagram is not.

SPLIT
Spectrogram and trace diagram share a window.

ON
Spectrogram and trace diagram share a window.

OFF
Only the trace diagram is displayed, the spectrogram is not.

*RST: OFF

Example: `CALC4:SPEC:LAY FULL`
Shows the spectrogram in window 4. The corresponding trace diagram is hidden.

Manual operation: See "Spectrogram State" on page 1224

CALCulate<n>:SGRam[:STATe] <State>
CALCulate<n>:SPECtrogram[:STATe] <State>

Enables or disables the spectrogram.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:SGR ON`
Activates the Spectrogram result display.

CALCulate<n>:SGRam:THReedim[:STATe] <State>
CALCulate<n>:SPECtrogram:THReedim[:STATe] <State>

Activates or deactivates a 3-dimensional spectrogram for the selected result display.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `CALC:SPEC:THR:STAT ON`

Manual operation: See "Appearance" on page 1224

CALCulate<n>:SGRam:TRACe <Trace>
CALCulate<n>:SPECtrogram:TRACe <Trace>

Determines the trace in the result display the Spectrogram is based on.

Suffix:
<n> Window 1 to 16

Parameters:
<Trace> TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

How many traces are available depends on the selected result display.

Example: `CALC2:SPEC:TRAC TRACE3`

Manual operation: See "Trace" on page 1225

CALCulate<n>:SGRam:TSTamp:DATA <Frames>
CALCulate<n>:SPECtrogram:TSTamp:DATA? <Frames>

Queries the starting time of the frames.

The return values consist of four values for each frame. If the "Spectrogram" is empty, the command returns '0,0,0,0'. The times are given as delta values, which simplifies evaluating relative results; however, you can also calculate the absolute date and time as displayed on the screen.

The frame results themselves are returned with `TRAC:DATA? SGR`

See `TRACe<n>[:DATA]` on page 688.

Suffix:
<n> Window 1 to 16

Query parameters:
<Frames> CURRent | ALL

CURRent
Returns the starting time of the current frame.

ALL
Returns the starting time for all frames. The results are sorted in descending order, beginning with the current frame.

Return values:
<Seconds> Number of seconds that have passed since 01.01.1970 until the frame start

<Nanoseconds> Number of nanoseconds that have passed *in addition to the <Seconds>* since 01.01.1970 until the frame start.

<Reserved> The third value is reserved for future uses.

<Reserved> The fourth value is reserved for future uses.

Example: `CALC:SGR:TST:DATA? ALL`
Returns the starting times of all frames sorted in a descending order.

Usage: Query only

Manual operation: See "Show Time Stamp" on page 1225

CALCulate<n>:SGRam:TSTamp[:STATe] <State>
CALCulate<n>:SPECtrogram:TSTamp[:STATe] <State>

Activates and deactivates the time stamp.

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- `CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe` on page 724
- `CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe` on page 720
- `CALCulate<n>:SPECtrogram:FRAMe:SELect` on page 680

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: CALC:SGR:TST ON
Activates the time stamp.

Manual operation: See "Show Time Stamp" on page 1225

Configuring the color map

DISPlay[:WINDow<n>]:SGRam:COLor:DEFault 684
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault 684
DISPlay[:WINDow<n>]:SGRam:COLor:LOWer 684
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer 684
DISPlay[:WINDow<n>]:SGRam:COLor:SHAPe 684
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe 684
DISPlay[:WINDow<n>]:SGRam:COLor:UPPer 685
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer 685
DISPlay[:WINDow<n>]:SGRam:COLor[:STYLe] 685
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe] 685

DISPlay[:WINDow<n>]:SGRam:COLor:DEFault
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault

Restores the original color map.

Suffix:
<n> Window 1 to 16

Example: DISP:WIND:SPEC:COL:DEF

Manual operation: See "Set to default" on page 1229

DISPlay[:WINDow<n>]:SGRam:COLor:LOWer <Percentage>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>

Defines the starting point of the color map.

Suffix:
<n> Window 1 to 16

Parameters:
<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: DISP:WIND:SGR:COL:LOW 10
Sets the start of the color map to 10%.

Manual operation: See "Start / Stop" on page 1228

DISPlay[:WINDow<n>]:SGRam:COLor:SHAPe <Shape>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe <Shape>

Defines the shape and focus of the color curve for the spectrogram result display.

Suffix:
<n> Window 1 to 16

Parameters:
<Shape> Shape of the color curve.
Range: -1 to 1
*RST: 0

Example: `DISP:WIND:SPEC:COL:SHAP 0`

Manual operation: See "Shape" on page 1228

DISPlay[:WINDow<n>]:SGRam:COLor:UPPer <Percentage>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>

Defines the endpoint of the color map.

Suffix:
<n> Window 1 to 16

Parameters:
<Percentage> Statistical frequency percentage.
Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:UPP 95`
Sets the start of the color map to 95%.

Manual operation: See "Start / Stop" on page 1228

DISPlay[:WINDow<n>]:SGRam:COLor[:STYLe] <ColorScheme>
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe] <ColorScheme>

Selects the color scheme.

Suffix:
<n> Window 1 to 16

Parameters:
<ColorScheme> COLor | RADar | GRAYscale | HOT | COLD

HOT
Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

COLD
Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

RADar
Uses a color range from black over green to light turquoise with shades of green in between.

GRAYscale
Shows the results in shades of gray.

*RST: HOT

Example: `DISP:WIND:SPEC:COL GRAY`
Changes the color scheme of the spectrogram to black and white.

Manual operation: See "Hot/Cold/Radar/Grayscale" on page 1229

Using trace mathematics

The following commands control trace mathematics.

CALCulate<n>:MATH<t>[:EXPRession][:DEFine] 686
CALCulate<n>:MATH<t>:MODE 686
CALCulate<n>:MATH<t>:POSition 687
CALCulate<n>:MATH<t>:STATe 687

CALCulate<n>:MATH<t>[:EXPRession][:DEFine] <Expression>

Selects the mathematical expression for trace mathematics.

Before you can use the command, you have to enable trace mathematics.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<Expression> <expr>

(TRACE1-TRACE2)
Subtracts trace 2 from trace 1.

(TRACE1-TRACE3)
Subtracts trace 3 from trace 1.

(TRACE1-TRACE4)
Subtracts trace 4 from trace 1.

(TRACE1-TRACE5)
Subtracts trace 5 from trace 1.

(TRACE1-TRACE6)
Subtracts trace 6 from trace 1.

Example:
```
//Enable trace mathematics.
CALC:MATH:STAT ON
//Subtract trace 3 from trace 1.
CALC:MATH:EXPR:DEF (TRACE1-TRACE3)
```

Manual operation: See "Trace math function" on page 1222

CALCulate<n>:MATH<t>:MODE <Mode>

Selects the way the FSWX calculates trace mathematics.

Suffix:
<n> Window 1 to 16

<t> irrelevant

Parameters:
<Mode> LINear | LOGarithmic | POWer

LINear
Linear calculation.

LOGarithmic
Logarithmic calculation.

POWer
Linear power calculation.

*RST: LOGarithmic

Example: `CALC:MATH:MODE LIN`
Selects linear calculation.

Manual operation: See "Math Mode" on page 1222

CALCulate<n>:MATH<t>:POSition <Position>

Defines the position of the trace resulting from the mathematical operation.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<Position> Vertical position of the trace in % of the height of the diagram area.
100 PCT corresponds to the upper diagram border.

Range: -100 to 200
*RST: 50
Default unit: PCT

Example: `CALC:MATH:POS 100`
Moves the trace to the top of the diagram area.

Manual operation: See "Math Position" on page 1222

CALCulate<n>:MATH<t>:STATe <State>

Enables or disables the trace mathematics.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MATH:STAT ON`
Turns on trace mathematics.

Manual operation: See "Trace math function" on page 1222

Retrieving trace results

This section describes how to retrieve data from standard traces.

For spectrograms see also "Marker search (spectrograms)" on page 718.

Commands required to export traces (and other result data) are described in Section 4.14.12.5, "Storing measurement results", on page 801.

TRACe<n>[:DATA] 688
TRACe<n>[:DATA]:MEMory? 689
TRACe<n>[:DATA]:X? 690

TRACe<n>[:DATA] <Trace>,<Data>
TRACe<n>[:DATA]? <ResultType>

This command queries current trace data and measurement results.

If you use it as a setting command, it transfers trace data from an external source to the FSWX.

The data format depends on `FORMat[:DATA]` on page 802.

Suffix:
<n> Window 1 to 16

Parameters:
<Trace> Selects the trace to write the data to.

TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

<Data> Contains the data to transfer.

Query parameters:
<ResultType> TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6 | SPECtrogram | SGRam | PSPectrum | HMAXhold | LIST | SPURious | ESPLine | BTOBits | BTOFm

Selects the type of result to be returned.

Example: `TRAC TRACE1,+A$`
Transfers trace data ('+A$') to trace 1.

Example: `TRAC? TRACE3`
Queries the data of trace 3.

Manual operation: See "Diagram" on page 80
See "Result Summary State" on page 1057
See "TOI diagram" on page 1158

Table 4-68: Return values for TRACE1 to TRACE6 parameter

The trace data consists of a list of measured power levels. The number of power levels in the list depends on the currently selected number of sweep points. The unit depends on the measurement and on the configured unit. For the auto peak detector, the command returns positive peak values only. (To retrieve negative peak values, define a second trace with a negative peak detector.) For SEM or Spurious Emission measurement results, query the x-values as well, as they are not equidistant (see`TRACe<n>[:DATA]:X?` on page 690).

Table 4-69: Return values for LIST parameter

For each peak, the command returns 11 values in the following order: <No>,<StartFreq>,<StopFreq>,<RBW>,<PeakFreq>,<PowerAbs>,<PowerRel>,<PowerDelta>,<LimitCheck>,<Unused1>,<Unused2> ● <No>: range number ● <StartFreq>,<StopFreq>: start and stop frequency of the range ● <RBW>: resolution bandwidth ● <PeakFreq>: frequency of the peak in a range ● <PowerAbs>: absolute power of the peak in dBm ● <PowerRel>: power of the peak in relation to the channel power in dBc ● <PowerDelta>: distance from the peak to the limit line in dB, positive values indicate a failed limit check ● <LimitCheck>: state of the limit check (0 = PASS, 1 = FAIL) ● <Unused1>,<Unused2>: reserved (0.0)

TRACe<n>[:DATA]:MEMory? <Trace>[, <OffsSwPoint>, <NoOfSwPoints>]

Queries the previously captured trace data for the specified trace from the memory. As an offset and number of sweep points to be retrieved can be specified, the trace data can be retrieved in smaller portions, making the command faster than the `TRAC:DATA?` command. This is useful if only specific parts of the trace data are of interest.

If no parameters are specified with the command, the entire trace data is retrieved. In this case, the command returns the same results as `TRAC:DATA? TRACE1`.

For details on the returned values, see the `TRAC:DATA? <TRACE...>` command.

Suffix:
<n> Window 1 to 16

Query parameters:
<Trace> TRACe1 | TRACe2 | TRACe3 | TRACe4 | TRACe5 | TRACe6

<OffsSwPoint> The offset in sweep points related to the start of the measurement at which data retrieval is to start.

<NoOfSwPoints> Number of sweep points to be retrieved from the trace.

Return values:
<SweepPointValues>

Example: `TRAC:DATA:MEM? TRACE1,25,100`
Retrieves 100 sweep points from trace 1, starting at sweep point 25.

Usage: Query only

TRACe<n>[:DATA]:X? <TraceNumber>

Queries the horizontal trace data for each sweep point in the specified window, for example the frequency in frequency domain or the time in time domain measurements.

For more information, see "X-value of the sweep point" on page 283.

This is especially useful for traces with non-equidistant x-values, e.g. for SEM or Spurious Emissions measurements.

Suffix:
<n> Window 1 to 16

Query parameters:
<TraceNumber> Trace number.
TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

Return values:
<X-Values>

Example: `TRAC3:X? TRACE1`
Returns the x-values for trace 1 in window 3.

Usage: Query only

Importing and exporting traces

FORMat:DEXPort:CSEParator 690
FORMat:DEXPort:FORMat 691
FORMat:DEXPort:TRACes 691
FORMat:DEXPort:XDIStrib 691
FORMat:DIMPort:TRACes 692
MMEMory:LOAD<n>:TRACe 692
MMEMory:STORe<n>:TRACe 693

FORMat:DEXPort:CSEParator <Separator>

Selects the column separator for exported trace data.

The selected value is not affected by a preset. The command therefore has no reset value.

Parameters:
<Separator> **COMMa**
Selects a comma as a separator.
SEMicolon
Selects a semicolon as a separator.

TAB
Selects a tabulator as a separator.

*RST: n/a

Example: //Select column separator
`FORM:DEXP:CSEP TAB`

Manual operation: See "Column Separator" on page 369

FORMat:DEXPort:FORMat <FileFormat>

Determines the format of the ASCII file to be imported or exported. Depending on the external program that creates the data file or evaluates it, a comma-separated list (CSV) or a plain data format (DAT) file is required.

Parameters:
<FileFormat> CSV | DAT

*RST: DAT

Example: `FORM:DEXP:FORM CSV`

Manual operation: See "File Type" on page 369

FORMat:DEXPort:TRACes <Selection>

Selects the data to be included in a data export file.

Parameters:
<Selection> SINGle | ALL

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. "Result Summary", marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

Example: `FORM:DEXP:TRAC ALL`

Manual operation: See "Export scope" on page 369

FORMat:DEXPort:XDIStrib <XDistribution>

Defines how the x-values of the trace are determined in the frequency domain.

For more information, see "X-value of the sweep point" on page 283.

Parameters:
<XDistribution> STARtstop | BINCentered

BINCentered
The full measurement span is divided by the number of sweep points to obtain *bin*s. The x-value of the sweep point is defined as the x-value at the center of the bin (bin/2).

STARtstop
(Default): The x-value of the first sweep point corresponds to the starting point of the full measurement span. The x-value of the last sweep point corresponds to the endpoint of the full measurement span. All other sweep points are divided evenly between the first and last points.

Example: `FORM:DEXP:XDIS BINC`

Manual operation: See "X-Value Distribution" on page 369

FORMat:DIMPort:TRACes <Selection>

Selects the data to be included in a data import file (see `MMEMory:LOAD<n>:TRACe` on page 692).

For more information, see Section 4.10.4.5, "How to import traces", on page 372.

Parameters:
<Selection> SINGle | ALL

SINGle
Only a single trace is selected for import, namely the one specified by the `MMEMory:LOAD<n>:TRACe` on page 692 command.

ALL
Imports several traces at once, overwriting the existing trace data for any active trace in the result display with the same trace number. Data from the import file for currently not active traces is not imported.
The <trace> parameter for the `MMEMory:LOAD<n>:TRACe` on page 692 command is ignored.

*RST: SINGle

Example: `FORM:DIMP:TRAC ALL`

Manual operation: See "Import scope" on page 371
See "Import ASCII File" on page 372

MMEMory:LOAD<n>:TRACe <Trace>, <FileName>

Imports trace data from the specified window to an ASCII file.

Suffix:
<n> Window 1 to 16

Parameters:

<Trace> Number of the trace to be stored
(This parameter is ignored for `FORMat:DIMPort:TRACes ALL`).

<FileName> String containing the path and name of the import file.

Example: `MMEM:LOAD:TRAC 1,'C:/TEST.ASC'`

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

Exports trace data from the specified window to an ASCII file.

For details on data formats, see Section 4.10.4.7, "Reference: ASCII file export format", on page 374.

Suffix:

<n> Window 1 to 16

Parameters:

<Trace> Number of the trace to be stored
(This parameter is ignored if the option "Export all Traces and all Table Results" is activated in the Export configuration settings, see `FORMat:DEXPort:TRACes` on page 691).

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 1,'C:/TEST.ASC'`
Stores trace 1 from window 1 in the file `TEST.ASC`.

Manual operation: See "Export to ASCII File" on page 370

Programming example: configuring a spectrogram

This example demonstrates how to configure a spectrogram for a basic frequency sweep in a remote environment. The spectrogram is displayed in addition to the spectrum display, in a new window. In addition, the usage of special spectrogram markers is demonstrated (see "Marker search (spectrograms)" on page 718).



Basic trace settings are demonstrated in the Section 5.5.3.1, "Programming example: performing a basic frequency sweep", on page 1432.

```
//-----------Preparing the Measurement ------------
*RST
//Resets the instrument
LAY:ADD? '1',BEL,SGR
//Displays a new window below window 1 and activates spectrogram display.
//The new window name is returned as a result: '2'.
//The spectrogram is updated with each new sweep.
INIT:CONT OFF
//Selects single sweep mode.
```

```
//--------------Configuring the Spectrogram--------------
CALC:SGR:CLE
//Clears the displayed spectrogram to start a new one.
CALC:SGR:CONT ON
//Configures a continuous spectrogram for a series of measurements.
//The display is not cleared when a new measurement is started.
CALC:SGR:FRAM:COUN 100
//Sets the number of frames to be recorded per sweep to 100.
CALC:SGR:HDEP 1000
//Sets the number of frames to be stored to 1000 (=10 sweeps)
CALC:SGR:TST ON
//Activates a time stamp for each frame.

//--------------Configuring the Color Map----------------
DISP:WIND:SGR:COL GRAY
//Defines a gray-scaled coloring: low values light gray, high values dark gray.
DISP:WIND:SGR:COL:LOW 30
DISP:WIND:SGR:COL:UPP 70
DISP:WIND:SGR:COL:SHAP 0.8
//Defines a color map for a range that comprises 40% of the measurement range,
//excluding 30% at each end. The colors are not scaled linearly; the light gray
//colors are stretched to distinguish low values better.

//--------------Performing the Measurement---------------
SWE:COUN 10
//Defines 10 sweeps to be performed per measurement.
INIT;*WAI
//Initiates a new measurement and waits until the sweeps have finished.
//The spectrogram is updated with each new sweep.


//--------------Positioning Markers----------------------
CALC:MARK:SGR:SAR MEM
//Includes all frames in the memory in the search area

CALC:MARK1:SGR:FRAM -1s
//Sets marker 1 to the frame 1 second after measurement begin. (Note the
//negative value!
CALC:MARK1:MIN
//Sets marker 1 to the minimum level in this frame.
CALC:MARK1:SGR:Y:MIN
//Sets marker 1 to the minimum level for the same frequency the marker is
//currently positioned at in all frames.

CALC:MARK2:SGR:XY:MAX
//Sets marker 2 to the maximum level in the entire spectrogram.

CALC:DELT1:SGR:FRAM 3s
//Sets the deltamarker 1 to the frame captured 3 seconds after marker 1. By default
//it is set to the peak of that frame and displays the level difference to marker 1.
```

```
//Note the positive value!
CALC:DELT1:MIN
//Sets deltamarker 1 to the minimum level in this frame.

CALC:DELT3:SGR:XY:MAX
//Sets deltamarker 3 to the maximum level in the entire spectrogram. By default
//its value is the difference to marker 1. We will change it to refer to marker 2.
CALC:DELT3:MREF 2
//Deltamarker 3 now refers to marker 2, both are positioned on the maximum of the
//spectrogram. Thus, D3=0. We will move deltamarker 3 to the next peak level
//for the same frequency.
CALC:DELT3:SGR:Y:MAX:NEXT

//---------------Retrieving Results----------------------
CALC:MARK1:X?
CALC:MARK1:Y?
CALC:MARK1:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of marker 1.

CALC:MARK2:X?
CALC:MARK2:Y?
CALC:MARK2:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of marker 2.

CALC:DELT1:X?
CALC:DELT1:Y?
CALC:DELT1:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of deltamarker 1.

CALC:DELT3:X?
CALC:DELT3:Y?
CALC:DELT3:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of deltamarker 3.

CALC:SGR:TST:DATA? ALL
//Queries the time stamps of all stored frames.
CALC:SGR:FRAM:SEL -1
//Selects the frame that was captured 1 second after measurement start (Note the
//negative value!). This frame is displayed in the Spectrum window.
TRAC:DATA? SGR
//Retrieves the trace data for the spectrogram. For each frame, the power level
//and frequency at each sweep point are returned.
TRAC:DATA? TRACE1
//Retrieves the trace data for the selected frame only.
```

4.14.11.3 Working with markers

The commands required to work with markers and marker functions in a remote environment are described here.

In the "Spectrum" application, markers are identical in all windows. Thus, the suffix <n> for the window is generally irrelevant.

- Setting up individual markers....696
- General marker settings....704
- Configuring and performing a marker search....705
- Positioning the marker....710
- Retrieving marker results....717
- Marker search (spectrograms)....718
- Fixed reference marker settings....728
- Marker peak lists....730
- Noise measurement marker....734
- Phase noise measurement marker....735
- Band power marker....738
- N dB down marker....742
- Signal count marker....745
- Marker demodulation....747
- Programming examples for using markers and marker functions....750

Setting up individual markers

The following commands define the position of markers in the diagram.

CALCulate<n>:DELTamarker<m>:AOFF....696
CALCulate<n>:DELTamarker<m>:LINK....697
CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTa<md>....697
CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>....698
CALCulate<n>:DELTamarker<m>:MODE....698
CALCulate<n>:DELTamarker<m>:MREFerence....699
CALCulate<n>:DELTamarker<m>[:STATe]....699
CALCulate<n>:DELTamarker<m>:TRACe....700
CALCulate<n>:DELTamarker<m>:X....700
CALCulate<n>:DELTamarker<m>:X:RELative?....701
CALCulate<n>:MARKer<m>:AOFF....701
CALCulate<n>:MARKer<ms>:LINK:TO:DELTa<md>....701
CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>....702
CALCulate<n>:MARKer<m>[:STATe]....702
CALCulate<n>:MARKer<m>:TRACe....703
CALCulate<n>:MARKer<m>:X....703

CALCulate<n>:DELTamarker<m>:AOFF

Turns off *all* delta markers.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:AOFF`
Turns off all delta markers.

CALCulate<n>:DELTamarker<m>:LINK <State>

Links delta marker <m> to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Tip: to link any marker to a different marker than marker 1, use the `CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>` or `CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>` commands.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2:LINK ON`

Manual operation: See "Link to Marker" on page 1185

CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTa<md> <State>

Links the delta source marker <ms> to any active destination delta marker <md>.

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

Suffix:

<n> Window 1 to 16

<ms> source Marker 1 to 16

<md> destination Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2:LINK:TO:DELT3 ON`
Links D2 and D3.

CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> <State>

Links the delta source marker <ms> to any active destination marker <md> (normal or delta marker). If you move <md> along the x-axis, <ms> follows to the same horizontal position.

- If <md> is a delta marker, it is turned into a normal marker. To maintain the delta marker, use `CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTa<md>` on page 697.
- If <md> is the reference marker for the delta marker <ms>, the delta marker is initially set to the same horizontal position as the normal marker. To change the relative distance (delta) value again, use `CALCulate<n>:DELTamarker<m>:X` on page 700. Then the delta between the two markers is maintained when you move the normal marker.

Suffix:

<n> Window 1 to 16

<ms> source Marker 1 to 16

<md> destination Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT4:LINK:TO:MARK2 ON`
Links the delta marker 4 to the marker 2.

Example: D2 and D3 are active.
`CALC:DELT2:LINK:TO:MARK3 ON`
Converts D3 into M3 and links D2 and M3

Manual operation: See "Link to Marker" on page 1185

CALCulate<n>:DELTamarker<m>:MODE <Mode>

Defines whether the position of a delta marker is provided as an absolute value or relative to a reference marker. Note that this setting applies to *all* windows.

Note that when you *query* the position of a delta marker, the result is always an absolute value (see `CALCulate<n>:DELTamarker<m>:X` on page 700).

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<Mode> ABSolute | RELative

ABSolute
Delta marker position in absolute terms.

RELative
Delta marker position in relation to a reference marker.

*RST: RELative

Example: `CALC:DELT:MODE ABS`
Absolute delta marker position.

CALCulate<n>:DELTamarker<m>:MREFerence <Reference>

Selects a reference marker for a delta marker other than marker 1.

The reference can be another marker or the fixed reference.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Reference> **FIXed**
Selects the fixed reference as the reference.

Example: `CALC:DELT3:MREF 2`
Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See "Ref Marker" on page 1184

CALCulate<n>:DELTamarker<m>[:STATe] <State>

Enables or disables delta markers.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker <x>" on page 1183
See "Marker State" on page 1184
See "Marker Type" on page 1184
See "Select Marker" on page 1187
See "Marker State" on page 1200
See "Marker Type" on page 1201
See "Marker State" on page 1203
See "Marker Type" on page 1203
See "Marker State" on page 1210
See "Marker Type" on page 1210

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

Selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

Moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
The position is relative to the reference marker.
To select an absolute position, you have to change the delta marker mode with `CALCulate<n>:DELTamarker<m>:MODE` on page 698.
A query returns the absolute position of the delta marker.

Range: The value range and unit depend on the measurement and scale of the x-axis.
Default unit: Hz

Example: CALC:DELT:X?
Outputs the absolute x-value of delta marker 1.

Manual operation: See "Marker 1/Marker 2/Marker 3" on page 1164
See "Marker <x>" on page 1183
See "Marker Position X-Value" on page 1184

CALCulate<n>:DELTamarker<m>:X:RELative?

Queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<Position> Position of the delta marker in relation to the reference marker.

Example: CALC:DELT3:X:REL?
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

Manual operation: See "Marker 1/Marker 2/Marker 3" on page 1164
See "Marker <x>" on page 1183

CALCulate<n>:MARKer<m>:AOFF

Turns off all markers.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:MARK:AOFF
Switches off all markers.

Manual operation: See "All Markers Off" on page 1185

CALCulate<n>:MARKer<ms>:LINK:TO:DELTa<md> <State>

Links the normal source marker <ms> to any active delta destination marker <md>.

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

Suffix:
<n> Window 1 to 16

<ms> source Marker 1 to 16

<md> destination Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:LINK:TO:DELT2 ON`
Links marker 4 to delta marker 2.

CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> <State>

Links the normal source marker <ms> to any active destination marker <md> (normal or delta marker).

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

Suffix:

<n> Window 1 to 16

<ms> source marker, see Marker 1 to 16

<md> destination marker, see Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:LINK:TO:MARK2 ON`
Links marker 4 to marker 2.

Manual operation: See "Link to Marker" on page 1185

CALCulate<n>:MARKer<m>[:STATe] <State>

Enables or disables markers. If the corresponding marker number is currently active as a delta marker, it is turned into a normal marker.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker <x>" on page 1183
See "Marker State" on page 1184
See "Marker Type" on page 1184
See "Select Marker" on page 1187
See "Marker State" on page 1200
See "Marker Type" on page 1201
See "Marker State" on page 1203
See "Marker Type" on page 1203
See "Marker State" on page 1210
See "Marker Type" on page 1210

CALCulate<n>:MARKer<m>:TRACe <Trace>

Selects the trace that the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Trace> **1 to 6**
Trace number the marker is assigned to.

Example: //Assign marker to trace 1
`CALC:MARK3:TRAC 2`

Manual operation: See "Trace" on page 1185

CALCulate<n>:MARKer<m>:X <Position>

Moves a marker to a specific coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<Position> Numeric value that defines the marker position on the x-axis. The unit depends on the result display.

Range: The range depends on the current x-axis range.
Default unit: Hz

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 80
See "Marker Peak List" on page 80
See "M1" on page 1158
See "M2" on page 1158
See "M3" on page 1158
See "M4" on page 1159
See "Marker 1/Marker 2/Marker 3/Marker 4" on page 1160
See "Marker 1/Marker 2/Marker 3" on page 1164
See "Marker <x>" on page 1183
See "Marker Position X-Value" on page 1184

General marker settings

The following commands control general marker functionality.

Remote commands exclusive to general marker functionality

DISPlay[:WINDow<n>]:MTABle 704
DISPlay[:WINDow<n>]:MINFo[:STATe] 705
CALCulate<n>:MARKer<m>:X:SSIZe 705

DISPlay[:WINDow<n>]:MTABle <DisplayMode>

Enables or disables the marker table.

Suffix:

<n> Window 1 to 16

Parameters:

<DisplayMode> AUTO | ON | OFF

ON | 1
Turns on the marker table.

OFF | 0
Turns off the marker table.

AUTO
Turns on the marker table if 3 or more markers are active.

*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Show Marker Table" on page 1186

DISPlay[:WINDow<n>]:MINFo[:STATe] <State>

Enables or disables the marker information in all diagrams.

Suffix:
<n> Window 1 to 16

Parameters:
<State> **ON | 1**
Displays the marker information in the diagrams.
OFF | 0
Hides the marker information in the diagrams.
*RST: 1

Example: `DISP:MINF OFF`
Hides the marker information.

Manual operation: See "Show Marker Info" on page 1186

CALCulate<n>:MARKer<m>:X:SSIZe <StepSize>

Selects the marker step size mode for *all* markers in *all* windows.

The step size defines the distance that the marker moves when you move it with the rotary knob.

It therefore takes effect in manual operation only.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<StepSize> STANdard | POINts
STANdard
the marker moves from one pixel to the next
POINts
the marker moves from one sweep point to the next
*RST: POINts

Example: `CALC:MARK:X:SSIZ STAN`
Sets the marker step size to one pixel.

Manual operation: See "Marker Stepsize" on page 1186

Configuring and performing a marker search

The following commands control the marker search.

CALCulate<n>:MARKer<m>:LOEXclude 706
CALCulate<n>:MARKer<m>:PEXCursion 706
CALCulate<n>:MARKer<m>:SEARch 707
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] 707

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT 708
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt 708
CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] 709
CALCulate<n>:THReshold 709
CALCulate<n>:THReshold:STATe 710

CALCulate<n>:MARKer<m>:LOEXclude <State>

Enables or disables the suppression of the local oscillator during automatic marker positioning (for *all* markers in *all* windows).

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `CALC:MARK:LOEX ON`

Manual operation: See "Exclude LO" on page 1189

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

Defines the peak excursion (for *all* markers in *all* windows).

The peak excursion defines the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Application/Result display	Unit
Spectrum	dB
Receiver	dB
ADEMOD, RF	dB
ADEMOD, AM	PCT
ADEMOD, FM	kHz
ADEMOD, PM	RAD
MCGD	dBm, DEG, RAD, S, MS, US, NS, PS, SC

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:

<Excursion> The distance to a trace maximum or trace minimum that the value must exceed to recognize a new maximum or new minimum, respectively.

*RST: 6 dB in the Spectrum application and RF displays
Default unit: dB

Example: `CALC:MARK:PEXC 10dB`
Defines peak excursion as 10 dB.

Manual operation: See "Peak Excursion" on page 1189

CALCulate<n>:MARKer<m>:SEARch <MarkRealImag>

Selects the trace type that a marker search is performed on.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<MarkRealImag> REAL | IMAG | MAGNitude

REAL
Marker search functions are performed on the real trace of the "I/Q" measurement.

IMAG
Marker search functions are performed on the imaginary trace of the "I/Q" measurement.

MAGN
Marker search functions are performed on the magnitude of the I and Q data.

*RST: REAL

Example: `CALC4:MARK:SEAR IMAG`

CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] <State>

Enables or disables marker search limits for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:X:SLIM ON`
Switches on search limitation.

Manual operation: See "Search Limits(Left / Right)" on page 1139
See "Limits State" on page 1144
See "Left Limit / Right Limit" on page 1190
See "Search Limits Off" on page 1190

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <SearchLimit>

Defines the left limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<SearchLimit> The value range depends on the frequency range or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.
*RST: left diagram border
Default unit: Hz

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:LEFT 10MHz`
Sets the left limit of the search range to 10 MHz.

Manual operation: See "Search Limits(Left / Right)" on page 1139
See "Left/ Right Limits" on page 1144
See "Left Limit / Right Limit" on page 1190

CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt <Limit>

Defines the right limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<Limit> The value range depends on the frequency range or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: right diagram border
Default unit: Hz

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual operation: See "Search Limits(Left / Right)" on page 1139
See "Left/ Right Limits" on page 1144
See "Left Limit / Right Limit" on page 1190

CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] <State>

Adjusts the marker search range to the zoom area for *all* markers in *all* windows.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:X:SLIM:ZOOM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual operation: See "Adjust to Zoom Area" on page 1190

CALCulate<n>:THReshold <Level>

Defines a threshold level for the marker peak search (for *all* markers in *all* windows).

Note that you must enable the use of the threshold using `CALCulate<n>:THReshold:STATe` on page 710.

Suffix:

<n> Window 1 to 16

Parameters:

<Level> Numeric value. The value range and unit are variable.

*RST: -120 dBm
Default unit: dBm

Example: `CALC:THR:STAT ON`

Example: `CALC:THR -82DBM`
Enables the search threshold and sets the threshold value to -82 dBm.

Manual operation: See "Threshold" on page 1190

CALCulate<n>:THReshold:STATe <State>

Enables or disables a threshold for the marker peak search (for *all* markers in *all* windows).

Suffix:

<n> Window 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:THR:STAT ON`
Switches on the threshold line.

Manual operation: See "Threshold" on page 1190
See "Search Limits Off" on page 1190

Positioning the marker

This section contains remote commands necessary to position the marker on a trace.

Useful commands regarding the marker position described elsewhere:

- `CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 1413
- `CALCulate<n>:MARKer<m>:FUNCtion:REFerence` on page 613

Remote commands exclusive to positioning the marker

- Positioning normal markers....710
- Positioning delta markers....714

Positioning normal markers

The following commands position markers on the trace.

CALCulate<n>:MARKer<m>:MAXimum:AUTO 711
CALCulate<n>:MARKer<m>:MAXimum:LEFT 711
CALCulate<n>:MARKer<m>:MAXimum:NEXT 712
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] 712
CALCulate<n>:MARKer<m>:MAXimum:RIGHt 712
CALCulate<n>:MARKer<m>:MINimum:AUTO 712
CALCulate<n>:MARKer<m>:MINimum:LEFT 713
CALCulate<n>:MARKer<m>:MINimum:NEXT 713
CALCulate<n>:MARKer<m>:MINimum[:PEAK] 714
CALCulate<n>:MARKer<m>:MINimum:RIGHt 714

CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>

Enables or disables an automatic marker peak search for a trace maximum. The FSWX performs the peak search after each sweep.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:MAX:AUTO ON`
Activates the automatic peak search function for marker 1 at the end of each particular sweep.

Manual operation: See "Auto Peak" on page 1189

CALCulate<n>:MARKer<m>:MAXimum:LEFT

Moves a marker to the next positive peak.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:MAX:LEFT`

Manual operation: See "Set to Next Peak" on page 1192

CALCulate<n>:MARKer<m>:MAXimum:NEXT

Moves a marker to the next positive peak.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:MAX:NEXT`

Manual operation: See "Set to Next Peak" on page 1192

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

Moves a marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:MAX:PEAK`

Manual operation: See "Set to Peak / [Peak Search]" on page 1192

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

Moves a marker to the next positive peak.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:MAX:RIGH`

Manual operation: See "Set to Next Peak" on page 1192

CALCulate<n>:MARKer<m>:MINimum:AUTO <State>

Enables or disables an automatic marker peak search for a trace minimum. The FSWX performs the peak search after each sweep.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:MIN:AUTO ON`
Activates the automatic minimum value search function for marker 1 at the end of each particular sweep.

Manual operation: See "Auto Peak" on page 1189

CALCulate<n>:MARKer<m>:MINimum:LEFT

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:MIN:LEFT`

Manual operation: See "Set to Next Minimum" on page 1193

CALCulate<n>:MARKer<m>:MINimum:NEXT

Moves a marker to the next minimum peak value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:MIN:NEXT`

Manual operation: See "Set to Next Minimum" on page 1193

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

Moves a marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:MIN:PEAK`

Manual operation: See "Set to Minimum" on page 1193

CALCulate<n>:MARKer<m>:MINimum:RIGHt

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:MIN:RIGH`

Manual operation: See "Set to Next Minimum" on page 1193

Positioning delta markers

The following commands position delta markers on the trace.

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT 714
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT 715
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] 715
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt 715
CALCulate<n>:DELTamarker<m>:MINimum:LEFT 716
CALCulate<n>:DELTamarker<m>:MINimum:NEXT 716
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] 716
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt 717

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

Moves a delta marker to the next positive peak value.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:MAX:LEFT`

Manual operation: See "Set to Next Peak" on page 1192

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

Moves a marker to the next positive peak value.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:MAX:NEXT`

Manual operation: See "Set to Next Peak" on page 1192

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

Moves a delta marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:MAX:PEAK`

Manual operation: See "Set to Peak / [Peak Search]" on page 1192

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

Moves a delta marker to the next positive peak value on the trace.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:MAX:RIGHT`

Manual operation: See "Set to Next Peak" on page 1192

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:MIN:LEFT`

Manual operation: See "Set to Next Minimum" on page 1193

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

Moves a marker to the next minimum peak value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:MAX:NEXT`

Manual operation: See "Set to Next Minimum" on page 1193

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

Moves a delta marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:DELT:MIN:PEAK

Manual operation: See "Set to Minimum" on page 1193

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:DELT:MIN:RIGH

Manual operation: See "Set to Next Minimum" on page 1193

Retrieving marker results

The following commands are used to retrieve the results of markers.



You can use the marker values to position the center frequency or reference level directly using the following commands:

- CALCulate<n>:MARKer<m>:FUNCtion:CENTer on page 1413
- CALCulate<n>:MARKer<m>:FUNCtion:REFerence on page 613

Useful commands for retrieving results described elsewhere:

- CALCulate<n>:DELTamarker<m>:X on page 700
- CALCulate<n>:MARKer<m>:X on page 703
- CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:COUNt? on page 731
- CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:X? on page 733
- CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:Y? on page 733
- CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult? on page 734
- CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult? on page 736
- CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult? on page 741
- CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult? on page 739
- CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult? on page 744
- CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency? on page 743
- CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:QFACtor? on page 744

- CALCulate<n>:MARKer<m>:COUNt:FREQuency? on page 746

Remote commands exclusive to retrieving marker results

CALCulate<n>:DELTamarker<m>:Y....718
CALCulate<n>:MARKer<m>:Y?....718

CALCulate<n>:DELTamarker<m>:Y <Position>

Queries the result at the position of the specified delta marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Position> Result at the position of the delta marker.
The unit is variable and depends on the one you have currently set.

Default unit: dBm

Example: CALC:DELT:Y?

Manual operation: See "Marker <x>" on page 1183

CALCulate<n>:MARKer<m>:Y?

Queries the result at the position of the specified marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<Result> The position of the marker on the y-axis.

Default unit: DBM

Example: CALC:MARK:Y?

Usage: Query only

Manual operation: See "Marker Table" on page 80
See "Marker Peak List" on page 80
See "Marker <x>" on page 1183

Marker search (spectrograms)

The following commands automatically define the marker and delta marker position in the spectrogram.

The usage of these markers is demonstrated in "Programming example: configuring a spectrogram" on page 693.

Using markers

The following commands control spectrogram markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the markers.

- `CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 711
- `CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 712
- `CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 712
- `CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 712
- `CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 713
- `CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 713
- `CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 714
- `CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 714

Remote commands exclusive to spectrogram markers

CALCulate<n>:MARKer<m>:SGRam:FRAMe 720
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe 720
CALCulate<n>:MARKer<m>:SGRam:SARea 720
CALCulate<n>:MARKer<m>:SPECtrogram:SARea 720
CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK] 721
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK] 721
CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK] 721
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK] 721
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVe 721
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe 721
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELow 721
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow 721
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT 722
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT 722
CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK] 722
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK] 722
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVe 722
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe 722
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELow 722
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow 722
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT 723
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT 723
CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK] 723
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK] 723

CALCulate<n>:MARKer<m>:SGRam:FRAMe <Frame>
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe <Frame> | <Time>

Positions a marker on a particular frame.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.
Default unit: S

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the (negative) distance to frame 0 in seconds.
The range depends on the history depth.

Example: `CALC:MARK:SGR:FRAM -20`
Sets the marker on the 20th frame before the present.
`CALC:MARK2:SGR:FRAM -2s`
Sets second marker on the frame 2 seconds ago.

Manual operation: See "Frame (Spectrogram only)" on page 1184

CALCulate<n>:MARKer<m>:SGRam:SARea <SearchArea>
CALCulate<n>:MARKer<m>:SPECtrogram:SARea <SearchArea>

Defines the marker search area for all spectrogram markers in the application instance.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<SearchArea> VISible | MEMory

VISible
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Example: `CALC:MARK:SPEC:SAR VIS`

Manual operation: See "Search Area" on page 1191

CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK]

Moves a marker to the highest level of the spectrogram.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:SPEC:XY:MAX:PEAK`

CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK]

Moves a marker to the minimum level of the spectrogram.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:SPEC:XY:MIN:PEAK`

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe

Moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:SPEC:Y:MAX:ABOV`

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow

Moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:SPEC:Y:MAX:BEL`

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT

Moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:SPEC:Y:MAX:NEXT`

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK]

Moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker was not active yet, the command looks for the peak level in the whole spectrogram.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:SPEC:Y:MAX:PEAK`

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe

Moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:SPEC:Y:MIN:ABOV`

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow

Moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16
<m> Marker 1 to 16
Example: CALC:MARK:SPEC:Y:MIN:BEL

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT

Moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16
<m> Marker 1 to 16
Example: CALC:MARK:SPEC:Y:MIN:NEXT

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK]

Moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker was not active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

Suffix:
<n> Window 1 to 16
<m> Marker 1 to 16
Example: CALC:MARK:SPEC:Y:MIN:PEAK

Using delta markers

The following commands control spectrogram delta markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the delta markers.

- CALCulate<n>:DELTamarker<m>:MAXimum:LEFT on page 714
- CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 715
- CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] on page 715
- CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt on page 715
- CALCulate<n>:DELTamarker<m>:MINimum:LEFT on page 716
- CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 716

- CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 716
- CALCulate<n>:DELTamarker<m>:MINimum:RIGHt on page 717

Remote commands exclusive to spectrogram markers

CALCulate<n>:DELTamarker<m>:SGRam:FRAMe....724
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe....724
CALCulate<n>:DELTamarker<m>:SGRam:SARea....725
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea....725
CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK]....725
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]....725
CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK]....725
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK]....725
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe....726
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe....726
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow....726
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow....726
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT....726
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT....726
CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK]....726
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK]....726
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe....727
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe....727
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow....727
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow....727
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT....727
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT....727
CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK]....728
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK]....728

CALCulate<n>:DELTamarker<m>:SGRam:FRAMe <Frame>
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe <Frame>

Positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<Frame> Selects a frame either by its frame number or time stamp.
The frame number is available if the time stamp is off. The range depends on the history depth.
The time stamp is available if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Default unit: s

Example: CALC:DELT4:SGR:FRAM -20
Sets fourth deltamarker 20 frames below marker 1.
CALC:DELT4:SGR:FRAM 2 s
Sets fourth deltamarker 2 seconds above the position of marker 1.

Manual operation: See "Frame (Spectrogram only)" on page 1184

CALCulate<n>:DELTamarker<m>:SGRam:SARea <SearchArea>
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea <SearchArea>

Defines the marker search area for *all* spectrogram markers in the application instance.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<SearchArea> VISible | MEMory

VISible
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Example: CALC:DELT:SPEC:SAR MEM

Manual operation: See "Search Area" on page 1191

CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]

Moves a marker to the highest level of the spectrogram over all frequencies.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:DELT:SPEC:XY:MAX:PEAK

CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK]

Moves a delta marker to the minimum level of the spectrogram over all frequencies.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:DELT:SPEC:XY:MIN:PEAK

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe

Moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:DELT:SPEC:Y:MAX:ABOV

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow

Moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:DELT:SPEC:Y:MAX:BEL

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT

Moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:DELT:SPEC:Y:MAX:NEXT

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK]

Moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker was not active yet, the command looks for the peak level in the whole spectrogram.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:SPEC:Y:MAX:PEAK`

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe

Moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:SPEC:Y:MIN:ABOV`

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow

Moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:SPEC:Y:MIN:BEL`

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT

Moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:SPEC:Y:MIN:NEXT`

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK]

Moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker was not active yet, the command looks for the peak level in the whole spectrogram first. Then it moves the marker vertically to the minimum level.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:SPEC:Y:MIN:PEAK`

Fixed reference marker settings

The following commands configure a fixed reference marker.

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK] 728
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X 728
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y 729
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y:OFFSet 729
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed[:STATe] 730

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]

Moves the fixed reference marker to the peak power.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:DELT:FUNC:FIX:RPO:MAX`
Sets the reference point level for delta markers to the peak of the selected trace.

Manual operation: See "Peak Search" on page 1206

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X <RefPoint>

Defines the horizontal position of the fixed delta marker reference point. The coordinates of the reference can be anywhere in the diagram.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<RefPoint> Numeric value that defines the horizontal position of the reference.
For frequency domain measurements, it is a frequency in Hz.
For time domain measurements, it is a point in time in s.

*RST: Fixed Reference: OFF
Default unit: Hz

Example: `CALC:DELT:FUNC:FIX:RPO:X 128 MHz`
Sets the frequency reference to 128 MHz.

Manual operation: See "Reference Point" on page 1204
See "Frequency / Time" on page 1206

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y <RefPoint>

Defines the vertical position of the fixed delta marker reference point. The coordinates of the reference can be anywhere in the diagram.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<RefPoint> Numeric value that defines the vertical position of the reference. The unit and value range is variable.

*RST: Fixed Reference: OFF
Default unit: dBm

Example: `CALC:DELT:FUNC:FIX:RPO:Y -10dBm`
Sets the reference point level for delta markers to -10 dBm.

Manual operation: See "Reference Point" on page 1204
See "Level" on page 1206

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y:OFFSet <Offset>

Defines a level offset for the fixed delta marker reference point.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<Offset> Numeric value

*RST: 0
Default unit: dB

Example: `CALC:DELT:FUNC:FIX:RPO:Y:OFFS 1`

CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed[:STATe] <State>

Activates or deactivates a marker that defines a fixed reference point for relative marker analysis.

If necessary, the command activates a marker and positions it on the peak power.

Then you can change the coordinates of the fixed reference independent of the marker. The fixed reference is independent of the trace and is applied to all active delta markers.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT:FUNC:FIX ON`
Switches on the measurement with fixed reference value for all delta markers.
`CALC:DELT:FUNC:FIX:RPO:X 128 MHZ`
Sets the frequency reference to 128 MHz.
`CALC:DELT:FUNC:FIX:RPO:Y 30 DBM`
Sets the reference level to +30 dBm.

Manual operation: See "Reference Point" on page 1204
See "Fixed Reference State" on page 1206

Marker peak lists

Useful commands for peak lists described elsewhere

- `CALCulate<n>:MARKer<m>:PEXCursion` on page 706
- `MMEMory:STORe<n>:PEAK` on page 803
- "Configuring and performing a marker search" on page 705

Remote commands exclusive to peak lists

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe] 731
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:COUNt? 731
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks[:IMMediate] 731
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE 732
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT 732
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe 733
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:X? 733
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:Y? 733

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe] <State>

Enables or disables labels for peaks found during a peak search.

The labels correspond to the marker number in the marker peak list.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `CALC:MARK:FUNC:FPE:ANN:LAB:STAT OFF`
Removes the peak labels from the diagram

Manual operation: See "Display Marker Numbers" on page 1196

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:COUNt?

Queries the number of peaks that have been found during a peak search.

The actual number of peaks can differ from the defined number of peaks because of the peak excursion.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<NumberOfPeaks>

Example: `CALC:MARK:FUNC:FPE:COUN?`
Queries the number of peaks.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks[:IMMediate] <Peaks>

Initiates a peak search.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<Peaks> This parameter defines the number of peaks to find during the search.
Note that the actual number of peaks found during the search also depends on the peak excursion you have set with CALCulate<n>:MARKer<m>:PEXCursion.

Range: 1 to 200

Example: CALC:MARK:PEXC 5
Defines a peak excursion of 5 dB, i.e. peaks must be at least 5 dB apart to be detected as a peak.
CALC:MARK:FUNC:FPE 10
Initiates a search for 10 peaks on the current trace.

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE <MaxNoPeaks>

Defines the maximum number of peaks that the FSWX looks for during a peak search.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<MaxNoPeaks> Maximum number of peaks to be determined.

Range: 1 to 500
*RST: 50

Example: CALC:MARK:FUNC:FPE:LIST:SIZE 10
The marker peak list will contain a maximum of 10 peaks.

Manual operation: See "Maximum Number of Peaks" on page 1196

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT <SortMode>

Selects the order in which the results of a peak search are returned.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<SortMode> X | Y

X
Sorts the peaks according to increasing position on the x-axis.

Y
Sorts the peaks according to decreasing position on the y-axis.

*RST: X

Example: CALC:MARK:FUNC:FPE:SORT Y
Sets the sort mode to decreasing y values

Manual operation: See "Sort Mode" on page 1196

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe <State>

Enables or disables a peak search.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:FUNC:FPE:STAT ON`
Activates marker peak search

Manual operation: See "Marker Peak List State" on page 1195

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:X?

Queries the position of the peaks on the x-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<PeakPosition> Position of the peaks on the x-axis. The unit depends on the measurement.

Example: `CALC:MARK:FUNC:FPE:X?`

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:Y?

Queries the position of the peaks on the y-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:

<PeakPosition> Position of the peaks on the y-axis. The unit depends on the measurement.

Example: `CALC:MARK:FUNC:FPE:Y?`

Usage: Query only

Noise measurement marker

The following commands control the noise measurement marker function.

CALCulate<n>:MARKer<m>:FUNCtion:NOISe:AOFF 734
CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult? 734
CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] 735

CALCulate<n>:MARKer<m>:FUNCtion:NOISe:AOFF

Removes all noise markers in the specified window.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:FUNC:NOIS:AOFF`

Manual operation: See "All Noise Markers Off" on page 1201

CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult?

Queries the result of the noise measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Return values:

<NoiseLevel> Current noise level. The unit is the one currently active.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK2 ON`
Switches on marker 2.
`CALC:MARK2:FUNC:NOIS ON`
Switches on noise measurement for marker 2.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK2:FUNC:NOIS:RES?`
Outputs the noise result of marker 2.

Usage: Query only

Manual operation: See "Noise Measurement State" on page 1201

CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] <State>

Enables or disables the noise measurement at the marker position.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:FUNC:NOIS ON`
Switches on the noise measurement.

Manual operation: See "Noise Measurement State" on page 1201

Phase noise measurement marker

The following commands control the phase noise measurement marker function.

Useful commands for phase noise markers described elsewhere

- `CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]`
- `CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X`
- `CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y`

Remote commands exclusive to phase noise markers

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO 736
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult? 736
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe] 737

CALCulate<n>:MARKer<m>:FUNCtion:PNOise:AOFF 737
CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult? 737
CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe] 738

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO <State>

Enables or disables an automatic peak search for the fixed reference marker at the end of a sweep.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT:FUNC:PNO:AUTO ON`
Activates an automatic peak search for the reference marker in a phase-noise measurement.

Manual operation: See "Reference Point" on page 1204

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?

Prerequisite: Spectrum application

Queries the result of a phase noise measurement.

If necessary, the command activates the measurement first.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<PhaseNoise> numeric value

The difference in level between the reference point and the noise power density at the position of the specified delta marker.

Example: `CALC:DELT2:FUNC:PNO:RES?`
Outputs the result of phase-noise measurement of the delta-marker 2.

Usage: Query only

Manual operation: See "Phase Noise measurement state" on page 1203

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe] <State>

Enables or disables the phase noise measurement at the delta marker position.

The reference marker for phase noise measurements is either a normal marker or a fixed reference. If necessary, the command turns on the reference marker.

The correction values for the bandwidth and the log amplifier are considered in the measurement.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off.

ON | 1
Switches the function on.

Example: `CALC:DELT:FUNC:PNO ON`
Switches on the phase-noise measurement with all delta markers.
`CALC:DELT:FUNC:FIX:RPO:X 128 MHZ`
Sets the frequency reference to 128 MHz.
`CALC:DELT:FUNC:FIX:RPO:Y 30 DBM`
Sets the reference level to +30 dBm

Manual operation: See "Phase Noise measurement state" on page 1203
See "All Phase Noise Markers Off" on page 1204

CALCulate<n>:MARKer<m>:FUNCtion:PNOise:AOFF

Removes all phase noise markers in the specified window.

Suffix:
<n> Window 1 to 16

<m> irrelevant

Example: `CALC:MARK:FUNC:PNO:AOFF`

CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult?

Queries the result of a phase noise measurement.

If necessary, the command activates the measurement first.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:

<PhaseNoise> numeric value

The difference between the measured carrier power and the noise power at the position of the specified (normal) marker.

Example: `CALC:MARK2:FUNC:PNO:RES?`
Outputs the result of phase-noise measurement of the marker 2.

Usage: Query only

Manual operation: See "Phase Noise measurement state" on page 1203

CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe] <State>

Enables or disables the phase noise measurement at the marker position.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK2:FUNC:PNO ON`
Switches on the phase-noise measurement for the marker 2.

Manual operation: See "Phase Noise measurement state" on page 1203
See "All Phase Noise Markers Off" on page 1204

Band power marker

The following commands control the marker for band power measurements.

Using markers

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:AOFF 738
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE 739
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult? 739
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN 740
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] 740

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:AOFF

Removes all band power markers in the specified window.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:MARK:FUNC:BPOW:AOFF

Manual operation: See "All Bandpower Markers Off" on page 1212

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE <Mode>

Selects the way the results for a band power marker are displayed.

(Note: relative power results are only available for delta markers, see CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE on page 740.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Mode> POWer | RPOWer | DENSity

POWer
The result is displayed as an absolute power. The power unit depends on the CALCulate<n>:UNIT:POWer setting.

DENSity
The result is displayed as a density in dBm/Hz.

*RST: POWer

Example: CALC:MARK4:FUNC:BPOW:MODE DENS
Configures marker 4 to show the measurement results in dBm/Hz.

Manual operation: See "Power Mode" on page 1211

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult?

Queries the results of the band power measurement.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<Power> Signal power over the marker bandwidth.

Example: Activate the band power marker:
CALC:MARK:FUNC:BPOW:STAT ON
Select the density mode for the result:
CALC:MARK:FUNC:BPOW:MODE DENS
Query the result:
CALC:MARK:FUNC:BPOW:RES?
Response:
20dBm/Hz

Usage: Query only

Manual operation: See "Band Power State" on page 1211

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN <Span>

Defines the bandwidth around the marker position.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Span> Frequency. The maximum span depends on the marker position and FSWX model.

*RST: 5% of current span
Default unit: Hz

Example: `CALC:MARK:FUNC:BPOW:SPAN 2MHz`
Measures the band power over 2 MHz around the marker.

Manual operation: See "Span" on page 1211

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] <State>

Enables or disables markers for band power measurements.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:FUNC:BPOW:STAT ON`
Activates or turns marker 4 into a band power marker.

Manual operation: See "Band Power State" on page 1211

Using delta markers

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE....740
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult?....741
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN....741
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe]....742

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE <Mode>

Selects the way the results for a band power delta marker are displayed.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<Mode> POWer | RPOWer | DENSity

POWer
Result is displayed as an absolute power. The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.

DENSity
Result is displayed as a density in dBm/Hz.

RPOWer
Prerequisite: delta band power marker
The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker. The powers are subtracted logarithmically, so the result is a dB value.
[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]

*RST: POWer

Example: `CALC:DELT:FUNC:BPOW:MODE POW`

Manual operation: See "Power Mode" on page 1211

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult?

Queries the results of the band power measurement.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Return values:

<Power> Signal power over the delta marker bandwidth.

Example: `CALC:DELT:FUNC:BPOW:RES?`

Usage: Query only

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN <Span>

Defines the bandwidth around the delta marker position.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<Span> Frequency range. The maximum span depends on the marker position and FSWX model.

*RST: 5% of current span
Default unit: Hz

Example: `CALC:DELT:FUNC:BPOW:SPAN 20`

Manual operation: See "Span" on page 1211

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe] <State>

Enables or disables delta markers for band power measurements.

If necessary, the command also turns on a reference marker.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT:FUNC:BPOW:STAT OFF`

N dB down marker

The following commands control the n dB down markers.

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown 742
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency? 743
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:QFACtor? 744
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult? 744
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe 744
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME? 745

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown <Distance>

Defines the distance of the n dB down markers to the reference marker.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<Distance> Distance of the temporary markers to the reference marker in dB.
For a positive offset, the markers T1 and T2 are placed *below* the active reference point.
For a negative offset (for example for notch filter measurements), the markers T1 and T2 are placed *above* the active reference point.

*RST: 6dB
Default unit: dB

Example: `CALC:MARK:FUNC:NDBD 3dB`
Sets the distance to the reference marker to 3 dB.

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency?

Queries the position of the n dB down markers on the x-axis when measuring in the frequency domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Return values:

<Frequency> **<frequency 1>**
Absolute frequency of the n dB marker to the left of the reference marker in Hz

<frequency 2>
Absolute frequency of the n dB marker to the right of the reference marker in Hz.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK:FUNC:NDBD ON`
Switches on the n dB down function.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK:FUNC:NDBD:FREQ?`
This command would return, for example, 100000000, 200000000, meaning that the first marker position is at 100 MHz, the second marker position is at 200 MHz

Usage: Query only

Manual operation: See "n dB down value" on page 1208

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:QFACtor?

Queries the Q factor of n dB down measurements.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<QFactor>

Example: `CALC:MARK:FUNC:NDBD:QFAC?`

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult?

Queries the distance of the n dB down markers from each other.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<Distance> The result depends on the span.
For frequency domain measurements, the command returns the bandwidth between the two n dB down markers in Hz.
For time domain measurements, the command returns the pulse width between the two n dB down markers in seconds.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`CALC:MARK:FUNC:NDBD ON`
Switches on the n dB down function.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK:FUNC:NDBD:RES?`
Outputs the measured value.

Usage: Query only

Manual operation: See "n dB down State" on page 1208

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe <State>

Enables or disables the n dB Down marker function.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:FUNC:NDBD:STAT ON`
Turns the n dB Down marker on.

Manual operation: See "n dB down State" on page 1208

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME?

Queries the position of the n dB down markers on the x-axis when measuring in the time domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Return values:

<TimeX1> Absolute position in time of the n dB marker to the left of the reference marker in seconds

<TimeX2> Absolute position in time of the n dB marker to the right of the reference marker in seconds

Example: `INIT:CONT OFF`
Switches to single sweep mode
`CALC:MARK:FUNC:NDBD ON`
Switches on the n dB down function.
`INIT;*WAI`
Starts a sweep and waits for the end.
`CALC:MARK:FUNC:NDBD:TIME?`
Outputs the time values of the temporary markers.

Usage: Query only

Manual operation: See "n dB down value" on page 1208

Signal count marker

The following commands control the frequency counter.

CALCulate<n>:MARKer<m>:COUNt 746
CALCulate<n>:MARKer<m>:COUNt:FREQuency? 746
CALCulate<n>:MARKer<m>:COUNt:RESolution 747

CALCulate<n>:MARKer<m>:COUNt <State>

Enables or disables the frequency counter at the marker position.

The frequency counter works for one marker only. If you perform a frequency count with another marker, the FSWX deactivates the frequency count of the first marker.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode.
```
CALC:MARK ON
```
Switches on marker 1.
```
CALC:MARK:COUN ON
```
Switches on the frequency counter for marker 1.
```
INIT;*WAI
```
Starts a sweep and waits for the end.
```
CALC:MARK:COUN:FREQ?
```
Outputs the measured value.

Manual operation: See "Signal Count marker state" on page 1198

CALCulate<n>:MARKer<m>:COUNt:FREQuency?

Queries the frequency at the marker position.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Before you can use the command, you have to turn on the frequency counter.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<Frequency> Frequency at the marker position.

Example:
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
CALC:MARK ON
```
Switches on marker 2.
```
CALC:MARK:COUN ON
```
Activates the frequency counter for marker 1.
```
INIT;*WAI
```
Starts a sweep and waits for the end.
```
CALC:MARK:COUN:FREQ?
```
Outputs the measured value of marker 1.

Usage: Query only

CALCulate<n>:MARKer<m>:COUNt:RESolution <Resolution>

Defines the resolution of the frequency counter.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Resolution> 0.001 | 0.01 | 0.1 | 1 | 10 | 100 | 1000 | 10000 Hz

*RST: 0.1 Hz
Default unit: Hz

Example:
```
CALC:MARK:COUN:RES 1kHz
```
Sets the resolution of the frequency counter to 1 kHz.

Manual operation: See "Resolution" on page 1198

Marker demodulation

The following commands control the demodulation of AM and FM signals at the marker position.

CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:CONTinuous....747
CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:HOLDoff....748
CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:SELect....748
CALCulate<n>:MARKer<m>:FUNCtion:DEModulation[:STATe]....749
[SENSe:]DEMod:SQUelch:LEVel....749
[SENSe:]DEMod:SQUelch[:STATe]....749

CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:CONTinuous <State>

Enables or disables continuous demodulation of the signal at the marker position in the frequency domain.

In the time domain continuous demodulation is always on.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC2:MARK3:FUNC:DEM:CONT ON`
Switches on the continuous demodulation.

Manual operation: See "Continuous Demodulation" on page 1214

CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:HOLDoff <Duration>

Defines for how long the the signal at the marker position is demodulated.

In the time domain continuous demodulation is always on.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Duration> Range: 10 ms to 1000 s
*RST: Marker demodulation = OFF
Default unit: s

Example: `CALC:MARK:FUNC:DEM:HOLD 3s`

Manual operation: See "Marker Stop Time" on page 1214

CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:SELect <DemodMode>

Selects the demodulation mode at the marker position.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<DemodMode> AM | FM | PM | AC | AUDio

AM
AM demodulation

FM
FM demodulation

PM
FM demodulation

AC
AC video demodulation

AUDio
Audio demodulation

*RST: AM

Example: `CALC:MARK:FUNC:DEM:SEL FM`

Manual operation: See "Modulation Type" on page 1214

CALCulate<n>:MARKer<m>:FUNCtion:DEModulation[:STATe] <State>

Enables or disables the audio demodulator when the measurement reaches a marker position.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK3:FUNC:DEM ON`
Switches on the demodulation for marker 3.

Manual operation: See "Marker Demodulation State" on page 1213

[SENSe:]DEMod:SQUelch:LEVel <Threshold>

Defines the threshold for selective demodulation.

All signals below the threshold are not demodulated.

Parameters:
<Threshold> Percentage of the display height.

Range: 0 to 100
*RST: 50

Example: `DEM:SQU:LEV 80`
Sets the squelch level to 80% of the displayed signal.

Manual operation: See "Squelch Level" on page 1214

[SENSe:]DEMod:SQUelch[:STATe] <State>

Enables or disables selective demodulation at the marker position.

For selective demodulation, the FSWX turns on a video trigger whose level corresponds to the squelch level. Therefore it turns off other triggers or gates.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off.

ON | 1
Switches the function on.

Example: `DEM:SQU ON`
Signals below the level threshold are not sent to the audio output.

Manual operation: See "Squelch" on page 1214

Programming examples for using markers and marker functions

Various programming examples on how to use markers and the special marker functions are provided here.

The use of spectrogram markers is demonstrated in "Programming example: configuring a spectrogram" on page 693.

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Example: basic markers

This example demonstrates how to configure and define markers for a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in Section 5.5.3.1, "Programming example: performing a basic frequency sweep", on page 1432 has been performed and thus does not begin by presetting the instrument.

```
//--------------Configuring marker behavior ------------------
DISP:MTAB ON
//Marker information is always displayed in a separate table.
CALC:MARK:X:SSIZ STAN
//The marker moves from one pixel to the next instead of sweep points in manual op.
```

```
CALC:MARK:PEXC 6dB
//Defines a peak excursion of 6 dB.
CALC:MARK:X:SLIM ON
CALC:MARK:X:SLIM:LEFT 50MHz
CALC:MARK:X:SLIM:RIGH 150MHz
//Restricts the search area for peaks to the frequencies between 50 and 150 MHz.
CALC:THR -100dBm
CALC:THR:STAT ON
//Configures a threshold level for peak searches at -100 dBm.

//--------------Defining and positioning markers -------------
CALC:MARK1 ON
//Activates marker 1 and sets it to the peak of trace 1.
CALC:MARK2:TRAC 2
//Activates marker 2 and sets it to the peak of trace 2.
CALC:MARK3:X 150MHz
//Activates marker 3 and sets it to the freq. 150 MHz  on trace 1.
CALC:MARK4:TRAC 4
//Activates marker 4 and sets it to the peak of trace 4.

CALC:MARK1:MAX:AUTO ON
//Moves M1 to the current peak of trace 1 after each sweep.
CALC:MARK2:MAX:NEXT
//Moves M2 to the next lower peak of trace 2.

CALC:DELT5 ON
CALC:DELT5:LINK ON
//Activates delta marker 5 and links it to marker 1. If M1 moves, so does D5.
CALC:DELT5:MREF 4
//Changes the reference for D5 to marker 4. D5 now shows the difference between
//the peak of trace 1 after each sweep and the value at the same position in
//trace 4, which is a copy of trace 1, averaged over 10 sweeps.
CALC:DELT5:MODE REL
//Shows the difference as relative values.

CALC:DELT6 ON
CALC:DELT6:MAX:NEXT
//Activates delta marker 6 and sets it to the next lower maximum of trace 1.
//Thus it shows the difference between the two highest peaks in trace 1.

//--------------Retrieving marker values ----------------------
CALC:MARK1:Y?
CALC:MARK2:Y?
CALC:MARK3:Y?
CALC:MARK4:Y?
CALC:DELT5:Y?
CALC:DELT6:Y?
//Retrieves the marker levels of each active normal and delta marker.
CALC:DELT5:X:REL?
CALC:DELT6:X:REL?
```

```
//Retrieves the frequency difference between the delta marker and marker 1.

//--------------Deactivating all markers ---------------------
//CALC:MARK:AOFF
//CALC:DELT:AOFF
```

Example: marker search in spectrograms

This example demonstrates how to search for peak values in spectrograms in a remote environment. It assumes that a spectrogram is already available (see "Programming example: configuring a spectrogram" on page 693) and thus does not begin by presetting the instrument.

```
//---------------- Analyzing the results using markers ------------------
//Set marker1 on the peak power in the most recent spectrum and query
//its position
CALC2:SPEC:FRAM:SEL 0
CALC2:MARK1 ON
CALC2:MARK1:X?
CALC2:MARK1:Y?

//Set marker2 on the peak power in frame at -324ms and query its position
CALC2:MARK2 ON
CALC2:MARK2:SGR:FRAM -324ms
CALC2:MARK2:X?
CALC2:MARK2:Y?

//Set marker3 on peak power level in the entire spectrogram in memory and
//query its position
CALC2:MARK3 ON
CALC2:MARK:SPEC:SAR MEM
CALC2:MARK3:SPEC:XY:MAX
CALC2:MARK3:X?
CALC2:MARK3:Y?

//Move marker 3 to the next lower peak level for the same frequency
CALC2:MARK3:SPEC:Y:MAX:NEXT
CALC2:MARK3:X?
CALC2:MARK3:Y?

//Set marker 4 to the highest level in the (visible) spectrogram.
CALC2:MARK:SPEC:SAR VIS
CALC2:MARK4:SPEC:XY:MAX
//Move marker 4 to the next higher level in the frames above its current position.
CALC2:MARK4:SPEC:Y:MAX:ABOV
```

Basic frequency sweep measurement for marker function examples

Markers can only be placed on an existing trace. The following example provides a simple frequency sweep measurement to be used as a basis for the subsequent marker function scripts.

```
//-------------- Configuring the basic frequency sweep ------------
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.
FREQ:CENT 100MHz
//Defines the center frequency
FREQ:SPAN 200MHz
//Sets the span to 100 MHz on either side of the center frequency.
DISP:TRAC1:Y:RLEV 0dBm
//Sets the reference level to 0 dBm.

//------- Performing the measurement ------------------------
INIT;*WAI
//Performs a measurement and waits for it to end
```

Example: using a fixed reference marker

This example demonstrates how to configure and use reference markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "Basic frequency sweep measurement for marker function examples" on page 752 has been performed and thus does not begin by presetting the instrument.

```
//-----------Configuring the reference marker ------------
//Activate a fixed reference marker. It is set to the current maximum of trace 1.
CALC:DELT:FUNC:FIX ON
//Set the reference frequency to 128 MHz.
CALC:DELT:FUNC:FIX:RPO:X 128 MHZ
//Set the reference level to +30 dBm.
CALC:DELT:FUNC:FIX:RPO:Y 30 DBM

//Use the fixed reference marker as a reference for deltamarker 2
CALC:DELT2:MREF FIX

//Reset the reference marker to the current maximum of trace 1
CALC:DELT:FUNC:FIX:RPO:MAX
//Query the new position of the reference marker
CALC:DELT:FUNC:FIX:RPO:X?
CALC:DELT:FUNC:FIX:RPO:Y?
```

Example: obtaining a marker peak list

This example demonstrates how to obtain a marker peak list in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "Basic frequency sweep measurement for marker function examples" on page 752 has been performed and thus does not begin by presetting the instrument.

In this example, the peak search is restricted to the frequency range of 50 MHz to 150 MHz. The top 5 power levels with a peak excursion of 10dB and a minimum of -100

dBm are to be determined and displayed with their marker numbers. The results are sorted by frequency values. The resulting peak list is then exported to a file.

```
//----------- Configuring the peak search ------------
CALC:MARK:X:SLIM ON
CALC:MARK:X:SLIM:LEFT 50MHz
CALC:MARK:X:SLIM:RIGH 150MHz
CALC:MARK:PEXC 10DB
CALC:THR -100DBM
CALC:THR:STAT ON

CALC:MARK:FUNC:FPE:STAT ON
CALC:MARK:FUNC:FPE:LIST:SIZE 5
CALC:MARK:FUNC:FPE:SORT X
CALC:MARK:FUNC:FPE:ANN:LAB ON

//--------------- Retrieving results -------------
CALC:MARK:FUNC:FPE:COUN?
CALC:MARK:FUNC:FPE:X?
CALC:MARK:FUNC:FPE:Y?

//------------ Exporting the peak list ------------
MMEM:STOR:PEAK 'PeakList'
```

Example: measuring noise density

This example demonstrates how to measure noise density using noise markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "Basic frequency sweep measurement for marker function examples" on page 752 has been performed and thus does not begin by presetting the instrument.

```
CALC:MARK1:FUNC:NOIS ON
//Switches on noise measurement at marker 1.

INIT;*WAI
//Performs a measurement and waits for it to end

CALC:MARK1:FUNC:NOIS:RES?
//Queries the measured noise level (per Hz bandwidth)
```

Example: measuring phase noise

This example demonstrates how to measure phase noise using markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "Basic frequency sweep measurement for marker function examples" on page 752 has been performed and thus does not begin by presetting the instrument.

```
//------------- Configuring the phase noise marker -------------------
DET SAMP
//Switches to Sample detector
```

```
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level

CALC:DELT:FUNC:PNO ON
//Activates phase noise marker function

CALC:DELT1 ON
CALC:DELT1:X 100kHz

CALC:DELT2 ON
CALC:DELT2:X 500kHz

CALC:DELT3 ON
CALC:DELT3:X 1MHz

CALC:DELT4 ON
CALC:DELT4:X 1.5MHz

//Activates the phase noise measurement function for offsets 100kHz/500kHz/1MHz/1.5MHz.

BAND:VID?
//Queries the used VBW (= 0.1*RBW)


//-------- Querying the phase noise results -----------------------------

CALC:DELT1:FUNC:PNO:RES?
CALC:DELT2:FUNC:PNO:RES?
CALC:DELT3:FUNC:PNO:RES?
CALC:DELT4:FUNC:PNO:RES?
//Queries the difference in level between the peak and the noise power density
//measured at the deltamarkers, referred to the carrier power level (dBc)
```

Example: measuring the power in a channel using band power markers

This example demonstrates how to measure the power in a specific channel or band using markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "Basic frequency sweep measurement for marker function examples" on page 752 has been performed and thus does not begin by presetting the instrument.

```
//------------- Configuring the band power marker ------------------
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level
CALC:MARK1:FUNC:BPOW:STAT ON
//Activates the band power measurement for the band around marker 1
CALC:MARK1:FUNC:BPOW:SPAN 30MHz
//Sets the bandwidth to be measured to 30 MHz
CALC:MARK1:FUNC:BPOW:MODE DENS
//Sets the result to be a density (power per Hz bandwidth)
```

```
CALC:DELT2 ON
//Activates deltamarker2
CALC:DELT2:FUNC:BPOW:STAT ON
//Activates the band power measurement for the band around deltamarker 2
CALC:DELT2:FUNC:BPOW:SPAN 30MHz
//Sets the bandwidth to be measured to 30 MHz
CALC:DELT2:FUNC:BPOW:MODE DENS
//Sets the result to be a density (power per Hz bandwidth)

CALC:DELT3 ON
//Activates deltamarker3
CALC:DELT3:FUNC:BPOW:STAT ON
//Activates the band power measurement for the band around deltamarker 3
CALC:DELT3:FUNC:BPOW:SPAN 30MHz
//Sets the bandwidth to be measured to 30 MHz
CALC:DELT3:FUNC:BPOW:MODE DENS
//Sets the result to be a density (power per Hz bandwidth)

//---------------Retrieving Results-------------
CALC:MARK1:FUNC:BPOW:RES?
//Returns the power sum for the specified bandwidth around marker 1.
CALC:DELT2:FUNC:BPOW:RES?
//Returns the power sum for the specified bandwidth around deltamarker 2.
CALC:DELT3:FUNC:BPOW:RES?
//Returns the power sum for the specified bandwidth around deltamarker 3.
```

Example: measuring characteristic bandwidths (using the n dB down marker)

This example demonstrates how to measure a characteristic bandwidth using markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "Basic frequency sweep measurement for marker function examples" on page 752 has been performed and thus does not begin by presetting the instrument.

```
//------------- Configuring the n dB down marker -------------------
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level
CALC:MARK1:FUNC:NDBD 3DB
//Sets the level offset to 3 dB
CALC:MARK1:FUNC:NDBD:STAT ON
//Activates the n dB down measurement

//---------------Retrieving Results-------------
CALC:MARK:FUNC:NDBD:RES?
//Returns the bandwidth at the specified power offset.
CALC:MARK:FUNC:NDBD:FREQ?
//Returns the frequencies of the temporary markers at the power offsets
CALC:MARK:FUNC:NDBD:QFAC?
//Returns the quality factor of the resulting bandwidth
```

Examples: demodulating marker values and providing audio output

The following examples demonstrate how to demodulate markers and provide audio output in a remote environment.

- Example: providing audio output for individual marker values.....757
- Example: demodulating and providing audio output continuously.....757

Example: providing audio output for individual marker values

This example demonstrates how to demodulate markers and provide audio output in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "Basic frequency sweep measurement for marker function examples" on page 752 has been performed and thus does not begin by presetting the instrument.

Audio output is provided for 5 s each time the signal reaches its initial maximum. However, only if it is higher than -90 dBm (10% of the total y-axis range), to ignore noise.

```
//------------- Configuring the marker demodulation -------------------
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level
CALC:MARK1:FUNC:DEM:SEL FM
//Selects FM demodulation
CALC:MARK1:FUNC:DEM:HOLD 5s
//Defines an output duration of 5s
DEM:SQU:LEV 10
//Sets a squelch level for noise
DEM:SQU ON
//Activates squelching
CALC:MARK1:FUNC:DEM ON
//Activates demodulation

//------- Performing the measurement -------------------------
INIT;*WAI
//Performs a measurement and waits for it to end

//---------------Retrieving Results-------------
//Results are only provided as audio output!
```

Example: demodulating and providing audio output continuously

This example demonstrates how to demodulate markers and provide audio output in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "Basic frequency sweep measurement for marker function examples" on page 752 has been performed and thus does not begin by presetting the instrument.

```
//------------- Configuring the marker demodulation -------------------
CALC:MARK1 ON
//Activates marker1
CALC:MARK1:FUNC:DEM:SEL FM
```

```
//Selects FM demodulation
DEM:SQU:LEV 10
//Sets a squelch level for noise
DEM:SQU ON
//Activates squelching
CALC:MARK1:FUNC:DEM:CONT ON
//Activates continuous demodulation

//------- Performing the measurement -------------------------
INIT:CONT ON
//Performs a measurement and provides continuous audio output

//---------------Retrieving Results-------------
//Results are only provided as audio output!
```

Example: performing a highly accurate frequency measurement using the signal count marker

This example demonstrates how to determine highly accurate frequency values using signal count markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "Basic frequency sweep measurement for marker function examples" on page 752 has been performed and thus does not begin by presetting the instrument.

```
//------------- Configuring the signal count marker -------------------
CALC:MARK1 ON
//Activates marker1
CALC:MARK1:COUN ON
//Switches on the frequency counter for marker 1.
CALC:MARK1:COUN:RES 1kHz
//Sets the resolution of the frequency counter to 1kHz

//------- Performing the measurement -------------------------
INIT;*WAI
//Performs a measurement and waits for it to end

//---------------Retrieving Results-------------
CALC:MARK1:COUN:FREQ?
//Returns the signal counter value as the precise marker frequency.
```

4.14.11.4 Configuring display lines

The commands required to configure display lines in a remote environment are described here.

CALCulate<n>:DLINe<dl> 759
CALCulate<n>:DLINe<dl>:STATe 759
CALCulate<n>:FLINe<dl> 759
CALCulate<n>:FLINe<dl>:STATe 760
CALCulate<n>:TLINe<dl> 760
CALCulate<n>:TLINe<dl>:STATe 761

CALCulate<n>:DLINe<dl> <Position>

Defines the (horizontal) position of a display line.

Suffix:
<n> Window 1 to 16

<dl> 1 | 2

Parameters:
<Position> The value range is variable.
You can use any unit you want, the FSWX then converts the unit to the currently selected unit. If you omit a unit, the FSWX uses the currently selected unit.

*RST: (state is OFF)
Default unit: dBm

Example: `CALC:DLIN2 -20dBm`
Positions the second display line at -20 dBm.

Manual operation: See "Horizontal Line 1/ Horizontal Line 2" on page 316

CALCulate<n>:DLINe<dl>:STATe <State>

Enables or disables a display line

Suffix:
<n> Window 1 to 16

<dl> 1 | 2

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DLIN2:STAT ON`
Turns on display line 2.

CALCulate<n>:FLINe<dl> <Frequency>

Defines the position of a frequency line.

Suffix:
<n> Window 1 to 16

<dl> 1 to 4
frequency line

Parameters:

<Frequency> Note that you cannot set a frequency line to a position that is outside the current span.

Range: 0 Hz to Fmax
*RST: (STATe to OFF)
Default unit: Hz

Example: `CALC:FLIN2 120MHz`
Sets frequency line 2 to a frequency of 120 MHz.

Manual operation: See "Vertical Line <x>" on page 315

CALCulate<n>:FLINe<dl>:STATe <State>

Turns a frequency line on and off

Suffix:

<n> Window 1 to 16

<dl> 1 to 4
frequency line

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:FLIN2:STAT ON`
Turns frequency line 2 on.

CALCulate<n>:TLINe<dl> <Time>

Defines the position of a time line.

Suffix:

<n> Window 1 to 16

<dl> 1 to 4
time line

Parameters:

<Time> Note that you cannot set a time line to a position that is higher than the current sweep time.

Range: 0 s to 1600 s
*RST: (STATe to OFF)
Default unit: s

Example: `CALC:TLIN 10ms`
Sets the first time line to 10 ms.

Manual operation: See "Vertical Line <x>" on page 315
See "Horizontal Line 1/ Horizontal Line 2" on page 316

CALCulate<n>:TLINe<dl>:STATe <State>

Turns a time line on and off

Suffix:
<n> Window 1 to 16

<dl> 1 to 4
time line

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:TLIN:STAT ON`
Turns the first time line on.

4.14.11.5 Defining limit checks

Note that in remote control, upper and lower limit lines are configured using separate commands. Thus, you must decide in advance which you want to configure. The x-values for both upper and lower limit lines are defined as a common control line. This control line is the reference for the y-values for both upper and lower limit lines.

- Configuring limit lines....761
- Managing limit lines....772
- Checking the results of a limit check....775
- Programming example: using limit lines....776

Configuring limit lines

CALCulate<n>:LIMit<li>:COMMent....762
CALCulate<n>:LIMit<li>:CONTrol[:DATA]....762
CALCulate<n>:LIMit<li>:CONTrol:DOMain....762
CALCulate<n>:LIMit<li>:CONTrol:MODE....763
CALCulate<n>:LIMit<li>:CONTrol:OFFSet....763
CALCulate<n>:LIMit<li>:CONTrol:SHIFt....764
CALCulate<n>:LIMit<li>:CONTrol:SPACing....764
CALCulate<n>:LIMit<li>:LOWer[:DATA]....764
CALCulate<n>:LIMit<li>:LOWer:MARGin....765
CALCulate<n>:LIMit<li>:LOWer:MODE....765
CALCulate<n>:LIMit<li>:LOWer:OFFSet....766
CALCulate<n>:LIMit<li>:LOWer:SHIFt....766
CALCulate<n>:LIMit<li>:LOWer:SPACing....766
CALCulate<n>:LIMit<li>:LOWer:STATe....767

CALCulate<n>:LIMit<li>:LOWer:THReshold....767
CALCulate<n>:LIMit<li>:NAME....767
CALCulate<n>:LIMit<li>:UNIT....768
CALCulate<n>:LIMit<li>:UPPer[:DATA]....768
CALCulate<n>:LIMit<li>:UPPer:MARGin....769
CALCulate<n>:LIMit<li>:UPPer:MODE....769
CALCulate<n>:LIMit<li>:UPPer:OFFSet....770
CALCulate<n>:LIMit<li>:UPPer:SHIFt....770
CALCulate<n>:LIMit<li>:UPPer:SPACing....770
CALCulate<n>:LIMit<li>:UPPer:STATe....771
CALCulate<n>:LIMit<li>:UPPer:THReshold....771

CALCulate<n>:LIMit<li>:COMMent <Comment>

Defines a comment for a limit line.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<Comment> String containing the description of the limit line.

Example: `CALC:LIM:COMM 'MyLimitLIne'`

Manual operation: See "Comment" on page 326

CALCulate<n>:LIMit<li>:CONTrol[:DATA] <LimitLinePoints>...

Defines the horizontal definition points of a limit line.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<LimitLinePoints> Variable number of x-axis values.
Note that the number of horizontal values has to be the same as the number of vertical values set with `CALCulate<n>:LIMit<li>:LOWer[:DATA]` or `CALCulate<n>:LIMit<li>:UPPer[:DATA]`. If not, the FSWX either adds missing values or ignores surplus values.
The unit is Hz or s.

*RST: -
Default unit: Hz

Manual operation: See "Data points (Position / Value)" on page 328

CALCulate<n>:LIMit<li>:CONTrol:DOMain <SpanSetting>

Selects the domain of the limit line.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<SpanSetting> FREQuency | TIME

FREQuency
For limit lines that apply to a range of frequencies.

TIME
For limit lines that apply to a period of time.

*RST: FREQuency

Example: `CALC:LIM:CONT:DOM FREQ`
Select a limit line in the frequency domain.

Manual operation: See "Unit" on page 327

CALCulate<n>:LIMit<li>:CONTrol:MODE <Mode>

Selects the horizontal limit line scaling.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<Mode> RELative | ABSolute

ABSolute
Limit line is defined by absolute physical values (Hz or s).

RELative
Limit line is defined by relative values related to the center frequency (frequency domain) or the left diagram border (time domain).

*RST: ABSolute

Example: `CALC:LIM:CONT:MODE ABS`

Manual operation: See "Position" on page 327

CALCulate<n>:LIMit<li>:CONTrol:OFFSet <Offset>

Defines an offset for a complete limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Offset> Numeric value.
The unit depends on the scale of the x-axis.
*RST: 0

Example: `CALC:LIM:CONT:OFFS 2`

Manual operation: See "X-Offset on relative values" on page 325

CALCulate<n>:LIMit<li>:CONTrol:SHIFt <Distance>

Moves a complete limit line horizontally.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Distance> Numeric value.
The unit depends on the scale of the x-axis.

Example: `CALC:LIM:CONT:SHIF 2`

Manual operation: See "Shift all Positions (X)" on page 328

CALCulate<n>:LIMit<li>:CONTrol:SPACing <InterpolMode>

Selects linear or logarithmic interpolation for the calculation of limit lines from one horizontal point to the next.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<InterpolMode> LINear | LOGarithmic
*RST: LIN

Example: `CALC:LIM:CONT:SPAC LIN`

Manual operation: See "Axis-Scaling" on page 327

CALCulate<n>:LIMit<li>:LOWer[:DATA] <LimitLinePoints>...

Defines the vertical definition points of a lower limit line.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<LimitLinePoints> Variable number of level values.
Note that the number of vertical values has to be the same as the number of horizontal values set with `CALCulate<n>:LIMit<li>:CONTrol[:DATA]`. If not, the FSWX either adds missing values or ignores surplus values.
The unit depends on `CALCulate<n>:LIMit<li>:UNIT` on page 768.

*RST: Limit line state is OFF

Example: `CALC:LIM:LOW:DATA 2,4,6`

Manual operation: See "Data points (Position / Value)" on page 328

CALCulate<n>:LIMit<li>:LOWer:MARGin <Margin>

Defines an area around a lower limit line where limit check violations are still tolerated.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Margin> **numeric value**

*RST: 0
Default unit: dB

Example: `CALC:LIM:LOW:MARG 2`

Manual operation: See "Margin" on page 328

CALCulate<n>:LIMit<li>:LOWer:MODE <Mode>

Selects the vertical limit line scaling.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Mode> RELative | ABSolute

ABSolute
Limit line is defined by absolute physical values.
The unit is variable.

RELative
Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Example: `CALC:LIM:LOW:MODE REL`

Manual operation: See "Value" on page 327

CALCulate<n>:LIMit<li>:LOWer:OFFSet <Offset>

Defines an offset for a complete lower limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<Offset> Numeric value.

*RST: 0
Default unit: dB

Example: `CALC:LIM:LOW:OFFS 2`

Manual operation: See "Y-Offset on relative values" on page 325

CALCulate<n>:LIMit<li>:LOWer:SHIFt <Distance>

Moves a complete lower limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<Distance> Defines the distance that the limit line moves.
The unit depends on `CALCulate<n>:LIMit<li>:UNIT` on page 768.

Example: `CALC:LIM:LOW:SHIF 2`

Manual operation: See "Shift all Values (Y)" on page 328

CALCulate<n>:LIMit<li>:LOWer:SPACing <InterpolType>

Selects linear or logarithmic interpolation for the calculation of a lower limit line from one horizontal point to the next.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<InterpolType> LINear | LOGarithmic

*RST: LIN

Example: CALC:LIM:LOW:SPAC LIN

Manual operation: See "Limit" on page 327

CALCulate<n>:LIMit<li>:LOWer:STATe <State>

Enables or disables a lower limit line.

Before you can use the command, you have to select a limit line with CALCulate<n>:LIMit<li>:NAME on page 767.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: CALC:LIM:LOW:STAT OFF

Manual operation: See "State" on page 324

CALCulate<n>:LIMit<li>:LOWer:THReshold <Threshold>

Defines a threshold for relative limit lines.

The FSWX uses the threshold for the limit check, if the limit line violates the threshold.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<Threshold> Numeric value.
The unit depends on CALCulate<n>:LIMit<li>:UNIT on page 768.

*RST: -200 dBm

Example: CALC:LIM:LOW:THR 2

Manual operation: See "Threshold" on page 327

CALCulate<n>:LIMit<li>:NAME <Name>

Selects a limit line that already exists or defines a name for a new limit line.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Name> String containing the limit line name.

*RST: REM1 to REM8 for lines 1 to 8

Example: `CALC:LIM:NAME 'Limit1'`

Manual operation: See "Name" on page 326

CALCulate<n>:LIMit<li>:UNIT <Unit>

Defines the unit of a limit line.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Unit> DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | A | DB | DBM_mhz | DBM_hz | DBUV_mhz | DBMV_mhz | DBUa_mhz | DBUV_m | DBUa_m | DBUV_mmhz | DBUa_mmhz | DBPW_mhz | DBPT_mhz | DBPT | DEG | RAD | S | HZ | PCT | UNITless | DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | DB | DBUV_M | DBUA_M | DBM_hz | DBM_mhz | DBUV_mhz | DBMV_mhz | DBUa_mhz | DBUV_m | DBUa_m | DBUV_mmhz | DBUa_mmhz | DBPW_mhz | DBPT_mhz | DBPT | (unitless)

If you select a dB-based unit for the limit line, the command automatically turns the limit line into a relative limit line.

*RST: DBM

Example: `CALC:LIM:UNIT DBM`

Manual operation: See "Unit" on page 327

CALCulate<n>:LIMit<li>:UPPer[:DATA] <LimitLinePoints>...

Defines the vertical definition points of an upper limit line.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<LimitLinePoints> Variable number of level values.
Note that the number of vertical values has to be the same as the number of horizontal values set with `CALCulate<n>:LIMit<li>:CONTrol[:DATA]`. If not, the FSWX either adds missing values or ignores surplus values.
The unit depends on `CALCulate<n>:LIMit<li>:UNIT` on page 768.

*RST: Limit line state is OFF

Example: `CALC:LIM:UPP:DATA 2,4,6`

Manual operation: See "Data points (Position / Value)" on page 328

CALCulate<n>:LIMit<li>:UPPer:MARGin <Margin>

Defines an area around an upper limit line where limit check violations are still tolerated.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Margin> **numeric value**

*RST: 0
Default unit: dB

Example: `CALC:LIM:UPP:MARG 2`

Manual operation: See "Margin" on page 328

CALCulate<n>:LIMit<li>:UPPer:MODE <Mode>

Selects the vertical limit line scaling.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Mode> RELative | ABSolute

ABSolute
Limit line is defined by absolute physical values.
The unit is variable.

RELative
Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Example: `CALC:LIM:UPP:MODE REL`

Manual operation: See "Value" on page 327

CALCulate<n>:LIMit<li>:UPPer:OFFSet <Offset>

Defines an offset for a complete upper limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<Offset> Numeric value.

*RST: 0
Default unit: dB

Example: `CALC:LIM:UPP:OFFS 2`

Manual operation: See "Y-Offset on relative values" on page 325

CALCulate<n>:LIMit<li>:UPPer:SHIFt <Distance>

Moves a complete upper limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<Distance> Defines the distance that the limit line moves.
The unit depends on `CALCulate<n>:LIMit<li>:UNIT` on page 768.

Example: `CALC:LIM:UPP:SHIF 2`

Manual operation: See "Shift all Values (Y)" on page 328

CALCulate<n>:LIMit<li>:UPPer:SPACing <InterpolType>

Selects linear or logarithmic interpolation for the calculation of an upper limit line from one horizontal point to the next.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<InterpolType> LINear | LOGarithmic

*RST: LIN

Example: `CALC:LIM:UPP:SPAC LOG`

Manual operation: See "Limit" on page 327

CALCulate<n>:LIMit<li>:UPPer:STATe <State>

Enables or disables an upper limit line.

Before you can use the command, you have to select a limit line with `CALCulate<n>:LIMit<li>:NAME` on page 767.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:LIM:UPP:STAT OFF`

Manual operation: See "State" on page 324

CALCulate<n>:LIMit<li>:UPPer:THReshold <Limit>

Defines an absolute limit for limit lines with a relative scale.

The FSWX uses the threshold for the limit check, if the limit line violates the threshold.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Limit> Numeric value.
The unit depends on `CALCulate<n>:LIMit<li>:UNIT` on page 768.

*RST: -200
Default unit: dBm

Example: `CALC:LIM:UPP:THR 2`

Manual operation: See "Threshold" on page 327

Managing limit lines

Useful commands for managing limit lines described in the FSWX User Manual:

- `MMEMory:SELect[:ITEM]:LINes[:ACTive]` on page 786
- `MMEMory:STORe<1|2>:TYPE` on page 790
- `MMEMory:LOAD:TYPE` on page 789

Remote commands exclusive to managing limit lines:

CALCulate<n>:LIMit<li>:ACTive?....772
CALCulate<n>:LIMit<li>:COPY....772
CALCulate<n>:LIMit<li>:DELete....773
CALCulate<n>:LIMit<li>:STATe....773
CALCulate<n>:LIMit<li>:TRACe<t>:CHECk....773
MMEMory:LOAD<n>:LIMit....774
MMEMory:STORe<n>:LIMit....774

CALCulate<n>:LIMit<li>:ACTive?

Queries the names of *all* active limit lines.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Return values:

<LimitLines> String containing the names of all active limit lines in alphabetical order.

Example: `CALC:LIM:ACT?`
Queries the names of all active limit lines.

Usage: Query only

Manual operation: See "State" on page 324

CALCulate<n>:LIMit<li>:COPY <Line>

Copies a limit line.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Line> **1 to 8**
number of the new limit line

<name>
String containing the name of the limit line.

Example: CALC:LIM1:COPY 2
Copies limit line 1 to line 2.
CALC:LIM1:COPY 'FM2'
Copies limit line 1 to a new line named FM2.

CALCulate<n>:LIMit<li>:DELete

Deletes a limit line.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Example: CALC:LIM2:DEL

Manual operation: See "Delete" on page 325

CALCulate<n>:LIMit<li>:STATe <State>

Enables or disables the limit check for a specific limit line.

To query the limit check result, use CALCulate<n>:LIMit<li>:FAIL?.

Note that a new command exists to activate the limit check and define the trace to be checked in one step (see CALCulate<n>:LIMit<li>:TRACe<t>:CHECk on page 773).

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: CALC:LIM:STAT ON
Switches on the limit check for limit line 1.

Manual operation: See "Disable all Lines" on page 324

CALCulate<n>:LIMit<li>:TRACe<t>:CHECk <State>

Enables or disables the limit check for a specific trace.

To query the limit check result, use CALCulate<n>:LIMit<li>:FAIL?.

Note that this command replaces the two commands from previous signal and spectrum analyzers (which are still supported, however):

- CALCulate<n>:LIMit<li>:TRACe<t>

- CALCulate<n>:LIMit<li>:STATe

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<t> Trace 1 to 6

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: CALC:LIM3:TRAC2:CHEC ON
Switches on the limit check for limit line 3 on trace 2.

Manual operation: See "Check Traces" on page 324

MMEMory:LOAD<n>:LIMit <FileName>

Loads the limit line from the selected file in .CSV format.

Suffix:
<n> Window 1 to 16

Parameters:
<FileName> String containing the path and name of the CSV import file.

Example: MMEM:LOAD:LIM 'C:/TEST.CSV'

Manual operation: See "Import" on page 329

MMEMory:STORe<n>:LIMit <FileName>, <LimitLineName>

Exports limit line data to an ASCII (CSV) file.

For details on the file format see "Reference: limit line file format" on page 322.

Suffix:
<n> Window 1 to 16

Parameters:
<FileName> String containing the path and name of the target file.

<LimitLineName> Name of the limit line to be exported.

Example: MMEM:STOR:LIM 'C:/TEST', 'UpperLimitLine'
Stores the limit line named "UpperLimitLine" in the file TEST.CSV.

Manual operation: See "Export" on page 329

Checking the results of a limit check

CALCulate<n>:LIMit<li>:CLEar[:IMMediate] 775
CALCulate<n>:LIMit<li>:FAIL? 775

CALCulate<n>:LIMit<li>:CLEar[:IMMediate]

Deletes the result of the current limit check.

The command works on *all* limit lines in *all* measurement windows at the same time.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Example: `CALC:LIM:CLE`
Deletes the result of the limit check.

CALCulate<n>:LIMit<li>:FAIL?

Queries the result of a limit check in the specified window.

Note that for SEM measurements, the limit line suffix <li> is irrelevant, as only one specific SEM limit line is checked for the currently relevant power class.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Return values:
<Result> **0**
PASS
1
FAIL

Example: `INIT;*WAI`
Starts a new sweep and waits for its end.
`CALC2:LIM3:FAIL?`
Queries the result of the check for limit line 3 in window 2.

Usage: Query only

Manual operation: See "Limit Check <n>" on page 1045
See "Limit Check" on page 1080

Programming example: using limit lines

The following examples demonstrate how to work with limit lines in a remote environment.

- Example: configuring limit lines....776
- Example: performing a limit check....777

Example: configuring limit lines

This example demonstrates how to configure 2 limit lines - an upper and a lower limit - for a measurement in a remote environment.

```
//------------- Configuring the limit lines ---------------------
CALC:LIM1:NAME 'FM1'
//Names limit line 1 'FM1'.

CALC:LIM1:CONT:MODE ABS
//Selects absolute scaling for the horizontal axis.
CALC:LIM1:CONT 1 MHz,50MHz,100 MHz,150MHz,200MHz
//Defines 5 horizontal definition points for limit line 1.
CALC:LIM1:UPP:MODE ABS
//Selects an absolute vertical scale for limit line 1.
CALC:LIM1:UNIT DBM
//Selects the unit dBm for limit line 1.
CALC:LIM1:UPP -10,-5,0,-5,-10
//Defines 5 definition points for limit line 1.

CALC:LIM1:UPP:MARG 5dB
//Defines an area of 5 dB around limit line 1 where limit check violations
//are still tolerated.

CALC:LIM1:UPP:SHIF -10DB
//Shifts the limit line 1 by -10 dB.
CALC:LIM1:UPP:OFFS -3dB
//Defines an additional -3 dB offset for limit line 1.

CALC:LIM3:NAME 'FM3'
//Names limit line 3 'FM3'.

CALC:LIM3:LOW:MODE REL
//Selects a relative vertical scale for limit line 3.
CALC:LIM3:UNIT DB

CALC:LIM3:CONT 1 MHz,50MHz,100 MHz,150MHz,200MHz
//Defines 5 horizontal definition points for limit line 3.
CALC:LIM3:LOW -90,-60,-40,-60,-90
//Defines 5 definition points relative to the reference level for limit line 3.

CALC:LIM3:LOW:SHIF 2
//Shifts the limit line 3 by 2dB.
CALC:LIM3:LOW:OFFS 3
```

```
//Defines an additional 3 dB offset for limit line 3.

CALC:LIM3:LOW:THR -200DBM
//Defines a power threshold of -200dBm that must be exceeded for limit to be checked

CALC:LIM3:LOW:MARG 5dB
//Defines an area of 5dB around limit line 3 where limit check violations
//are still tolerated.

//-------------- Storing the limit lines -----------------------
MMEM:SEL:CHAN:LIN:ALL ON
MMEM:STOR:TYPE CHAN
MMEM:STOR:STAT 1,'LimitLines_FM1_FM3'
```

Example: performing a limit check

This example demonstrates how to perform a limit check during a basic frequency sweep measurement in a remote environment. The limit lines configured in "Example: configuring limit lines" on page 776 are assumed to exist and be active.

```
//--------------Preparing the instrument ---------------------
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.

//--------------Configuring the measurement -------------
FREQ:CENT 100MHz
//Defines the center frequency
FREQ:SPAN 200MHz
//Sets the span to 100 MHz on either side of the center frequency.
SENS:SWE:COUN 10
//Defines 10 sweeps to be performed in each measurement.
DISP:TRAC1:Y:RLEV 0dBm
//Sets the reference level to 0 dBm.
TRIG:SOUR POW
TRIG:LEV:POW -10dBm
//Defines triggering when the second intermediate frequency rises to a level
//of -10 dBm.

//--------------Configuring the Trace--------------------------
DISP:TRAC2 ON
DISP:TRAC2:MODE AVER
DISP:TRAC3 ON
DISP:TRAC3:MODE MAXH
//Configures 3 traces: 1 (default): clear/write; 2: average; 3: max hold

//------------- Configuring the limit check ------------------
MMEM:LOAD:TYPE REPL
MMEM:LOAD:STAT 1,'LimitLines_FM1_FM3'
//Loads the limit lines stored in 'LimitLines_FM1_FM3'
```

```
CALC:LIM1:NAME 'FM1'
CALC:LIM1:UPP:STAT ON
//Activates upper limit FM1 as line 1.
CALC:LIM3:NAME 'FM3'
CALC:LIM3:LOW:STAT ON
//Activates lower limit line FM3 as line 3.
CALC:LIM:ACT?
//Queries the names of all active limit lines
//Result: 'FM1,FM3'
CALC:LIM1:TRAC3:CHEC ON
//Activates the upper limit to be checked against trace3 (maxhold trace)
CALC:LIM3:TRAC2:CHEC ON
//Activates the upper limit to be checked against trace2 (average trace)
CALC:LIM:CLE
//Clears the previous limit check results

//------------- Performing the measurement---------------------
INIT;*WAI
//Initiates a new measurement and waits until the last sweep has finished.

//-------------- Retrieving limit check results---------------------------

CALC:LIM1:FAIL?
//Queries the result of the upper limit line check
CALC:LIM3:FAIL?
//Queries the result of the lower limit line check
```

4.14.12 Managing settings and results

The commands required to store and load instrument settings and import and export measurement results in a remote environment are described here.

The tasks for manual operation are described in Section 4.10, "File and data management", on page 351.

For details on storage locations, refer to Section 4.10.1.2, "Overview of default storage locations", on page 355.

The filenames (<FileName> parameter) are given as string parameters enclosed in quotation marks. They also comply with Windows conventions. Windows filenames do not distinguish between uppercase and lowercase notation.

Pathnames

Storage locations can be specified either as absolute (including the entire path) or relative paths (including only subfolders of the current folder). Use the `MMEM:CDIR?` query to determine the current folder.

- General data storage and loading commands 779
- Selecting the items to store 784
- Storing and loading instrument settings 787

- Storing or printing screenshots 791
- Storing measurement results 801
- Importing and exporting I/Q data 804
- Examples: managing data 806

4.14.12.1 General data storage and loading commands

The following commands are available for all applications.

See also:

- `FORMat[:DATA]` on page 802

FORMat:DEXPort:DSEParator 779
MMEMory:CATalog 780
MMEMory:CATalog:LONG? 780
MMEMory:CDIRectory 780
MMEMory:COMMent 781
MMEMory:COPY 781
MMEMory:DATA 781
MMEMory:DELete:IMMediate 782
MMEMory:MDIRectory 782
MMEMory:MOVE 783
MMEMory:NAME 783
MMEMory:RDIRectory 783
MMEMory:UDIRectory? 783

FORMat:DEXPort:DSEParator <Separator>

Selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator> POINt | COMMa

COMMa
Uses a comma as a decimal separator, e.g. *4,05*.

POINt
Uses a point as a decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual operation: See "Decimal Separator" on page 370
See "Decimal Separator" on page 407
See "Save Evaluation List" on page 1058
See "Save Evaluation List" on page 1082

MMEMory:CATalog <FileName>

Returns the contents of a particular directory.

Parameters:

<FileName> String containing the path and directory
If you leave out the path, the command returns the contents of the directory selected with `MMEMory:CDIRectory` on page 780.
The path can be relative or absolute. You can use wildcards ('*') to query a certain type of files only.
If you use a specific file as a parameter, the command returns the name of the file if the file is found in the specified directory. It returns an error if the file is not found (`"-256,"File name not found"`).

Example: `MMEM:CAT? 'C:/Data/SPOOL?.PNG'`
Returns all files in `C:/Data/` whose names start with `SPOOL`, have 6 characters and the extension `.PNG`, e.g.:
`SPOOL1.PNG,SPOOL2.PNG,SPOOL3.PNG`

Example: `MMEM:CAT? 'C:/Data/SPOOL6.PNG'`
Query whether the file '`SPOOL6.PNG`' also exists in the directory; Result:
`-256,"File name not found;:MMEMory:CATalog? 'C:/Data/SPOOL6.PNG'`

Manual operation: See "Selecting the storage location" on page 1055

MMEMory:CATalog:LONG? <Directory>

Returns the contents of a particular directory with additional information about the files.

Query parameters:

<Directory> String containing the path and directory.
If you leave out the path, the command returns the contents of the directory selected with `MMEMory:CDIRectory` on page 780.
The path can be relative or absolute. Using wildcards ('*') is possible to query a certain type of files only.

Usage: Query only

Example:

```
MMEM:CAT:LONG?
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user'
```

MMEMory:CDIRectory <Directory>

Changes the current directory.

Parameters:

<Directory> String containing the path to another directory.
The path can be relative or absolute.

Example:

```
MMEM:CDIR
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user'
```

MMEMory:COMMent <Comment>

Defines a comment for the stored settings.

Parameters:

<Comment> String containing the comment.

Example: `MMEMory:COMMent "ACP measurement with Standard Tetra from 23.05."`
`MMEMory::MMEMory:STORe1:STATe 1, "ACP_T"`
As a result, in the selection list for recall settings, the comment `"ACP measurement with Standard Tetra from 23.05."` is added to the ACP entry.

Manual operation: See "Comment" on page 363

MMEMory:COPY <FileName>, <FileName>

Copies one or more files to another directory.

Parameters:

<FileName> String containing the path and filename of the source file.

<FileName> String containing the path and name of the target file.
The path can be relative or absolute.

Example:

```
MMEM:COPY
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/Original.csv',
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/Copy.csv'
```

MMEMory:DATA <FileName>[, <Data>]
MMEMory:DATA? <FileName>

Writes block data into a file. Set the delimiter to EOI to obtain error-free data transfer.

When you query the contents of a file, you can save them in a file on the remote control computer.

The command is useful for reading stored settings files or trace data from the instrument or for transferring them to the instrument

Parameters:

<Data> <block_data>

Data block with the following structure.
#
Hash sign.
<number>
Length of the length information.
<number>
Length information of the binary data (number of bytes).
<data>
Binary data with the indicated <number> of bytes.

Parameters for setting and query:
<FileName>

Example:
```
MMEM:NAME '/Public/User/Testfile.txt'
```
Creates a new file called 'testfile.txt'.
```
MMEM:DATA 'Testfile.txt',#220Contents of the
file
```
The parameter means:
#2: hash sign and length of the length information (20 bytes = 2 digits)
20: indicates the number of subsequent binary data bytes.
Contents of the file: store 20 binary bytes (characters) to the file.
```
MMEM:DATA? 'Testfile.txt'
```
Returns the contents of the file.

MMEMory:DELete:IMMediate <FileName>

Deletes a file.

Parameters:
<FileName> String containing the path and filename of the file to delete.
The path can be relative or absolute.

Example:

```
MMEM:DEL:IMM
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/old.csv'
```

MMEMory:MDIRectory <Directory>

Creates a new directory.

Parameters:
<Directory> String containing the path and new directory name
The path can be relative or absolute.

Example:

```
MMEM:MDIR
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/archive'
```

MMEMory:MOVE <FileName>, <FileName>

Moves a file to another directory.

The command also renames the file if you define a new name in the target directory.

If you do not include a path for <NewFileName>, the command just renames the file.

Parameters:

<FileName> String containing the path and filename of the source file.

<FileName> String containing the path and name of the target file.

Example: `MMEM:MOVE 'C:/TEST01.CFG','SETUP.CFG'`
Renames `TEST01.CFG` in `SETUP.CFG` in directory `C:/`.

MMEMory:NAME <FileName>

Has several purposes, depending on the context it is used in.

- It creates a new and empty file.
- It defines the filename for screenshots
  See `HCOPy[:IMMediate]` on page 796.

Parameters:

<FileName> String containing the path and name of the target file.

Example: `MMEM:NAME 'C:/Data/PRINT1.BMP'`
Selects the file name.

MMEMory:RDIRectory <Directory>

Deletes the indicated directory.

Parameters:

<Directory> String containing the path of the directory to delete.
Note that the directory you want to remove must be empty.

Example:

```
MMEM:RDIR
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/archive'
```

MMEMory:UDIRectory?

Queries the directory in which data created by the user is stored.

Return values:

<UserDirectory> Path in the FSWX file system.
The default path is
`home/instrument/.local/share/rohde-schwarz/esmain/fswx/use`
.

Usage: Query only

4.14.12.2 Selecting the items to store

The following commands select the items to be included in the configuration file.

Depending on the used command, either the items from the entire instrument (`MMEMory:SELect[:ITEM]...`), or only those from the currently selected application instance (`MMEM:SELect:CHANnel[:ITEM]...`) are stored.

MMEMory:SELect:CHANnel[:ITEM]:ALL....784
MMEMory:SELect[:ITEM]:ALL....784
MMEMory:SELect:CHANnel[:ITEM]:DEFault....784
MMEMory:SELect[:ITEM]:DEFault....784
MMEMory:SELect:CHANnel[:ITEM]:HWSettings....785
MMEMory:SELect[:ITEM]:HWSettings....785
MMEMory:SELect:CHANnel[:ITEM]:LINes:ALL....785
MMEMory:SELect[:ITEM]:LINes:ALL....785
MMEMory:SELect:CHANnel[:ITEM]:NONE....785
MMEMory:SELect[:ITEM]:NONE....785
MMEMory:SELect:CHANnel[:ITEM]:SPECtrogram....786
MMEMory:SELect:CHANnel[:ITEM]:SGRam....786
MMEMory:SELect[:ITEM]:SPECtrogram....786
MMEMory:SELect[:ITEM]:SGRam....786
MMEMory:SELect[:ITEM]:TRACe<1...3>[:ACTive]....786
MMEMory:SELect:CHANnel[:ITEM]:TRACe[:ACTive]....786
MMEMory:SELect:CHANnel[:ITEM]:TRACe<1...3>[:ACTive]....786
MMEMory:SELect[:ITEM]:LINes[:ACTive]....786
MMEMory:SELect:CHANnel[:ITEM]:TRANsducer:ALL....786
MMEMory:SELect[:ITEM]:TRANsducer:ALL....786

MMEMory:SELect:CHANnel[:ITEM]:ALL
MMEMory:SELect[:ITEM]:ALL

Includes all items when storing or loading a configuration file.

The items are:

- Hardware configuration: `MMEMory:SELect:CHANnel[:ITEM]:HWSettings` on page 785
- Limit lines: `MMEMory:SELect[:ITEM]:LINes:ALL` on page 785
- Spectrogram data: `MMEMory:SELect[:ITEM]:SGRam` on page 786
- Trace data: `MMEMory:SELect[:ITEM]:TRACe<1...3>[:ACTive]` on page 786
- Transducers: `MMEMory:SELect[:ITEM]:TRANsducer:ALL` on page 786

Example: `MMEM:SEL:ALL`

MMEMory:SELect:CHANnel[:ITEM]:DEFault
MMEMory:SELect[:ITEM]:DEFault

Selects the current settings as the only item to store to and load from a configuration file.

Example: MMEM:SEL:ITEM:DEF

MMEMory:SELect:CHANnel[:ITEM]:HWSettings <State>
MMEMory:SELect[:ITEM]:HWSettings <State>

Includes or excludes measurement (hardware) settings when storing or loading a configuration file.

Measurement settings include:

- General channel configuration
- Measurement hardware configuration including markers
- Limit lines
  Note that a configuration must include no more than 8 limit lines. This number includes active limit lines and inactive limit lines that were used last.
  Therefore the combination of inactivate limit lines depends on the sequence of use with MMEMory:LOAD:STATe on page 788.
- Color settings
- Configuration for the hardcopy output

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: MMEM:SEL:HWS ON

MMEMory:SELect:CHANnel[:ITEM]:LINes:ALL <State>
MMEMory:SELect[:ITEM]:LINes:ALL <State>

Includes or excludes all limit lines (active and inactive) when storing or loading a configuration file.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: MMEM:SEL:LIN:ALL ON

MMEMory:SELect:CHANnel[:ITEM]:NONE
MMEMory:SELect[:ITEM]:NONE

Does not include any of the following items when storing or loading a configuration file.

- Hardware configuration: MMEMory:SELect[:ITEM]:HWSettings on page 785
- Limit lines: MMEMory:SELect[:ITEM]:LINes:ALL on page 785
- Spectrogram data: MMEMory:SELect[:ITEM]:SGRam on page 786
- Trace data: MMEMory:SELect[:ITEM]:TRACe<1...3>[:ACTive] on page 786
- Transducers: MMEMory:SELect[:ITEM]:TRANsducer:ALL on page 786

Example: MMEM:SEL:NONE

MMEMory:SELect:CHANnel[:ITEM]:SPECtrogram <State>
MMEMory:SELect:CHANnel[:ITEM]:SGRam <State>
MMEMory:SELect[:ITEM]:SPECtrogram <State>
MMEMory:SELect[:ITEM]:SGRam <State>

Includes or excludes spectrogram data when storing or loading a configuration file.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: MMEM:SEL:SGR ON
Adds the spectrogram data to the list of data subsets.

MMEMory:SELect[:ITEM]:TRACe<1...3>[:ACTive] <State>
MMEMory:SELect:CHANnel[:ITEM]:TRACe[:ACTive] <State>
MMEMory:SELect:CHANnel[:ITEM]:TRACe<1...3>[:ACTive] <State>

This command includes or excludes trace data when storing or loading a configuration file.

Suffix:
<t> Trace 1 to 6

Parameters:
<State>

Example: MMEM:SEL:CHAN:ITEM:TRAC3 ON

MMEMory:SELect[:ITEM]:LINes[:ACTive] <State>

Includes or excludes active limit lines when storing or loading a configuration file.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: MMEM:SEL:ITEM:LIN:ACT ON

MMEMory:SELect:CHANnel[:ITEM]:TRANsducer:ALL <State>
MMEMory:SELect[:ITEM]:TRANsducer:ALL <State>

Includes or excludes transducer factors when storing or loading a configuration file.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: MMEM:SEL:TRAN:ALL ON

Manual operation: See "Save" on page 408

4.14.12.3 Storing and loading instrument settings

See also:

- INSTrument[:SELect] on page 544 to select the application instance.

MMEMory:CLEar:ALL....787
MMEMory:CLEar:STATe....787
MMEMory:LOAD:AUTO....787
MMEMory:LOAD:STATe....788
MMEMory:LOAD:TYPE....789
MMEMory:STORe<1|2>:STATe....789
MMEMory:STORe<1|2>:STATe:NEXT....790
MMEMory:STORe<1|2>:TYPE....790
SYSTem:PRESet[:EXEC]....790
SYSTem:PRESet:CHANnel[:EXEC]....791

MMEMory:CLEar:ALL

Deletes all instrument configuration files in the current directory.

You can select the directory with MMEMory:CDIRectory on page 780.

Example: MMEM:CLE:ALL

MMEMory:CLEar:STATe <1>, <FileName>

Deletes an instrument configuration file.

Parameters:
<1>

<FileName> String containing the path and name of the file to delete.
Optionally, the string can contain the file extension.

Example: MMEM:CLE:STAT 1,'TEST'

MMEMory:LOAD:AUTO <1>, <FileName>

Restores an instrument configuration and defines that configuration as the default state.

The default state is restored after a preset (*RST) or after you turn on the FSWX.

Parameters:
<1>

<FileName> **'Factory'**
Restores the factory settings as the default state.

'<file_name>'
String containing the path and name of the configuration file.
Note that only *instrument* settings files can be selected for the startup recall function; application instance files cause an error.

Manual operation: See "Recall File on Instrument Startup: Startup Recall" on page 364

Example:

```
MMEM:LOAD:AUTO 1,
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/mysettings.dfl
```

MMEMory:LOAD:STATe <1>, <FileName>

Restores and activates the instrument configuration stored in a `*.dfl` file.

Note that files with other formats cannot be loaded with this command.

The contents that are reloaded from the file are defined by the last selection made either in the "Save/Recall" dialogs (manual operation) or through the `MMEMory:SELect[:ITEM]` commands (remote operation; the settings are identical in both cases).

By default, the selection is limited to the user settings ("User Settings" selection in the dialogs, `HWSettings` in SCPI). The selection is not reset by [Preset] or `*RST`.

As a consequence, the results of a SCPI script using the `MMEMory:LOAD:STATe` command without a previous `MMEMory:SELect[:ITEM]` command can vary. The results depend on previous actions in the graphical user interface or in previous scripts, even if the script starts with the `*RST` command.

It is therefore recommended that you use the appropriate `MMEMory:SELect[:ITEM]` command before using `MMEMory:LOAD:STATe`.

Parameters:
<1>

<FileName> String containing the path and name of the file to load. Optionally, the string can include the file extension.

Manual operation: See "Recall From QuickSave" on page 364
See "Recall From File" on page 364

Example:

```
MMEM:SEL:ALL
```

//Save all items (user settings, all traces, all limit lines) from the FSWX.

```
MMEM:LOAD:STAT 1,
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/TEST01'
```

//Reloads all items

In the "Recall" dialog, select only "User Settings" and "All Limit Lines".

```
MMEM:LOAD:STAT 1,
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/TEST01'
```

//Reloads user settings and all limit lines.

```
*RST
```

//Reset instrument.

```
MMEM:LOAD:STAT 1,
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/TEST01'
```

//Selected items are retained. Reloads user settings and all limit lines.

Restart the instrument.

(Switch the [ON/OFF] key off and on).

```
MMEM:LOAD:STAT 1,
'home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/TEST01'
```

// Selected items are set to default. Reloads only the user settings.

MMEMory:LOAD:TYPE <Type>

Defines whether the application instances loaded with the subsequent `MMEM:LOAD:STAT` command replace the current application instance or activate a new application instance.

Parameters:

<Type> NEW | REPLace

NEW
The loaded settings are activated in a new application instance.

REPLace
The loaded settings replace the currently active application instance.

*RST: NEW

Example:

```
INST:SEL 'SPECTRUM2'
//Selects application instance 'SPECTRUM2'.
MMEM:STOR:TYP CHAN
//Specifies that application instance data is to be stored.
MMEM:STOR:STAT 1, 'C:/Analyzer/Spectrum'
//Stores the settings from application instance
//'SPECTRUM2' to the file 'C:/Analyzer/Spectrum'.
MMEM:LOAD:TYPE NEW
//Specifies that application instances are to be loaded
//in a new application instance.
MMEM:LOAD:STAT 1, 'C:/Analyzer/Spectrum'
//Loads the application instance from the file
//'C:/Analyzer/Spectrum' to the new application instance
//'SPECTRUM2*'.
```

MMEMory:STORe<1|2>:STATe <1>, <FileName>

Saves the current instrument configuration in a `*.dfl` file.

Suffix:

<1|2> irrelevant

Parameters:
<1>

<FileName> String containing the path and name of the target file.
The file extension is `.dfl`.

Example: `MMEM:STOR:STAT 1,'Save'`
Saves the current instrument settings in the file `Save.dfl`.

Manual operation: See "Save" on page 408

MMEMory:STORe<1|2>:STATe:NEXT

Saves the current instrument configuration in a `*.dfl` file.

The filename depends on the one you set with `MMEMory:STORe<1|2>:STATe` on page 789. This command adds a consecutive number to the filename.

Suffix:
<1|2> irrelevant

Example: `MMEM:STOR:STAT 1,'Save'`
Saves the current instrument settings in the file `Save.dfl`.
`MMEM:STOR:STAT:NEXT`
Saves the current instrument settings in the file `Save_001.dfl`
`MMEM:STOR:STAT:NEXT`
Saves the current instrument settings in the file `Save_002.dfl`

MMEMory:STORe<1|2>:TYPE <Type>

Defines whether the data from the entire instrument or only from the current application instance is stored with the subsequent `MMEM:STOR...` command.

Suffix:
<1|2> irrelevant

Parameters:
<Type> INSTrument | CHANnel

INSTrument
Stores data from the entire instrument.

CHANnel
Stores data from an individual application instance.

*RST: INST

Example: `INST:SEL 'SPECTRUM2'`
Selects application instance `'SPECTRUM2'`.
`MMEM:STOR:TYPE CHAN`
Specifies that application instance data is to be stored.

SYSTem:PRESet[:EXEC]

Presets the FSWX. It is identical to `*RST`.

Example: SYST:PRES

Usage: Event

SYSTem:PRESet:CHANnel[:EXEC]

Restores the default instrument settings in the current application instance.

Use INST:SEL to select the application instance.

For more information, see "Preset application instance" on page 958.

Example: INST:SEL 'Spectrum2'
Selects the application instance for "Spectrum2".
SYST:PRES:CHAN:EXEC
Restores the factory default settings to the "Spectrum2" application instance.

Usage: Event

Manual operation: See "Preset application instance" on page 958
See "Preset application instance" on page 1456

4.14.12.4 Storing or printing screenshots

Useful commands to configure screenshots described elsewhere

- MMEMory:NAME on page 783

Remote commands exclusive to configuring screenshots

DISPlay:LOGO ... 792
HCOPy:ABORt ... 792
HCOPy:CONTent ... 792
HCOPy:CMAP<it>:DEFault<ci> ... 793
HCOPy:CMAP<it>:HSL ... 794
HCOPy:CMAP<it>:PDEFined ... 794
HCOPy:DESTination<di> ... 794
HCOPy:DEVice:COLor ... 795
HCOPy:DEVice:LANGuage ... 795
HCOPy[:IMMediate] ... 796
HCOPy[:IMMediate]:NEXT ... 796
HCOPy:ITEM:WINDow:TEXT ... 796
HCOPy:PAGE:COUNt:STATe ... 796
HCOPy:PAGE:MARGin:BOTTom ... 797
HCOPy:PAGE:MARGin:LEFT ... 797
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HCOPy:PAGE:ORIentation ... 798
HCOPy:PAGE:WINDow:CHANnel:STATe ... 798
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HCOPy:PAGE:WINDow:SCALe....799
HCOPy:PAGE:WINDow:STATe....799
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SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt....800
SYSTem:COMMunicate:PRINter:ENUMerate[:NEXT]....801
SYSTem:COMMunicate:PRINter:SELect<di>....801

DISPlay:LOGO <State>

Enables or disables the printout of the Rohde & Schwarz company logo at the top of each page.

Parameters:

<State> 1 | 0 | ON | OFF

1 | ON
The logo is printed.

0 | OFF
The logo is not printed.

*RST: 1

Example: `DISP:LOGO OFF`

Manual operation: See "Include R&S Logo" on page 386

HCOPy:ABORt

Aborts a running hardcopy output.

Example: `HCOP:ABOR`

HCOPy:CONTent <Content>

Determines the type of content included in the printout.

This setting is independent of the printing device.

Parameters:

<Content> WINDows | HCOPy

WINDows
Includes only the selected windows in the printout. All currently active windows for the current application instance (or "Multi-View") are available for selection. How many windows are printed on each page of the printout is defined by `HCOPy:PAGE:WINDow:COUNt` on page 799.
This option is not available when copying to the clipboard (`HCOP:DEST 'SYST:COMM:CLIP'` or an image file (see `HCOPy:DEVice:LANGuage` on page 795).
If the destination is currently set to an image file or the clipboard, it is automatically changed to be a PDF file for the currently selected printing device.

HCOPy
Selects all measurement results displayed on the screen for the current application instance (or "MultiView"): diagrams, traces, markers, marker lists, limit lines, etc., including the application instance bar and status bar, for printout on a single page. Displayed items belonging to the software user interface (e.g. softkeys) are not included. The size and position of the elements in the printout is identical to the screen display.

*RST: HCOPy

Example:
```
HCOP:DEST1 'SYST:COMM:CLIP'
HCOP:CONT WIND
HCOP:DEST1?
//Result: 'MMEM'
HCOP:DEV:LANG1?
//Result: 'PDF'
```
"Print to clipboard" is automatically switched to "print to PDF file" when the contents are switched to "multiple windows".

Manual operation: See "Content" on page 384

HCOPy:CMAP<it>:DEFault<ci>

Defines the color scheme for print jobs.

For details see "Theme color settings" on page 390.

Suffix:
<it> Irrelevant.

<ci> Setting for manual operation, see table below.

Example:
```
HCOP:CMAP:DEF2
```
Selects the optimized color set for the color settings of a printout.

Manual setting	Description	Remote command
"Screen Colors (Print)"	Selects the current screen colors for the printout. The background is always printed in white and the grid in black.	`HCOP:CMAP:DEF1`
"Optimized Colors"	Selects an optimized color setting for the printout to improve the visibility of the colors (default setting). Trace 1 is blue, trace 2 black, trace 3 green, and the markers are turquoise. The background is always printed in white and the grid in black.	`HCOP:CMAP:DEF2`
"User Defined Colors"	Selects the user-defined color setting.	`HCOP:CMAP:DEF3`
"Screen Colors (Screenshot)"	Selects the current screen colors without any changes for a screenshot.	`HCOP:CMAP:DEF4`

HCOPy:CMAP<it>:HSL <hue>, <sat>, <lum>

Selects the color for various screen elements in print jobs.

Suffix:
<it> Selects the item for which the color scheme is to be defined.
For more information, see "Theme color settings" on page 390.

Parameters:
<hue> **hue**
Tint
Range: 0 to 1

<sat> **sat**
Saturation
Range: 0 to 1

<lum> **lum**
Brightness
Range: 0 to 1

Example: `HCOP:CMAP2:HSL 0.3,0.8,1.0`
Changes the grid color.

Manual operation: See "Userdefined Colors" on page 391

HCOPy:CMAP<it>:PDEFined <Color>

Selects a predefined color for various screen elements in print jobs.

Suffix:
<it> 1..n
Selects the item for which the color scheme is to be defined.
For more information, see "Theme color settings" on page 390.

Parameters:
<Color> BLACk | BLUE | BROWn | GREen | CYAN | RED | MAGenta | YELLow | WHITe | DGRay | LGRay | LBLue | LGReen | LCYan | LRED | LMAGenta

Example: `HCOP:CMAP2:PDEF GRE`

Manual operation: See "Predefined Colors" on page 391

HCOPy:DESTination<di> <Destination>

Selects the destination of a screenshot.

Note: To store a screenshot to a file, see `HCOPy:DEVice:LANGuage` on page 795.

Suffix:
<di> irrelevant

Parameters:
<Destination>

'MMEM'
Stores the screenshot to a file. Select the filename with MMEMory:NAME.
Define the file format with HCOPy:DEVice:LANGuage on page 795.

'SYSTem:COMMunicate:CLIPboard'
Stores the screenshot in the clipboard.

*RST: 'SYST:COMM:CLIP'

Example: To print to a *PRN file:

```
//Store the screenshot to a file
HCOP:DEST1 'MMEM'
//Define file name
MMEM:NAME 'C:/R_S/instr/user/MeasurementTestReport.png'
//Format: PNG file
HCOP:DEV:LANG PNG
//Print
HCOP:IMM
```

Manual operation: See "Save To" on page 383

HCOPy:DEVice:COLor <State>

Enables or disables color printing.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
Color printing

OFF | 0
Black and white printing

*RST: 1

Example:

```
HCOP:DEV:COL ON
```

HCOPy:DEVice:LANGuage <Language>

Selects the file format to store a screenshot to a file.

Parameters:

<Language> **BMP | JPG | PNG | PDF | SVG**
Data format for output to files

Example: To print a screenshot to a PNG file:

```
//Store the screenshot to a file
HCOP:DEST1 'MMEM'
//Define file name
MMEM:NAME 'C:/R_S/instr/user/MeasurementTestReport.png'
//Format: PNG file
HCOP:DEV:LANG PNG
//Print
HCOP:IMM
```

Manual operation: See "File Type" on page 384

HCOPy[:IMMediate]

Initiates a print job.

If you are printing to a file, the filename depends on `MMEMory:NAME`.

Example: `HCOP:IMM`

Manual operation: See "Take Screenshot" on page 389

HCOPy[:IMMediate]:NEXT

Initiates a print job.

If you are printing to a file, the filename depends on `MMEMory:NAME`. This command adds a consecutive number to the filename.

Example: `HCOP:IMM:NEXT`

Manual operation: See "Take Screenshot" on page 389

HCOPy:ITEM:WINDow:TEXT <Comment>

Defines a comment to be added to the printout.

Parameters:

<Comment> String containing the comment.

Example: `HCOP:ITEM:WIND:TEXT 'Report'`

Manual operation: See "Comment" on page 385

HCOPy:PAGE:COUNt:STATe <State>

Includes or excludes the page number for printouts consisting of multiple pages (`HCOPy:CONTent` on page 792).

Parameters:

<State> 1 | 0 | ON | OFF

1 | ON
The page number is printed.

0 | OFF
The page number is not printed.

*RST: 1

Example: HCOP:PAGE:COUN:STAT ON

Manual operation: See "Include Page Count" on page 386

HCOPy:PAGE:MARGin:BOTTom <Bottom>

Defines the margin at the bottom of the printout page on which no elements are printed. The margins are defined according to HCOPy:PAGE:MARGin:UNIT on page 798.

Parameters:
<Bottom> *RST: 4.23 mm

Example: HCOP:PAGE:MARG2:BOTT 2

Manual operation: See "Margins" on page 387

HCOPy:PAGE:MARGin:LEFT <Left>

Defines the margin at the left side of the printout page on which no elements are printed. The margins are defined according to HCOPy:PAGE:MARGin:UNIT on page 798.

Parameters:
<Left> *RST: 4.23 mm

Example: HCOP:PAGE:MARG2:LEFT 2

Manual operation: See "Margins" on page 387

HCOPy:PAGE:MARGin:RIGHt <Right>

Defines the margin at the right side of the printout page on which no elements are printed. The margins are defined according to HCOPy:PAGE:MARGin:UNIT on page 798.

Parameters:
<Right> *RST: 4.23 mm

Example: HCOP:PAGE:MARG2:RIGH 2

Manual operation: See "Margins" on page 387

HCOPy:PAGE:MARGin:TOP <Top>

Defines the margin at the top of the printout page on which no elements are printed. The margins are defined according to HCOPy:PAGE:MARGin:UNIT on page 798.

Parameters:
<Top> *RST: 4.23 mm

Example: HCOP:PAGE:MARG2:TOP 2

Manual operation: See "Margins" on page 387

HCOPy:PAGE:MARGin:UNIT <Unit>

Defines the unit in which the margins for the printout page are configured.

Parameters:

<Unit> MM | IN

MM
millimeters

IN
inches

*RST: MM

Example: HCOP:PAGE:MARG2:BOTT 2

Manual operation: See "Margins" on page 387

HCOPy:PAGE:ORIentation <Orientation>

Prerequisite: The output device is a printer or a PDF file.

The command selects the page orientation of the printout.

Parameters:

<Orientation> LANDscape | PORTrait

*RST: PORTrait

Example:
```
HCOP:DEV:LANG1 PDF
HCOP:PAGE:ORI2 LAND
```

Manual operation: See "Orientation" on page 387

HCOPy:PAGE:WINDow:CHANnel:STATe <Channel>, <State>

Selects all windows of the specified application instance to be included in the printout for HCOPy:CONTent on page 792.

Parameters:

<Channel> String containing the name of the application instance.
For a list of available application instance types, use INSTrument:LIST on page 543.

<State> 1 | 0 | ON | OFF

1 | ON
The application instance windows are included in the printout.

0 | OFF
The application instance windows are not included in the printout.

*RST: 1

Example: HCOP:CONT WIND
HCOP:PAGE:WIND2:CHAN 'IQ Capture',0
HCOP:PAGE:WIND2:STAT 'IQ Capture','1',1
Prints only window 1 in the I/Q Capture application instance.

Manual operation: See "Selected Windows" on page 385

HCOPy:PAGE:WINDow:COUNt <Count>

Defines how many windows are displayed on a single page of the printout for HCOPy:CONTent on page 792.

Parameters:
<Count> integer
*RST: 1

Example: HCOP:PAGE:WIND2:COUN 2

Manual operation: See "Windows Per Page" on page 387

HCOPy:PAGE:WINDow:SCALe <Scale>

Determines the scaling of the windows in the printout for HCOPy:CONTent on page 792.

Parameters:
<Scale> 1 | 0 | ON | OFF

1 | ON
Each window is scaled to fit the page size optimally, not regarding the aspect ratio of the original display. If more than one window is printed on one page (see HCOPy:PAGE:WINDow:COUNt on page 799), each window is printed in equal size.
("Size to fit")

0 | OFF
Each window is printed as large as possible while maintaining the aspect ratio of the original display.
("Maintain aspect ratio")

*RST: 1

Example: HCOP:PAGE:WIND2:SCAL 0

Manual operation: See "Scaling" on page 387

HCOPy:PAGE:WINDow:STATe <Channel>, <Window>, <State>

Selects the windows to be included in the printout for HCOPy:CONTent on page 792.

Parameters:
<Channel> String containing the name of the application instance.
For a list of available application instance types, use Table 4-54.

<Window> String containing the name of the existing window.
By default, the name of a window is the same as its index.
To determine the name and index of all active windows in the active application instance, use the `LAYout:CATalog[:WINDow]?` on page 657 query.

<State> 1 | 0 | ON | OFF

1 | ON
The window is included in the printout.

0 | OFF
The window is not included in the printout.

*RST: 1

Example:
```
HCOP:PAGE:WIND2:STAT 'IQ Capture','1',1
```

Manual operation: See "Selected Windows" on page 385

HCOPy:TDSTamp:STATe <State>

Includes or excludes the time and date in the printout.

Parameters:

<State> 1 | 0 | ON | OFF

1 | ON
The time and date are printed.

0 | OFF
The time and date are not printed.

*RST: 1

Example:
```
HCOP:TDST:STAT OFF
```

Manual operation: See "Include Timestamp" on page 387

HCOPy:THEMe:SELect <Theme>

The theme defines the colors and style used to store screen objects.

Parameters:

<Theme> **Dark**
(Default:) Uses a dark background, as seen on the FSWX screen.

Bright
Uses a white background, optimal for printing.

Manual operation: See "Theme for Screenshot" on page 387

SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt

Queries the name of the first available printer.

To query the name of other installed printers, use SYSTem:COMMunicate:PRINter:ENUMerate[:NEXT] on page 801.

Example: SYST:COMM:PRIN:ENUM:FIRS?

SYSTem:COMMunicate:PRINter:ENUMerate[:NEXT]

Prerequisite: SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt on page 800

Queries the name of available printers.

Example: SYST:COMM:PRIN:ENUM:NEXT?

SYSTem:COMMunicate:PRINter:SELect<di> <Printer>

Selects the printer that processes jobs sent by the FSWX.

Use HCOPy:DESTination<di> to select another output destination.

Suffix:
<di> 1..n
Printing device.

Parameters:
<Printer> String containing the printer name.
Use one of the following commands to query all available printers:
SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt on page 800
SYSTem:COMMunicate:PRINter:ENUMerate[:NEXT] on page 801
*RST: NONE

Example: SYST:COMM:PRIN:SEL 'PCB1'

4.14.12.5 Storing measurement results

The following commands can be used to store the results of a measurement.

Useful commands for storing results described elsewhere:

- MMEMory:STORe<n>:TRACe on page 693
- FORMat:DEXPort:TRACes on page 691

Remote commands exclusive to storing results:

FORMat[:DATA] 802
FORMat:DEXPort:HEADer 802
MMEMory:STORe<n>:LIST 803
MMEMory:STORe<n>:PEAK 803
MMEMory:STORe<n>:SGRam 803
MMEMory:STORe<n>:SPECtrogram 803
MMEMory:STORe<n>:SPURious 804

FORMat[:DATA] <Format>[, <BitLength>]

Selects the data format that is used to transmit data from the FSWX to the controlling computer.

Note that the command has no effect for data that you send to the FSWX. The FSWX automatically recognizes the data it receives, regardless of the format.

For details on data formats, see Section 4.10.4.7, "Reference: ASCII file export format", on page 374.

Parameters:

<Format>

ASCii
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats can be.

REAL
The data is stored as binary data (definite length block data according to IEEE 488.2). Each measurement value is formatted in 16-bit/32-bit/64-bit IEEE 754 floating-point-format.
For details, see Section 4.10.4.6, "Formats for returned values: ASCII format and binary format", on page 373.

<BitLength>

Length in bits for floating-point results

16
16-bit floating-point numbers.
Compared to `REAL,32` format, half as many numbers are returned.

32
32-bit floating-point numbers
For I/Q data, 8 bytes per sample are returned for this format setting.

64
64-bit floating-point numbers
Compared to `REAL,32` format, twice as many numbers are returned.

Example:

```
FORM REAL,32
```

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

For details on data formats, see Section 4.10.4.7, "Reference: ASCII file export format", on page 374.

Parameters:

<State>

ON | OFF | 0 | 1

*RST: 1

Example: `FORM:DEXP:HEAD OFF`

Manual operation: See "Include Instrument and Measurement Settings" on page 369

MMEMory:STORe<n>:LIST <FileName>

Exports the SEM and spurious emission list evaluation to a file.

The file format is *.dat.

Suffix:
<n> Window 1 to 16

Parameters:
<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:LIST 'test'`
Stores the current list evaluation results in the `test.dat` file.

Manual operation: See "Save Evaluation List" on page 1058
See "Save Evaluation List" on page 1082

MMEMory:STORe<n>:PEAK <FileName>

Exports the marker peak list to a file.

Suffix:
<n> Window 1 to 16

Parameters:
<FileName> String containing the path, name and extension of the target file.

Example: `MMEM:STOR:PEAK 'test.dat'`
Saves the current marker peak list in the file `test.dat`.

Manual operation: See "Export Peak List" on page 1196

MMEMory:STORe<n>:SGRam <FileName>
MMEMory:STORe<n>:SPECtrogram <FileName>

Exports spectrogram data to an ASCII file.

The file contains the data for every frame in the history buffer. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Note that, depending on the size of the history buffer, the process of exporting the data can take a while.

Suffix:
<n> Window 1 to 16

Parameters:
<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:SGR 'Spectrogram'`
Copies the spectrogram data to a file.

Manual operation: See "Export to ASCII File" on page 370

MMEMory:STORe<n>:SPURious <FileName>

Exports the marker peak list available for spurious emission measurements to a file.

Suffix:
<n> Window 1 to 16

Parameters:
<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:SPUR 'test'`
Saves the current marker peak list in the file test.dat.

4.14.12.6 Importing and exporting I/Q data

Alternatively to capturing I/Q data by the "Spectrum" application itself, you can import stored I/Q data from previous measurements or other applications to the "Spectrum" application. Furthermore, you can store I/Q data processed in the "Spectrum" application to a file for further evaluation in other applications.

I/Q data can only be exported in applications that process I/Q data, such as the "Spectrum" application or optional applications.

For more information, see Section 4.10.5, "I/Q data import and export", on page 377.

MMEMory:LOAD:IQ:STATe 804
MMEMory:STORe<n>:IQ:COMMent 805
MMEMory:STORe<n>:IQ:FORMat 805
MMEMory:STORe<n>:IQ:STATe 805

MMEMory:LOAD:IQ:STATe <FileName>, <FileName>

Restores I/Q data from a file.

Parameters:
<FileName> string

String containing the path and name of the source file.
The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`.
For `.mat` files, Matlab® v4 is assumed.

<FileName>

Example:
```
MMEM:LOAD:IQ:STAT 1, 'data.iqw'
MMEM:LOAD:IQ:STAT 1, 'data.iq.tar'
```
Loads I/Q data from the specified file.

Manual operation: See "I/Q Import" on page 378

MMEMory:STORe<n>:IQ:COMMent <Comment>

Adds a comment to a file that contains I/Q data.

Suffix:
<n> Window 1 to 16

Parameters:
<Comment> String containing the comment.

Example:
```
MMEM:STOR:IQ:COMM 'Device test 1b'
```
Creates a description for the export file.
```
MMEM:STOR:IQ:STAT 1, 'data.iq.tar'
```
Stores I/Q data and the comment to the specified file.

Manual operation: See "Comment" on page 379

MMEMory:STORe<n>:IQ:FORMat <Format>, <DataFormat>

Sets or queries the format of the I/Q data to be stored.

Suffix:
<n> Window 1 to 16

Parameters:
<Format> FLOat32 | INT32

FLOat32
32-bit floating point format.

INT32
32-bit integer format.

*RST: FLOat32

<DataFormat> COMPlex | REAL

COMPlex
Exports complex data.

REAL
Exports real data.

*RST: COMPlex

Example:
```
MMEM:STOR:IQ:FORM INT32,REAL
```

MMEMory:STORe<n>:IQ:STATe <1>, <FileName>

Writes the captured I/Q data to a file.

The file extension is `*.iq.tar`. By default, the contents of the file are in 32-bit floating point format.

Suffix:
<n> Window 1 to 16

Parameters:
<1>

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:IQ:STAT 1, 'data.iq.tar'`
Stores the captured I/Q data to the specified file.

Usage: Asynchronous command

Manual operation: See "I/Q Export" on page 379

4.14.12.7 Examples: managing data

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Storing data

```
MMEM:MSIS 'C:'
//Selects drive C: as the default storage device.

//-----Connecting a network drive--------
MMEM:NETW:USED?
//Returns a list of all drives in use in the network.
MMEM:NETW:UNUS?
//Returns a list of free drive names in the network.
MMEM:NETW:MAP 'Q:','Server/ACLRTest'
//Maps drive Q: to the directory 'Server/ACLRTest'

//-----Saving data on the instrument-----
MMEM:MDIR 'C:/R_S/INSTR/USER/Results'
//Creates a directory called 'Results' on drive C:
MMEM:NAME 'C:/R_S/INSTR/USER/Results/Test001.txt'
//Defines a file called 'Test001.txt'
MMEM:COMM 'ACLR test results'
//Creates a comment for the settings to be displayed in gui.
MMEM:DATA 'Test001.txt',#212FileContents
//Creates the file 'Test001.txt'and writes 12 characters to it

//-----Copying the data to another location---
MMEM:COPY 'C:/R_S/INSTR/USER/Results/Test001.txt','Q:'
//Copies the specified file to network drive Q:.
MMEM:DEL 'C:/R_S/INSTR/USER/Results/Test001.txt'
//Deletes the specified file from the instrument hard disk.
//or
//MMEM:MOVE 'C:/R_S/INSTR/USER/Results/Test001.xml','Q:/TestResults.txt'//
//Moves the file 'Test001.txt' to drive Q:, renames it to 'Testresults.txt'
```

```
//and removes it from the instrument hard disk.
MMEM:RDIR 'C:/R_S/INSTR/USER/Results'
//Deletes the directory called 'Results' from drive C:, unless it still
//contains any content.

//-----Disconnecting the network drive---
MMEM:NETW:DISC 'Q:'
//Disconnect drive Q:.
```

Loading data

```
MMEM:CDIR?
//Returns the path of the current directory.
//e.g.
C:/R_S/Instr/user/
MMEM:CDIR 'C:/R_S/INSTR/USER/Results'
//Changes the current directory.
MMEM:CAT? 'C:/R_S/INSTR/USER/Results/*.xml'
//or
MMEM:CAT? '*.xml'
//Returns a list of all xml files in the directory 'C:/R_S/INSTR/USER/Results'.
MMEM:CAT:LONG? '*.xml'
//Returns additional information about the xml files in the directory
// 'C:/R_S/INSTR/USER/Results'.
```

Storing instrument settings

In this example we will store the instrument settings for the "Spectrum" application instance.

```
INST:SEL 'SPECTRUM'
//Selects measurement channel 'SPECTRUM'.
MEMM:STOR:TYPE CHAN
//Specifies that channel-specific data is to be stored.
MMEM:STOR:STAT 1, 'C:/R_S/Instr/user/Spectrum'
//Stores the channel settings from the 'Spectrum' channel
// to the file 'Spectrum.dfl'.
```

Loading instrument settings

In this example we will load the hardware settings from the configuration file `Spectrum.dfl` to a new "Spectrum2" application instance.

```
MEMM:LOAD:TYPE NEW
//Specifies that settings will be loaded to a new channel besides the existing
//'Spectrum' channel.
MMEM:SEL:CHAN:HWS ON
//Selects only hardware settings to be loaded.
MMEM:LOAD:STAT 1, 'C:/R_S/Instr/user/Spectrum'
//Loads the channel-specific settings from the file 'C:/R_S/Instr/user/Spectrum.dfl'
//to a new channel. The new channel is named 'Spectrum2' to avoid a naming conflict
//with the existing 'Spectrum' channel.
```

```
INST:REN 'Spectrum2','Spectrum3'
//Renames the loaded channel to 'Spectrum3'.
```

Printing to a file

```
//Select bmp as the file format.
HCOP:DEV:LANG BMP
//Select the file name for the printout.
MMEM:NAME 'C:/R_S/INSTR/USER/Screenshot.bmp'
//Select all screen elements for printing
HCOP:ITEM:ALL
//Add a comment to the printout.
HCOP:ITEM:WIND:TEXT 'ACLRResults'
//Store the printout in a file called 'Screenshot.bmp'.
HCOP
//Store another printout in a file called 'Screenshot_001.bmp'.
HCOP:NEXT
```

Storing multiple graphical measurement results to a PDF file

This example demonstrates how to store graphical results from measurements in the "Spectrum" application and the "I/Q Capture" to a single PDF file. It assumes the "Spectrum" and "I/Q Capture" measurements have already been configured and performed, with the following screen layout:

'Spectrum': 1 Frequency Sweep

'Spectrum': 2 Spectrogram

'IQ Capture': 1 Magnitude

'IQ Capture': 2 Spectrum

```
//Switch to MultiView tab
DISP:ATAB ON

//Select windows to be stored to file
HCOP:CONT WIND
HCOP:PAGE:WIND:STAT 'Spectrum','1',ON
HCOP:PAGE:WIND:STAT 'Spectrum','2',ON
HCOP:PAGE:WIND:STAT 'IQ Capture','1',ON
HCOP:PAGE:WIND:STAT 'IQ Capture','2',ON

//Define contents to be printed on each page (logo, timestamp, page count)
DISP:LOGO ON
HCOP:TDST:STAT ON
HCOP:PAGE:COUN:STAT ON
//Define comment to be printed on each page
HCOP:ITEM:WIND:TEXT 'Measurement Test Report'

//Configure page layout (landscape, 1 display per page, margins 2cm on each side)
HCOP:PAGE:ORI1 LAND
HCOP:PAGE:WIND1:COUN 1
```

```
HCOP:PAGE:WIND1:SCAL 1
HCOP:PAGE:MARG1:BOTT 20
HCOP:PAGE:MARG1:LEFT 20
HCOP:PAGE:MARG1:RIGH 20
HCOP:PAGE:MARG1:TOP 20

//Configure the use of optimized colors for printout
HCOP:CMAP:DEF2

//Set format of printout to PDF.
HCOP:DEV:LANG1 PDF
//Define file name of printout
MMEM:NAME 'C:/R_S/instr/user/MeasurementTestReport.pdf'

//Store pdf of printout to file
HCOP:IMM
```

4.14.13 Configuring the FSWX

The remote commands required to set up the FSWX are described here.

- Configuring the reference frequency....809
- Calibration and checks....813
- Working with transducers....822
- Compensating for frequency response using touchstone files....826
- Customizing the screen layout....844
- Configuring the network and remote control....851
- Checking the system configuration....856
- Signal generator control commands....863
- Using service functions....865
- Remote commands for synchronizing parameters....867

4.14.13.1 Configuring the reference frequency

[SENSe:]ROSCillator:SOURce....809
[SENSe:]ROSCillator:EXTernal:FREQuency:MODE....810
[SENSe:]ROSCillator:EXTernal:FREQuency....810
[SENSe:]ROSCillator:SOURce:EAUTo?....811
[SENSe:]ROSCillator:EXTernal:FALLback....811
[SENSe:]ROSCillator:LBWidth....812
[SENSe:]ROSCillator:TRANge....812
[SENSe:]ROSCillator:OUTPut<o>....812
[SENSe:]ROSCillator:OSYNc....813

[SENSe:]ROSCillator:SOURce <Source>

Selects the input source for the reference frequency.

If you want to select an external reference, it must be connected to the FSWX.

Parameters:

<Source>

INTernal
The internal reference is used (10 MHz or optional OCXO).

EXTernal1
The external reference from the "Ref In 1" connector is used.

EXTernal2
The external reference from the "Ref In 2" connector is used.

Example:
```
ROSC:SOUR EXT1
```

Manual operation: See "Reference frequency input source" on page 400

[SENSe:]ROSCillator:EXTernal:FREQuency:MODE <Mode>

Defines which reference output connector is used.

Parameters:

<Mode>

E10 | E100 | VARiable

E10
The internal 10 MHz crystal oscillator or the optional and more precise OCXO signal is used.

E100
The signal at the "Ref In 1" connector is used.
Define the used frequency using `[SENSe:]ROSCillator:EXTernal:FREQuency` on page 810.

VARiable
The signal at the "Ref In 2" connector is used.
Define the used frequency using `[SENSe:]ROSCillator:EXTernal:FREQuency` on page 810.

Example:
//Select variable frequency mode
```
ROSC:EXT:FREQ:MODE VAR
```
//Set the frequency to 13 MHz.
```
ROSC:EXT:FREQ 13MHZ
```

Manual operation: See "Frequency Mode/Frequency" on page 401

[SENSe:]ROSCillator:EXTernal:FREQuency <RefFreq>

Defines the frequency of the external reference oscillator.

If the external reference oscillator is selected, the reference signal must be connected to the rear panel of the instrument.

Parameters:

<RefFreq>

Range: 1 MHz to 50 MHz
Default unit: Hz

Example: //Select variable frequency mode
```
ROSC:EXT:FREQ:MODE VAR
```
//Set the frequency to 13 MHz.
```
ROSC:EXT:FREQ 13MHZ
```

Manual operation: See "Frequency Mode/Frequency" on page 401

[SENSe:]ROSCillator:SOURce:EAUTo?

Queries the current reference type in case you enabled automatic switching to the internal reference if the external reference is missing.

Return values:

<Reference> INT | EXT

INT
Internal reference

EXT
External reference

Example:
```
SENS:ROSC:SOUR:EAUT?
```
Queries the currently available reference type.

Usage: Query only

[SENSe:]ROSCillator:EXTernal:FALLback <State>

Defines how the instrument reacts if an external reference is selected but none is available.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
If no valid external reference signal is available, the error message "External reference missing" is displayed. Additionally, the flag "NO REF" is displayed to indicate that no synchronization was performed *for the last measurement*.

ON | 1
If no external reference is available, the instrument automatically switches back to the internal reference. Note that you must re-activate the external reference if it becomes available again later.

*RST: 0

Example: Use the external reference at the "Ref In 1" connector. If no signal is available at the connector, use the internal reference.
```
ROSC:SOUR EXT1
ROSC:EXT:FALL 1
```

Manual operation: See "Behavior in case of missing external reference" on page 401

[SENSe:]ROSCillator:LBWidth <Bandwidth>

Defines the loop bandwidth, that is, the speed of internal synchronization with the reference frequency. The setting requires a compromise between performance and increasing phase noise.

For a variable external reference frequency with a narrow tuning range (+/- 0.5 ppm), the loop bandwidth is fixed to 0.1 Hz and cannot be changed.

Parameters:

<Bandwidth> 0.1 Hz | 1 Hz | 3 Hz | 10 Hz | 30 Hz | 100 Hz | 300 Hz

The possible values depend on the reference source and tuning range (see Table 4-36).

Default unit: Hz

Example: `ROSC:LBW 3`

Manual operation: See "Loop Bandwidth" on page 401

[SENSe:]ROSCillator:TRANge <Range>

Prerequisite: Variable external reference frequency

Defines the tuning range. It determines how far the frequency can deviate from the defined level in parts per million (10^{-6}).

Parameters:

<Range> WIDE | SMALI

The possible values depend on the reference source (see Table 4-36).

SMALI
With this smaller deviation (+/- 0.5 ppm) a very narrow fixed loop bandwidth of 0.1 Hz is realized. With this setting, the instrument can synchronize to an external reference signal with a very precise frequency. Due to the very narrow loop bandwidth, unwanted noise or spurious components on the external reference input signal are strongly attenuated. Furthermore, the loop requires about 30 seconds to reach a locked state. During this locking process, "NO REF" is displayed in the status bar.

WIDE
The larger deviation (+/- 6 ppm) allows the instrument to synchronize to less precise external reference input signals.

Example: `ROSC:TRAN WIDE`

Manual operation: See "Tuning Range" on page 401

[SENSe:]ROSCillator:OUTPut<o> <RefOut>

Determines whether the FSWX provides a reference frequency to other connected devices at the specified "Ref Out" connector.

Suffix:
<o> 1 | 2
Output connector

Parameters:
<RefOut> OFF | O10 | O100 | O1000 | O8000 | EXT1 | EXT2 | EXTernal1 | EXTernal2

Off
No output is provided to either "Ref Out" connector.

Output 10 MHz
Outputs a 10 MHz reference signal to the "Ref Out 1" connector.

Output 100 MHz
Outputs a 100 MHz reference signal to the "Ref Out 1" connector.

EXT1
Outputs the external reference signal provided at the "Ref In 1" connector to the "Ref Out 1" connector.

Output 1 GHz
Outputs a 1 GHz reference signal at the "Ref Out 2" connector.

Output 8 GHz
Outputs an 8 GHz reference signal at the "Ref Out 2" connector.

EXT2
Outputs the external reference signal provided at the "Ref In 2" connector to the "Ref Out 2" connector.

Example: `ROSC:OUTP2 EXT2`
Outputs the external reference signal provided at the "Ref In 2" connector to the "Ref Out 2" connector.

Manual operation: See "Reference Frequency Output 1" on page 402
See "Reference Frequency Output 2" on page 402

[SENSe:]ROSCillator:OSYNc <State>

If enabled, a 100 MHz reference signal is provided to the "SYNC TRIGGER OUTPUT" connector.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `ROSC:OSYN ON`

4.14.13.2 Calibration and checks

The following commands control calibration and checks on the FSWX.

CALibration[:ALL]?.....814
CALibration:DUE:DAYS.....815
CALibration:DUE:SCHedule.....816

CALibration:DUE:SHUTdown 816
CALibration:DUE:TIME 817
CALibration:DUE:WARMup 817
CALibration:PRESelection 817
CALibration:RESult? 818
CALibration:STATe 818
DIAGnostic:SERVice:CALibration:DATE 818
DIAGnostic:SERVice:CALibration:DUE:DATE 818
DIAGnostic:SERVice:CALibration:INTerval 819
DIAGnostic:SERVice:INPut:MC:CFRequency 819
DIAGnostic:SERVice:INPut:MC[:DISTance] 819
DIAGnostic:SERVice:INPut:MC:RANGe 819
DIAGnostic:SERVice:INPut:PULSed:MCFRequency 820
DIAGnostic:SERVice:INPut:PULSed:WBFRequency 820
DIAGnostic:SERVice:INPut:RF:CFRequency 820
DIAGnostic:SERVice:INPut:RF[:SPECtrum] 821
DIAGnostic:SERVice:INPut[:SELect] 821
DIAGnostic:SERVice:STESt:RESult? 821
SOURce<si>:TEMPerature:FRONtend 822

CALibration[:ALL]? [<Mode>]

Initiates a calibration (self-alignment) routine and queries if calibration was successful.

While acquiring correction data, the instrument does not accept any remote control commands.

Note: If you start a self-alignment remotely, then select the "Local" softkey while the alignment is still running, the instrument only returns to the manual operation state after the alignment is completed.

To recognize when the acquisition of correction data is completed, the MAV bit in the status byte can be used. If the associated bit is set in the Service Request Enable (SRE) register, the instrument generates a service request after the acquisition of correction data has been completed.

Return values:

<CalibrationFailed> ON | OFF | 0 | 1

OFF | 0
Calibration was successful.

ON | 1
Calibration was not successful.

Example:

```
*CLS
```
Resets the status management.
```
*SRE 16
```
Enables MAV bit in the Service Request Enable register.
```
*CAL?
```
Starts the correction data recording, and then a service request is generated.

Example: CAL:ALL ACLEAR
Deletes any existing self-alignment results and performs an extended self-alignment as performed in the factory.

Usage: Query only

Manual operation: See "Start Self Alignment" on page 422
See "Start Extended Self-Alignment" on page 423

CALibration:DUE:DAYS <Day1>[, <Day2>, <Day3>, <Day4>, <Day5>, <Day6>, <Day7>]

Defines the days on which a self-alignment is scheduled for CALibration:DUE:SCHedule ON. Up to 7 different days can be scheduled.

Parameters:

<Day1> ALL | MONDay | TUESday | WEDNesday | THURsday | FRIDay | SATurday | SUNDay

<Day2> ALL | MONDay | TUESday | WEDNesday | THURsday | FRIDay | SATurday | SUNDay

<Day3> ALL | MONDay | TUESday | WEDNesday | THURsday | FRIDay | SATurday | SUNDay

<Day4> ALL | MONDay | TUESday | WEDNesday | THURsday | FRIDay | SATurday | SUNDay

<Day5> ALL | MONDay | TUESday | WEDNesday | THURsday | FRIDay | SATurday | SUNDay

<Day6> ALL | MONDay | TUESday | WEDNesday | THURsday | FRIDay | SATurday | SUNDay

<Day7> ALL | MONDay | TUESday | WEDNesday | THURsday | FRIDay | SATurday | SUNDay

Example: //Schedule a self-alignment every Monday and Friday
```
CAL:DUE:DAYS MOND,FRID
```

Example: //Schedule a self-alignment every Sunday at 2 AM after a warmup period, then shut down instrument.
```
CAL:DUE:WARM
CAL:DUE:SCH ON
CAL:DUE:DAYS SUND
CAL:DUE:TIME '2:00'
CAL:DUE:SHUT
```

Manual operation: See "Schedule Execution" on page 422

CALibration:DUE:SCHedule <State>

If enabled, a self-alignment is performed regularly at specific days and time. Specify the date and time using the `CALibration:DUE:DAYS` and `CALibration:DUE:TIME` commands.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: //Schedule a self-alignment every Sunday at 2 AM after a warmup period, then shut down instrument.

```
CAL:DUE:WARM
CAL:DUE:SCH ON
CAL:DUE:DAYS SUND
CAL:DUE:TIME '2:00'
CAL:DUE:SHUT
```

Manual operation: See "Schedule Execution" on page 422

CALibration:DUE:SHUTdown <State>

If activated, the FSWX is automatically shut down after self-alignment is completed. Note that the instrument cannot be restarted via remote control.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: //Schedule a self-alignment every Sunday at 2 AM after a warmup period, then shut down instrument.

```
CAL:DUE:WARM
CAL:DUE:SCH ON
CAL:DUE:DAYS SUND
CAL:DUE:TIME '2:00'
CAL:DUE:SHUT
```

Manual operation: See "Shut down Instrument after Self-Alignment" on page 422

CALibration:DUE:TIME <Time>

Defines the time at which a self-alignment is scheduled for the days specified by `CALibration:DUE:DAYS`, if `CALibration:DUE:SCHedule ON`.

Parameters:

<Time> string with format 'hh:mm' (24 hours)

Example: //Schedule a self-alignment every Sunday at 2 AM after a warmup period, then shut down instrument.

```
CAL:DUE:WARM
CAL:DUE:SCH ON
CAL:DUE:DAYS SUND
CAL:DUE:TIME '2:00'
CAL:DUE:SHUT
```

Manual operation: See "Schedule Execution" on page 422

CALibration:DUE:WARMup <State>

If enabled, self-alignment is started automatically after the warm-up operation has completed.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off.

ON | 1
Switches the function on.

*RST: 0

Example: //Schedule a self-alignment every Sunday at 2 AM after a warmup period, then shut down instrument.

```
CAL:DUE:WARM
CAL:DUE:SCH ON
CAL:DUE:DAYS SUND
CAL:DUE:TIME '2:00'
CAL:DUE:SHUT
```

Manual operation: See "Await Warm-Up before Self-Alignment" on page 422

CALibration:PRESelection

Due to changes in temperature, the YIG-preselector frequency can become slightly offset. This command re-aligns the preselector quickly, without requiring a full self-alignment of the FSWX.

Prerequisite: YIG-preselector is available.

Example:

```
CAL:PRES?
```

Result:

```
0
```

CALibration:RESult?

Returns the results collected during calibration.

Return values:
<CalibrationData> String containing the calibration data.

Example:
```
CAL:RES?
```
would return, e.g.
```
Total Calibration Status:
PASSED, Date (dd/mm/yyyy): 12/07/2004,
Time: 16:24:54,Runtime: 00.06
```

Usage: Query only

Manual operation: See "Alignment Results" on page 423

CALibration:STATe <State>

Defines whether the calibration data is used for the measurement or ignored. This command is identical to `CAL:ALL ON|OFF`.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
The calibration data is ignored for the measurement.

ON | 1
The calibration data is used for the measurement.

*RST: 1

DIAGnostic:SERVice:CALibration:DATE <Date>

Defines the last date and time that the instrument was calibrated in ISO 8601 format.

Parameters:
<Date>

Example:
```
//Set calibration date
DIAG:SERV:CAL:DATE "2019-05-05T00:00:00Z"
```

Manual operation: See "Last Calibration Date" on page 455

DIAGnostic:SERVice:CALibration:DUE:DATE <Date>

Defines next date and time the instrument needs calibration to be done in ISO 8601 format. The response can be empty if no fixed due date for calibration exists.

Parameters:
<Date>

Example:
```
//Set calibration due date
DIAG:SERV:CAL:DUE:DATE "2020-05-12T00:00:00Z"
```

Manual operation: See "Next Calibration Due" on page 456

DIAGnostic:SERVice:CALibration:INTerval <Interval>

This command queries the recommended calibration interval (ISO 8601 duration).

Parameters:
<Interval>

Example:
```
//Query calibration interval
DIAG:SERV:CAL:INT?
//would return, for example (one year interval)
P1Y
```

Manual operation: See "Recommended Calibration Interval" on page 456

DIAGnostic:SERVice:INPut:MC:CFRequency <Frequency>

Defines the frequency of the calibration signal for FSWX models 43 GHz and higher.

Only takes effect if a microwave calibration signal is selected for input (`DIAGnostic:SERVice:INPut[:SELect]` on page 821)

Parameters:
<Frequency>
*RST: 8.004 GHz
Default unit: Hz

Example:
```
DIAG:SERV:INP:MC:CFR 8ghz
```

DIAGnostic:SERVice:INPut:MC[:DISTance] <Bandwidth>

Prerequisite: instrument models FSWX13/26.

Selects the distance of the peaks of the microwave calibration signal for calibration of the YIG filter.

Parameters:
<Bandwidth>
WIDE | SMALI

SMALI
Small offset of combline frequencies.

WIDE
Wide offset of combline frequencies.

Example:
```
DIAG:SERV:INP:MC:DIST WIDE
```

DIAGnostic:SERVice:INPut:MC:RANGe <Range>

For FSWX models using a microwave calibration signal (`DIAG:SERV:INP MCAL`). Defines the spectrum of the calibration as 43.5 GHz, or a wideband signal that covers the complete 85 GHz bandwidth. You can define the frequency of the microwave calibration signal using `DIAGnostic:SERVice:INPut:MC:CFRequency`.

Parameters:

<Range> 43.5 GHz | 85 GHz

Default unit: Hz

Example:

```
DIAG:SERV:INP MCAL
DIAG:SERV:INP:MC:RANG 85000000
DIAG:SERV:INP:MC:CFR 7399700
```

DIAGnostic:SERVice:INPut:PULSed:MCFRequency <Frequency>

Sets the calibration frequency for frequencies greater than 7 GHz. This command only takes effect if a microwave calibration signal is selected for input (`DIAGnostic:SERVice:INPut[:SELect]` on page 821).

Parameters:

<Frequency> *RST: 7 GHz

Default unit: Hz

Example:

```
DIAG:SERV:INP:PULS:MCFR 7.1 GHz
```

DIAGnostic:SERVice:INPut:PULSed:WBFRequency <Frequency>

Prerequisite: The bandwidth extension option R&S FSW3-B160 is installed.

Defines the frequency of the internal broadband calibration signal to be used for IF filter calibration.

Before you can use the command, you have to feed in a calibration signal with `DIAGnostic:SERVice:INPut[:SELect]` on page 821.

Parameters:

<Frequency> 2 MHz | 4 MHz | 8 MHz | 16 MHz

If you define a frequency that is not available, the FSWX uses the next available frequency.

*RST: 16 MHz

Default unit: Hz

Example:

```
DIAG:SERV:INP:PULS:WBFR 8 MHz
```

Defines a calibration signal frequency of 8 MHz.

Example:

```
DIAG:SERV:INP:SEL WBC
DIAG:SERV:INP:PULS:WBFR 4MHz
```

DIAGnostic:SERVice:INPut:RF:CFRequency <Frequency>

Defines the frequency of the provided calibration signal.

Parameters:

<Frequency> 100 MHz | 125 MHz | 250 MHz | 500 MHz

Range: 1 Hz to 500 MHz

*RST: 100.0 MHz

Default unit: Hz

Example:
```
DIAG:SERV:INP CAL
DIAG:SERV:INP:RF:CFR 500MHZ
```

Manual operation: See "Calibration Signal Frequency" on page 458

DIAGnostic:SERVice:INPut:RF[:SPECtrum] <Bandwidth>

Selects the bandwidth of the calibration signal.

Parameters:

<Bandwidth> NARRowband | BROadband

NARRowband
Narrowband signal for power calibration of the frontend.

BROadband
Broadband signal for calibration of the IF filter.

Example:
```
DIAG:SERV:INP:RF:SPEC BRO
```

DIAGnostic:SERVice:INPut[:SELect] <Signal>

Activates or deactivates the use of an internal calibration signal as input for the FSWX.

Parameters:

<Signal>

CALibration
Uses the calibration signal as RF input.

MCALibration
Uses the calibration signal for the microwave range as RF input.

RF
Uses the signal from the RF input.

*RST: RF

Example:
```
DIAG:SERV:INP CAL
```
Uses the calibration signal as RF input.

Manual operation: See "Calibration Signal" on page 457

DIAGnostic:SERVice:STESt:RESult?

Queries the self-test results.

Return values:

<Results> String of data containing the results.
The rows of the self-test result table are separated by commas.

Example:
```
DIAG:SERV:STES:RES?
```
would return, e.g.
```
"Total Selftest Status:
PASSED", "Date (dd/mm/yyyy): 09/07/2004 TIME:
16:24:54", "Runtime: 00:06", "...
```

Usage: Query only

SOURce<si>:TEMPerature:FRONtend

Queries the current frontend temperature of the FSWX.

During self-alignment, the instrument's (frontend) temperature is also measured (as soon as the instrument has warmed up completely). This temperature is used as a reference for a continuous temperature check during operation. If the current temperature deviates from the stored self-alignment temperature by a certain degree, a warning is displayed in the status bar. The warning indicates the resulting deviation in the measured power levels. A status bit in the `STATUs:QUEStionable:TEMPerature` register indicates a possible deviation.

Suffix:
<si> irrelevant

Return values:
<Temperature> Temperature in degrees Celsius.

Example: `SOUR:TEMP:FRON?`
Queries the temperature of the frontend sensor.

4.14.13.3 Working with transducers

The following commands configure and control transducer factors.

Useful commands for transducer management described elsewhere

- `MMEMory:SELect[:ITEM]:TRANsducer:ALL` on page 786

Remote commands exclusive to transducer management

[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe] 822
[SENSe:]CORRection:TRANsducer:CATalog? 823
[SENSe:]CORRection:TRANsducer:COMMent 823
[SENSe:]CORRection:TRANsducer:DATA 824
[SENSe:]CORRection:TRANsducer:DELete 824
[SENSe:]CORRection:TRANsducer:SCALing 824
[SENSe:]CORRection:TRANsducer:SELect 824
[SENSe:]CORRection:TRANsducer[:STATe] 825
[SENSe:]CORRection:TRANsducer:UNIT 825
MMEMory:LOAD<n>:TFACtor 826
MMEMory:STORe<n>:TFACtor 826

[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe] <State>

Enables or disables an automatic adjustment of the reference level to the transducer.

Before you can use the command, you have to select and turn on a transducer.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: SENS:CORR:TRAN:ADJ:RLEV:STAT ON

Manual operation: See "Adjustments: Reference Level" on page 405

[SENSe:]CORRection:TRANsducer:CATalog?

Queries all transducer factors stored on the FSWX.

After general data for the transducer storage directory, data for the individual files is listed.

The result is a comma-separated list of values with the following syntax:

<UsedMem>,<FreeMem>,<FileSize>,<FileName>[,<FileSize>,<FileName>]

For details see Section 4.1.6, "Methods of correcting the trace", on page 163.

Return values:

<UsedDiskSpace> numeric value in bytes
Amount of storage space required by all transducers files in the home/instrument/.local/share/rohde-schwarz/esmain/fswx/trd directory (= sum of all individual <FileSize> values)

<FreeDiskSpace> numeric value in bytes
Amount of free storage space on the FSWX

<FileSize> numeric value in bytes
Size of a single transducer file

<FileName> string
Name of a single transducer file

Example:
```
SENSE:CORR:TRAN:CAT?
//Result: 2743,2312620544,720,'FactorGSM.TDF',2023,'FactorBTS.TDF'
```

Usage: Query only

[SENSe:]CORRection:TRANsducer:COMMent <Comment>

Defines the comment for the selected transducer factor.

Before you can use the command, you have to select and turn on a transducer.

Parameters:

<Comment> *RST: (empty comment)

Example: SENS:CORR:TRAN:COMM 'Cable1'

Manual operation: See "Comment" on page 404
See "Comment" on page 406

[SENSe:]CORRection:TRANsducer:DATA {<Frequency>, <Level>}...

Configures transducer factors for specific trace points. A set of transducer factors defines an interpolated transducer line and can be stored on the instrument. You can define up to 1001 points.

For details see Section 4.1.6, "Methods of correcting the trace", on page 163.

Parameters:

<Frequency> Sort the frequencies in ascending order. The unit is optional.
Default unit: Hz

<Level> The unit for <Level> depends on `[SENSe:]CORRection:TRANsducer:UNIT`.

Example:
```
SENSe1:CORRection:TRANsducer:UNIT 'DB'
// Frequency Span 0 Hz to 4 Ghz
SENSe1:CORRection:TRANsducer:DATA 0,8,2GHz,5,4GHz,3
```

Manual operation: See "Transducer Factors (Position/Value)" on page 406

Table 4-70: Created transducer points in example

Frequency	Level
0 Hz	8 dB
2 GHz	5 dB
4 GHz	3 dB

[SENSe:]CORRection:TRANsducer:DELete

Deletes the currently selected transducer factor.

Before you can use the command, you have to select a transducer.

Example:
```
CORR:TRAN:DEL
```

Manual operation: See "Delete" on page 404

[SENSe:]CORRection:TRANsducer:SCALing <ScalingType>

Selects the frequency scaling of the transducer factor.

Parameters:

<ScalingType> LINear | LOGarithmic
*RST: LINear

Example:
```
SENS:CORR:TRAN:SCAL LOG
```

Manual operation: See "X-Axis scaling" on page 406

[SENSe:]CORRection:TRANsducer:SELect <Name>

Selects a transducer factor.

Parameters:

<Name> String containing the name of the transducer factor.
If the name does not exist yet, the FSWX creates a transducer factor by that name.

Example: `CORR:TRAN:SEL 'FACTOR1'`

Manual operation: See "State" on page 404
See "New Transducer" on page 404
See "Name" on page 406

[SENSe:]CORRection:TRANsducer[:STATe] <State>

Enables or disables the selected transducer factor.

Before you can use the command, you have to select a transducer.

Parameters:

<State> ON | OFF | 1 | 0
*RST: 0

Example: `SENS:CORR:TRAN:STAT OFF`

Manual operation: See "State" on page 404

[SENSe:]CORRection:TRANsducer:UNIT <Unit>

Selects the unit of the transducer factor.

Before you can use the command, you have to select and turn on a transducer.

Parameters:

<Unit> string as defined in table below
*RST: DB

Example: `CORR:TRAN:UNIT 'DBUV'`

Manual operation: See "Y-axis Unit" on page 406

String	Unit
'DB'	dB
'DBM'	dBm
'DBMV'	dBmV
'DBUV'	dBµV
'DBUV/M'	dBµV/m (Requires R&S FSW3-K54 (EMI measurements) option.)
'DBUA'	dBµA
'DBUA/M'	dBµA/m (Requires R&S FSW3-K54 (EMI measurements) option.)

String	Unit
'DBPW'	dBpW
'DBPT'	dBpT

MMEMory:LOAD<n>:TFACtor <FileName>

Loads the transducer factor from the selected file in `.CSV` format.

Suffix:
<n> Window 1 to 16

Parameters:
<FileName> String containing the path and name of the `CSV` import file.

Example: `MMEM:LOAD:TFAC 'C:/TEST.CSV'`

Manual operation: See "Import" on page 407

MMEMory:STORe<n>:TFACtor <FileName>, <TransdName>

Exports transducer factor data to an ASCII (CSV) file.

For details on the file format see Section 4.1.6.2, "Reference: transducer factor file format", on page 164.

Suffix:
<n> Window 1 to 16

Parameters:
<FileName> Name of the transducer factor to be exported.

<TransdName> Name of the transducer factor to be exported.

Example: `MMEM:STOR:TFAC 'C:/TEST', 'Transducer1'`
Stores the transducer factor named "Transducer1" in the file `TEST.CSV`.

Manual operation: See "Export" on page 407

4.14.13.4 Compensating for frequency response using touchstone files

If the User Defined Frequency Correction by SnP File (R&S FSW3-KR110) is installed, the FSWX supports the use of Touchstone (`.SnP`) files, as well as additional frequency response correction files in `.fres` format.

For details, see Section 4.1.6.3, "Input-specific frequency response correction", on page 165.

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- Programming example: using touchstone files 844

Remote commands for frequency response correction

The following commands require the User Defined Frequency Correction by SnP File (R&S FSW3-KR110) option.

Input-specific frequency correction

Frequency response correction can be configured for all inputs, or for particular input types only. Be sure to use the correct command for the required setting.

- `[SENSe:]CORRection:FRESponse<si>:INPut<ip>:USER:` commands are applied to RF input only. The suffix <si> defines the RF input source.
- `[SENSe:]CORRection:FRESponse<si>:FILE:USER:` commands are applied to file input only.
- `[SENSe:]CORRection:FRESponse<si>:USER:` commands are applied to all input types; queries refer to the currently active input source.

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:ADJust:RLEVel:STATe 829
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:ADJust:RLEVel:STATe 829
[SENSe:]CORRection:FRESponse<ip>:USER:ADJust:RLEVel:STATe 829
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:CATalog? 829
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:CATalog? 829
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:CATalog? 829
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:CLEar 830
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:CLEar 830
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:CLEar 830
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:FREQuency? 830
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:MAGNitude? 830
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:PHASe? 830
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:INSert 830
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:INSert 830
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:INSert 830
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:MAGNitude[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:MAGNitude[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:MAGNitude[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:PHASe[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:PHASe[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:PHASe[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:REMove 832
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:REMove 832
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:REMove 832
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:SELect 832
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:SELect 832
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SELect 832
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:SIZE? 833
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:SIZE? 833
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SIZE? 833
[SENSe:]CORRection:FRESponse<ip>:USER:FSTate 833
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:FREQuency? 834
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:MAGNitude? 834

[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:PHASe? 834
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:LOAD 834
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:LOAD 834
[SENSe:]CORRection:FRESponse<ip>:USER:LOAD 834
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:PRESet 834
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:PRESet 834
[SENSe:]CORRection:FRESponse<ip>:USER:PRESet 834
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:REFResh 834
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:REFResh 834
[SENSe:]CORRection:FRESponse<ip>:USER:SCOPe 835
[SENSe:]CORRection:FRESponse<ip>:USER:SCOVered? 835
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:CATalog? 836
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:CATalog? 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:CATalog? 836
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:CLEar 836
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:CLEar 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:CLEar 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:FREQuency<spi>? 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:MAGNitude<spi>? 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:PHASe<spi>? 836
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:INSert 837
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:INSert 837
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:INSert 837
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:MOVE 838
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:MOVE 838
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:MOVE 838
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:PORTs:FROM 838
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:PORTs:FROM 838
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:PORTs:FROM 838
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:PORTs:TO 839
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:PORTs:TO 839
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:PORTs:TO 839
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:REMove 839
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:REMove 839
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:REMove 839
[SENSe:]CORRection:FRESponse<ip>:USER:PSTate 840
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:SELect 840
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:SELect 840
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SELect 840
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:SIZE? 841
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:SIZE? 841
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE? 841
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:STATe 841
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:STATe 841
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:STATe 841
[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:FREQuency? 842
[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:MAGNitude? 842
[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:PHASe? 842
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:STATe 842
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:STATe 842

[SENSe:]CORRection:FRESponse<ip>:USER:STATe....842
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:STORe....843
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:STORe....843
[SENSe:]CORRection:FRESponse<ip>:USER:STORe....843
[SENSe:]CORRection:FRESponse<ip>:USER:VALid?....843

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:ADJust:RLEVel:STATe <State>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:ADJust:RLEVel:STATe <State>
[SENSe:]CORRection:FRESponse<ip>:USER:ADJust:RLEVel:STATe <State>

Enables or disables the automatic adjustment of the reference level to the active filter calculation configuration. The offset is the mean of the filter calculation.

For details and restrictions, see Section 4.1.6.3, "Input-specific frequency response correction", on page 165.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `SENS:CORR:FRES:USER:ADJ:RLEV:STAT OFF`

Manual operation: See "Reference Level Adjustment" on page 413

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:CATalog?
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:CATalog?
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:CATalog?

Returns a list of currently available `.fres` files in the var/lib/rohde-schwarz/esmain/fswx/user/fresponse directory.

Suffix:
<ip> Input

<fli> File list index

Return values:
<List>

Example: `SENS:CORR:FRES:USER:FLIS:CAT?`

Usage: Query only

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:CLEar
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:CLEar
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:CLEar

Removes **all** frequency response (`.fres`) files in the current configuration for the selected or all input types.

Suffix:
<ip> Input

<fli> File list index

Example: `SENS:CORR:FRES:USER:FLIS:CLE`

Usage: Event

Manual operation: See "Remove file" on page 416

[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:FREQuency?
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:MAGNitude?
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:PHASe?

Queries the trace values for the selected `.fres` file.

Suffix:
<ip> Input

<fli> 1..n
Index in frequency response file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SIZE?` to determine the maximum index number.

Example: `SENS:CORR:FRES:USER:FLIS2:DATA:PHAS?`

Usage: Query only

Manual operation: See "Selected File" on page 416

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:INSert <FilePath>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:INSert <FilePath>
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:INSert <FilePath>

Loads a frequency response (`.fres`) file to the current configuration. The maximum number of files per configuration is 15. The new file is added below the entry specified by the `<fli>` index. All other entries with a higher suffix are moved down by one position.

Suffix:
<ip> Input

<fli> 1..n
Index in frequency response file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SIZE?` to determine the maximum index number.

Parameters:

<FilePath> string

Path and filename
The default directory for `.fres` files is `var/lib/rohde-schwarz/esmain/fswx/user/fresponse`.

Example: `SENS:CORR:FRES:USER:FLIS2:INS 'C:/FRes.fres'`

Manual operation: See "Add File" on page 415

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:MAGNitude[:STATe] <State>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:MAGNitude[:STATe] <State>
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:MAGNitude[:STATe] <State>

Activates or deactivates the use of the correction data in the selected file for magnitude results.

Suffix:

<ip> Input

<fli> 1..n
Index in frequency response file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SIZE?` to determine the maximum index number.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Applies the data for magnitude results.

ON | 1
Does not apply the data for magnitude results.

*RST: 1

Example: `SENS:CORR:FRES:USER:FLIS2:MAGN:STAT ON`

Manual operation: See "Magnitude" on page 415

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:PHASe[:STATe] <State>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:PHASe[:STATe] <State>
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:PHASe[:STATe] <State>

Activates or deactivates the use of the correction data in the selected file for magnitude results.

Suffix:

<ip> Input

<fli> 1..n
Index in frequency response file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SIZE?` to determine the maximum index number.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Applies the data for magnitude results.

ON | 1
Does not apply the data for magnitude results.

*RST: 1

Example: `SENS:CORR:FRES:USER:FLIS2:PHAS:STAT ON`

Manual operation: See "Phase" on page 415

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:REMove
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:REMove
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:REMove

Removes the selected frequency response (`.fres`) file from the current configuration.

Suffix:
<ip> Input

<fli> 1..n
Index in frequency response file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SIZE?` to determine the maximum index number.

Example: `SENS:CORR:FRES:USER:FLIS2:REM`

Usage: Event

Manual operation: See "Remove file" on page 416

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:SELect <FilePath>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:SELect <FilePath>
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SELect <FilePath>

Loads an additional frequency response (`.fres`) file to the current configuration.

Suffix:
<ip> Input

<fli> 1..n
Index in frequency response file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SIZE?` to determine the maximum index number.

Parameters:

<FilePath> string

Path and filename
The default directory for `.fres` files is `var/lib/rohde-schwarz/esmain/fswx/user/fresponse`.

Example: `SENS:CORR:FRES:USER:FLIS2:SEL 'C:/FRes.fres'`

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:SIZE?
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:SIZE?
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SIZE?

Queries the number of entries in the list of `.fres` files for the current configuration.

Suffix:

<ip> Input

<fli> 1..n
irrelevant

Return values:

<Size> integer

Range: 1 to 15
*RST: 1

Example: `SENS:CORR:FRES:BASE:USER:FLIS:SIZE?`

Usage: Query only

[SENSe:]CORRection:FRESponse<ip>:USER:FSTate <State>

Activates or deactivates the use of additional frequency response (`.fres`) files. The correction data is these files is applied after any correction settings in active touchstone files.

For details, see Section 4.1.6.3, "Input-specific frequency response correction", on page 165.

Suffix:

<ip> Input

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Activates the files.

ON | 1
Deactivates the files.

*RST: 1

Example: `SENS:CORR:FRES:USER:FST ON`

[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:FREQuency?
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:MAGNitude?
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:PHASe?

Queries the trace values for the combined user correction files (`.snp+.fres`) in I/Q mode.

Suffix:
<ip> Input

Example: `SENS:CORR:FRES:USER:IQ:DATA:PHAS?`

Usage: Query only

Manual operation: See "I/Q Mode" on page 417

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:LOAD <FilePath>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:LOAD <FilePath>
[SENSe:]CORRection:FRESponse<ip>:USER:LOAD <FilePath>

Loads a stored user-defined frequency response correction scenario.

Suffix:
<ip> Input

Setting parameters:
<FilePath> string

Example: `SENS:CORR:FRES:USER:LOAD 'FRes1'`

Usage: Setting only

Manual operation: See "Load settings" on page 418

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:PRESet
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:PRESet
[SENSe:]CORRection:FRESponse<ip>:USER:PRESet

Restores the default frequency response correction settings (containing only files specific to the FSWX itself). Frequency response correction using `.fres` files is deactivated.

Suffix:
<ip> Input

Example: `SENS:CORR:FRES:USER:PRES`

Usage: Event

Manual operation: See "Clear settings" on page 418

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:REFResh
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:REFResh

Recalculates the input source correction filter.

Suffix:
<ip> Input

Example: `SENSe:CORRection:FRESponse:Input1:USER:REFResh`

Usage: Event

Manual operation: See "Reload Files" on page 418

[SENSe:]CORRection:FRESponse<ip>:USER:SCOPe <Frames>

Determines whether the frequency response correction settings are applied to all active application instances, or only the currently selected application instance.

Suffix:
<ip> Input

Parameters:
<Frames> CHANnel | ALL

CHANnel
The frequency response correction settings are applied to the currently selected application instance only.
To select an application instance, use `INSTrument[:SELect]`.
For a list of available application instances, use `INSTrument:LIST`.

ALL
The frequency response correction settings are applied to all active application instances.

Example:
```
INST:SEL 'MyIQSpectrum'

SENS:CORR:FRES:USER:SCOP CHAN
```
The filter is applied only to the application instance named 'MyIQSpectrum'.

Manual operation: See "Apply to" on page 413

[SENSe:]CORRection:FRESponse<ip>:USER:SCOVered?

Indicates whether the frequency correction file covers the full measurement span.

Suffix:
<ip> Input

Return values:
<Covered> 0 | 1

0
Span not fully covered

1
Full measurement span is covered

Example: `SENSe1:CORRection:FRESponse:USER:SCOVered?`

Usage: Query only

Manual operation: See "Preview" on page 416

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:CATalog?
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:CATalog?
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:CATalog?

Returns a list of currently configured touchstone format files.

Tip: to determine the currently *selected* file, use the `[SENSe:]CORRection:FRESponse<si>:xxx:SLISt<sli>:SELect?` query.

Suffix:
<ip> 1..n
irrelevant

<sli> Touchstone file 1 to 15

Return values:
<List> path and file name of all currently configured touchstone format files.

Example:
```
SENS:CORR:FRES:USER:SLIS:CAT?
home/instrument/.local/share/rohde-schwarz/esmain/fswx/use
MyS7p.s7p,home/instrument/.local/share/rohde-schwarz/esmai
MyS2p.s2p
```

Usage: Query only

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:CLEar
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:CLEar
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:CLEar

Removes **all** touchstone files from the current configuration for the selected or all input types.

Suffix:
<ip> Input

<sli> Touchstone file 1 to 15

Example:
```
SENS:CORR:FRES:USER:SLIS:CLE
```

Usage: Event

Manual operation: See "Remove file" on page 415

[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:FREQuency<spi>?
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:MAGNitude<spi>?
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:PHASe<spi>?

Queries the trace values for the specified `.snp` file and ports.

Suffix:

<ip> Input

<sli> 1..n
Index in Touchstone file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE?` to determine the maximum index number.

<spi> 1..4
S-port pair index, where:
1 = From port - from port
2 = To port - from port
3 = From port - to port
4 = To port - to port

Example:

```
SENS:CORR:FRES:USER:SLIS2:SEL 'FRes21.s2p'
SENS:CORR:FRES:USER:SLIS2:PORT:TO 2
SENS:CORR:FRES:USER:SLIS2:PORT:FROM 1
SENS:CORR:FRES:USER:SLIS2:DATA:PHAS3?
```

The correction data from port 1 to port 2 is returned.

Usage: Query only

Manual operation: See "Selected File" on page 416

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:INSert <FilePath>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:INSert <FilePath>
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:INSert <FilePath>

Loads a new Touchstone file for the current configuration. The default directory for Touchstone files is `var/lib/rohde-schwarz/esmain/fswx/user/fresponse`.

The maximum number of files per configuration is 15. The new file is added below the entry specified by the `<sli>` index. All other entries with a higher suffix are moved down by one position.

To change the order of the files, use the `[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:MOVE` command.

To determine which files are available, use `[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:CATalog?` on page 836.

Suffix:

<ip> Input

<sli> 1..n
Index in Touchstone file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE?` to determine the maximum index number.

Parameters:

<FilePath> string

Path and filename
The file extension of the Touchstone file must correspond to the number of ports included in the file. For example, a file containing 4 parameters for S11, S22, S12 and S21 must have the extension `.s2p`.

Manual operation: See "Add File" on page 414

Example:

```
SENS:CORR:FRES:USER:SLIS:INS
'var/lib/rohde-schwarz/esmain/fswx/user/fresponse/Fres.s2p'
```

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:MOVE <Direction>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:MOVE <Direction>
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:MOVE <Direction>

Moves the selected Touchstone file one position up or down in the list of files, changing the order in which the correction data is applied.

Suffix:

<ip> Input

<sli> 1..n
Index in Touchstone file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE?` to determine the maximum index number.
If an index outside the available range is specified, an error occurs.

Setting parameters:

<Direction> UP | DOWN

Example: `SENS:CORR:FRES:USER:SLIS:MOVE UP`

Usage: Setting only

Manual operation: See "Move file up or down" on page 415

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:PORTs:FROM
<PortFrom>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:PORTs:FROM
<PortFrom>
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:PORTs:FROM
<PortFrom>

SnP files can be defined for a varying number of input and output ports.

Define the ports from the touchstone file whose data is to be applied.

Suffix:

<ip> Input

<sli> 1..n
Index in Touchstone file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE?` to determine the maximum index number.

Parameters:
<PortFrom> *RST: 1

Example:
```
SENS:CORR:FRES:USER:SLIS:SEL 'FRes21.s2p'
SENS:CORR:FRES:USER:SLIS:PORT:TO 2
SENS:CORR:FRES:USER:SLIS:PORT:FROM 1
```
The correction data from port 1 to port 2 is included in the filter.

Manual operation: See "To - From" on page 414

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:PORTs:TO <PortTo>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:PORTs:TO <PortTo>
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:PORTs:TO <PortTo>

SnP files can be defined for a varying number of input and output ports.

You must define the ports from the touchstone file whose data is to be applied.

Suffix:
<ip> Input

<sli> 1..n
Index in Touchstone file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE?` to determine the maximum index number.

Parameters:
<PortTo> *RST: 1

Example:
```
SENS:CORR:FRES:USER:SLIS:SEL 'FRes21.s2p'
SENS:CORR:FRES:USER:SLIS:PORT:TO 2
SENS:CORR:FRES:USER:SLIS:PORT:FROM 1
```
The correction data from port 1 to port 2 is included in the filter.

Manual operation: See "To - From" on page 414

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:REMove
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:REMove
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:REMove

Removes the specified touchstone file from the list.

Suffix:
<ip> Input

<sli> 1..n
Index in Touchstone file list
Use [SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE? to determine the maximum index number.

Example: SENS:CORR:FRES:USER:SLIS2:REM

Usage: Event

Manual operation: See "Remove file" on page 415

[SENSe:]CORRection:FRESponse<ip>:USER:PSTate <State>

Prerequisite: remote operation

Activates or deactivates the preview of the user correction files for all input types.

The preview cannot be switched back on in manual operation.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 1

Example: SENS:CORR:FRES:USER:PST ON

Manual operation: See "Preview" on page 416

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:SELect <FilePath>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:SELect <FilePath>
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SELect <FilePath>

Selects a Touchstone format file from the specified directory to be loaded to the current configuration for the specified input type. If no input type is specified, the currently active input source is assumed.

The query returns the currently selected file.

To determine which files are available, use [SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:CATalog? on page 836.

Suffix:
<ip> Input

<sli> 1..n
Index in Touchstone file list
Use [SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE? to determine the maximum index number.
To replace an existing file in the configuration, specify its index.
To add a new file, use the next available index.
If an index outside the available range is specified, an error occurs.

Parameters:
<FilePath> string
Path and filename of the selected file.
The default directory for Touchstone files is var/lib/rohde-schwarz/esmain/fswx/user/fresponse.

Example: SENS:CORR:FRES:USER:SLIS:SEL 'C:/FRes21.s2p'

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:SIZE?
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:SIZE?
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE?

Queries the number of entries in the list of touchstone files for the current configuration.

Suffix:
<ip> Input
<sli> Touchstone file 1 to 15

Return values:
<Size> integer
Range: 1 to 15
*RST: 1

Example: SENS:CORR:FRES:USER:SLIS:SIZE?

Usage: Query only

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:STATe <State>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:STATe <State>
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:STATe <State>

Activates or deactivates the loaded file for the current configuration. Only active files are included in filter calculation.

For queries with no input type specified, the currently active input type is queried.

Suffix:
<ip> Input

<sli> 1..n
Index in Touchstone file list
Use `[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE?` to determine the maximum index number.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Activates the file.

ON | 1
Deactivates the file.

*RST: 1

Example: `SENS:CORR:FRES:USER:SLIS2:STAT ON`

[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:FREQuency?
[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:MAGNitude?
[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:PHASe?

Queries the trace values for the combined user correction files (`.snp+.fres`) in Spectrum mode.

Suffix:
<ip> Input

Example: `SENS:CORR:FRES:USER:SPEC:DATA:PHAS?`

Usage: Query only

Manual operation: See "Spectrum Mode" on page 418

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:STATe <State>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:STATe <State>
[SENSe:]CORRection:FRESponse<ip>:USER:STATe <State>

Activates or deactivates the general usage of user-defined frequency response correction settings.

Only if activated, the filter is calculated and applied to the results.

For details, see Section 4.1.6.3, "Input-specific frequency response correction", on page 165.

TPIS correction is not supported if user frequency response correction is active. If you activate frequency response correction, TPIS correction is automatically deactivated in all channels.

For details see the FSWX User Manual.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `SENS:CORR:FRES:USER:STAT`

Manual operation: See "Apply Correction" on page 413
See "Active" on page 414

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:STORe <FilePath>
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:STORe <FilePath>
[SENSe:]CORRection:FRESponse<ip>:USER:STORe <FilePath>

Stores a saveset for a user-defined frequency response correction scenario. By default, the saveset is stored in the `var/lib/rohde-schwarz/esmain/fswx/user/fresponse` directory.

Suffix:
<ip> Input

Setting parameters:
<FilePath> string

Example: `SENS:CORR:FRES:USER:STOR 'FRes1'`
Stores the current frequency response correction configuration to a file named `var/lib/rohde-schwarz/esmain/fswx/user/fresponse/FRes1.dfl`.

Usage: Setting only

Manual operation: See "Save settings" on page 419

[SENSe:]CORRection:FRESponse<ip>:USER:VALid?

Queries the validity of the user-defined correction settings.

Suffix:
<ip> Input

Return values:
<Validity> 0 | 1

1
The setting is valid.

0
The setting is not valid.

Example: `SENS:CORR:FRES:USER:VAL?`

Usage: Query only

Manual operation: See "Apply Correction" on page 413

Programming example: using touchstone files

This example demonstrates how to use Touchstone files in a basic "I/Q Capture" measurement setup in a remote environment.

```
----------Configuring the measurement ------------
*RST; *WAI
SYST:DISP:UPD ON
TRACe1:IQ ON
TRACe:IQ:EVAL ON
LAY:REPL:WIND "1",FREQ
INIT:CONT OFF

// Use calibration signal as input data
DIAG:SERV:INP CAL
DIAG:SERV:INP:RF:SPEC BRO
DIAG:SERV:INP:PULS:CFR 1MHz

// Set SR/Bandwidth and CF
TRAC:IQ:SRAT 100 MHz
FREQ:CENT 500MHz

// Activate S2P file
SENSe:CORRection:FRESponse:Input1:USER:PRESet
SENSe:CORRection:FRESponse:Input1:USER:SLISt1:SELect 'c:/BP_40MHz.s2p'
SENSe:CORRection:FRESponse:Input1:USER:STATe ON

INIT:IMM; *WAI
SYST:COMM:INT:REM OFF
```

4.14.13.5 Customizing the screen layout

The remote commands required to set up the display of the FSWX are described here.

- General display settings and items 844
- Colors and themes 848
- CMAP suffix assignment 850

General display settings and items

The following commands add, remove or customize general display and screen elements.

Useful commands for general display settings described elsewhere

- `DISPlay[:WINDow<n>]:MTABle` on page 704
- `DISPlay:FORMat` on page 648

Remote commands exclusive to general display settings

DISPlay:ANNotation:CBAR 845
DISPlay:ANNotation:FREQuency 845
DISPlay:SBAR[:STATe] 845
DISPlay:SKEYs[:STATe] 846
DISPlay:TBAR[:STATe] 846
DISPlay:TOUChscreen[:STATe] 846
DISPlay[:WINDow<n>]:TIME 846
DISPlay[:WINDow<n>]:TIME:FORMat 847
SYSTem:DISPlay:FPANel[:STATe] 847

DISPlay:ANNotation:CBAR <State>

Hides or displays the application info panel.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `DISP:ANN:CBAR OFF`

Manual operation: See "Application Info Panel" on page 428

DISPlay:ANNotation:FREQuency <State>

Enables or disables the label of the x-axis.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: `DISP:ANN:FREQ OFF`

Manual operation: See "Diagram Footer" on page 428

DISPlay:SBAR[:STATe] <State>

Enables or disables the status bar.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: `DISP:SBAR:OFF`

Manual operation: See "Status Bar" on page 428

DISPlay:SKEYs[:STATe] <State>

Enables or disables the softkey bar.

Parameters:

<State> ON | OFF | 0 | 1
*RST: 1

Example: `DISP:SKEY:OFF`

Manual operation: See "Soft Key Bar" on page 428

DISPlay:TBAR[:STATe] <State>

Enables or disables the toolbar.

Parameters:

<State> ON | OFF | 1 | 0
*RST: 0

Example: `DISP:TBAR ON`

Manual operation: See "Toolbar" on page 427

DISPlay:TOUChscreen[:STATe] <State>

Controls the touchscreen functionality.

Parameters:

<State> ON | FRAMe | OFF | TCOFf

ON | 1
Touchscreen is active for the entire screen.

OFF | 0
Touchscreen is inactivated for the entire screen.

FRAMe
Touchscreen is inactivated for the diagram area of the screen, but active for softkeys, toolbars and menus.

*RST: 1

Example: `DISP:TOUC:STAT ON`

Manual operation: See "Enabling and disabling the Touch Screen" on page 431

DISPlay[:WINDow<n>]:TIME <State>

Adds or removes the date and time from the display.

Suffix:

<n> irrelevant

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `DISP:TIME ON`

Manual operation: See "Date and Time" on page 428

DISPlay[:WINDow<n>]:TIME:FORMat <Format>

Selects the time and date format.

Suffix:
<n> Window 1 to 16

Parameters:
<Format> US | DE | ISO

DE
dd.mm.yyyy hh:mm:ss
24-hour format.

US
mm/dd/yyyy hh:mm:ss
12-hour format.

ISO
yyyy-mm-dd hh:mm:ss
24-hour format.

*RST: ISO

Example: `DISP:TIME ON`
Switches the screen display of date and time on.
`DISP:TIME:FORM US`
Switches the date and time format to US.

Manual operation: See "Date and Time Format" on page 426

SYSTem:DISPlay:FPANel[:STATe] <State>

Includes or excludes the front panel keys when working with the remote desktop.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `SYST:DISP:FPAN:STAT OFF`

Manual operation: See "Soft Frontpanel" on page 429

Colors and themes

Useful commands to customize display colors described elsewhere

The HCOPY commands define the print colors and thus only take effect on the display colors, if the display shows the printing colors.

- HCOPy:CMAP<it>:DEFault<ci> on page 793
- HCOPy:CMAP<it>:HSL on page 794
- HCOPy:CMAP<it>:PDEFined on page 794

Remote commands exclusive to customize the display colors and themes

DISPlay:CMAP<it>:DEFault<ci> 848
DISPlay:CMAP<it>:HSL 848
DISPlay:CMAP<it>:PDEFined 849
DISPlay:THEMe:CATalog? 849
DISPlay:THEMe:SELect 849

DISPlay:CMAP<it>:DEFault<ci>

Selects the color scheme for the display. The query returns the default color scheme.

Suffix:

<it> Irrelevant.

<ci> 1
Default color set 1 with a black background and white grid.
2
Default color set 2 with a white background and a black grid.
3
User-defined colors.
Suffix irrelevant for query

Return values:

<DefScheme> 1 | 2 | 3
The default color scheme used for the screen, as specified by the <ci> suffix.

Example:

```
DISP:CMAP:DEF2
```
Selects default setting 2 (white background and a black grid) for screen colors.
```
DISP:CMAP:DEF?
//Result: 2
```

DISPlay:CMAP<it>:HSL <hue>, <sat>, <lum>

Selects the color for various screen elements in the display.

Suffix:
<it> 1..n
Selects the item for which the color scheme is to be defined.
For more information, see "CMAP suffix assignment" on page 850.

Parameters:
<hue> Tint
Range: 0 to 1

<sat> Saturation
Range: 0 to 1

<lum> Brightness
Range: 0 to 1

Example: `DISP:CMAP2:HSL 0.3,0.8,1.0`
Changes the grid color.

DISPlay:CMAP<it>:PDEFined <Color>

Selects a predefined color for various screen elements.

Suffix:
<it> 1..n
Selects the item for which the color scheme is to be defined.
For more information, see "CMAP suffix assignment" on page 850.

Parameters:
<Color> BLACk | BLUE | BROWn | GREen | CYAN | RED | MAGenta | YELLow | WHITe | DGRay | LGRay | LBLue | LGReen | LCYan | LRED | LMAGenta

Example: `DISP:CMAP2:PDEF GRE`

DISPlay:THEMe:CATalog?

Queries all available display themes.

Return values:
<Themes> String containing all available display themes.

Example: `DISP:THEMe:CAT?`

Usage: Query only

Manual operation: See "Theme for Screenshot" on page 387
See "Color Theme" on page 426

DISPlay:THEMe:SELect <Theme>

Selects the display theme.

Parameters:

<Theme> String containing the name of the theme.

*RST: SPL

Example: `DISP:THEM:SEL "BlueOcean"`

Manual operation: See "Color Theme" on page 426

CMAP suffix assignment

Several commands to change the color settings of individual items of the display or printout are available. Which item is to be configured is defined using a <CMAP> suffix. The following assignment applies:

Suffix	Description
CMAP1	Background
CMAP2	Grid
CMAP3 *)	Common Text
CMAP4 *)	Check Status OK
CMAP5 *)	Check Status Error
CMAP6 *)	Text Special 1
CMAP7 *)	Text Special 2
CMAP8	Trace 1
CMAP9	Trace 2
CMAP10	Trace 3
CMAP11	Marker Info Text
CMAP12	Limit Lines
CMAP13	Limit and Margin Check – "Pass"
CMAP14	Limit and Margin Check – "Fail"
CMAP15 *)	Softkey Text
CMAP16 *)	Softkey Background
CMAP17 *)	Selected Field Text
CMAP18 *)	Selected Field Background
CMAP19 *)	Softkey 3D Bright Part
CMAP20 *)	Softkey 3D Dark Part
CMAP21 *)	Softkey State "On"
CMAP22 *)	Softkey State "Dialog open"
CMAP23 *)	Softkey Text Disabled
CMAP24	Logo

Suffix	Description
CMAP25	Trace 4
CMAP26	Grid – Minorlines
CMAP27	Marker
CMAP28	Display Lines
CMAP29 *)	Sweepcount – Text
CMAP30	Limit and Margin Check – Text
CMAP31	Limit and Margin Check – \"Margin\"
CMAP32 *)	Table Overall – Title Text
CMAP33 *)	Table Overall – Title Background
CMAP34 *)	Table Overall – Text
CMAP35 *)	Table Overall – Background
CMAP36 *)	Table Value – Title Text
CMAP37 *)	Table Value – Title Background
CMAP38 *)	Table Value – Text
CMAP39 *)	Table Value – Background
CMAP40	Trace 5
CMAP41	Trace 6

*) these settings can only be defined via the theme (`DISPlay:THEMe:SELect`) and are thus ignored in the SCPI command

4.14.13.6 Configuring the network and remote control

The following commands are required to configure a network or remote control for the FSWX.

Useful commands for configuring remote control described elsewhere:

- `SYSTem:LANGuage` on page 897

Remote commands exclusive to configuring a network and remote control

SYSTem:COMMunicate:GPIB[:SELF]:ADDRess 852
SYSTem:COMMunicate:GPIB[:SELF]:RTERminator 852
SYSTem:COMMunicate:INTernal:REMote 852
SYSTem:DISPlay:LOCK 853
SYSTem:DISPlay:UPDate 853
SYSTem:ERRor:DISPlay 853
SYSTem:IDENtify:FACTory 854
SYSTem:IDENtify[:STRing] 854
SYSTem:KLOCk 854
SYSTem:LXI:LANReset 855

SYSTem:LXI:MDEScription 855
SYSTem:LXI:PASSword 855
SYSTem:REVision:FACTory 855
SYSTem:SHIMmediate 855
SYSTem:SHIMmediate:STATe 856

SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <Address>

Sets the GPIB address of the FSWX.

Parameters:

<Address> Range: 0 to 30
*RST: (no influence on this parameter, factory default 20)

Example: `SYST:COMM:GPIB:ADDR 18`

Manual operation: See "GPIB Address" on page 518

SYSTem:COMMunicate:GPIB[:SELF]:RTERminator <Terminator>

Selects the GPIB receive terminator.

Output of binary data from the instrument to the control computer does not require such a terminator change.

Parameters:

<Terminator> LFEOI | EOI

LFEOI
According to the standard, the terminator in ASCII is <LF> and/or <EOI>.

EOI
For binary data transfers (e.g. trace data) from the control computer to the instrument, the binary data block can contain the binary code used for <LF>. Thus, do not interpret this binary code as a terminator in this particular case. Use only the receive terminator `EOI`.

*RST: LFEOI

Example: `SYST:COMM:GPIB:RTER EOI`

Manual operation: See "GPIB Terminator" on page 518

SYSTem:COMMunicate:INTernal:REMote <GoToRemote>

The instrument switches between manual and remote operation.

Note: If the local lockout function (`LLO` or `SYST:KLOC ON`) are enabled in remote control mode, manual operation is no longer available until `GTL` (or `SYST:KLOC OFF`) is executed.

Parameters:

<GoToRemote> ON | OFF | 0 | 1

OFF | 0
The instrument switches from remote to manual operation. You can operate the instrument locally.

ON | 1
The instrument switches from manual to remote operation.

*RST: 0

Example: `SYST:COMM:INT:REM OFF`
The instrument switches from remote to manual operation (corresponds to @LOC or selecting the "Local" softkey).

Manual operation: See "Local" on page 525

SYSTem:DISPlay:LOCK <State>

Defines whether the "Display Update" function remains available in remote operation or not.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
The function remains available.

ON | 1
The display is not updated during remote operation and cannot be turned on again locally until local operation is resumed. See `SYSTem:COMMunicate:INTernal:REMote` on page 852.

*RST: 0

Manual operation: See "Update Display during Remote Control" on page 518

SYSTem:DISPlay:UPDate <State>

Enables or disables the display update during remote operation.

If on, the FSWX updates the diagrams, traces and display fields only.

The best performance is obtained if the display update is off during remote control operation.

Parameters:
<State> ON | OFF | 1 | 0

*RST: 0

Example: `SYST:DISP:UPD ON`

Manual operation: See "Update Display during Remote Control" on page 518

SYSTem:ERRor:DISPlay <State>

Enables or disables the error display during remote operation.

If activated, the FSWX displays a message box at the bottom of the screen that contains the most recent type of error and the command that caused the error.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `SYST:ERR:DISP ON`

Manual operation: See "Show Remote Errors" on page 519

SYSTem:IDENtify:FACTory

Resets the query to `*IDN?` to its default value.

Example: `SYST:IDEN:FACT`

Usage: Event

Manual operation: See "Reset to Factory String" on page 517

SYSTem:IDENtify[:STRing] <String>

Defines the response to `*IDN?`.

Parameters:
<String> String containing the description of the instrument.

Example:
```
SYST:IDEN:STR
'Rohde&Schwarz,FSWX3026,1348.0000K26/100005,
1.30'
```

Manual operation: See "Remote Device Identification String" on page 517

SYSTem:KLOCk <State>

Locks or unlocks manual operation.

Parameters:
<State>

ON
LLO (local lockout). The instrument can only be operated remotely, not locally.

OFF
Unlocks the manual operation mode. To operate the instrument locally again, you must execute `SYST:COMM:INT:REM OFF` or select the "Local" softkey first.

*RST: state not affected by *RST

Example: `SYST:KLOC ON`
Activates LLO (remote control only)

Example:
```
SYST:KLOC OFF
SYST:COMM:INT:REM OFF
```
You can operate the instrument locally.

SYSTem:LXI:LANReset

Resets the LAN configuration, as well as the LAN password and instrument description.

Example: `SYST:LXI:LANR`

SYSTem:LXI:MDEScription <Description>

Defines the LAN instrument description.

Parameters:
<Description> String containing the instrument description.

Example: `SYST:LXI:MDES 'XYZ'`

SYSTem:LXI:PASSword <Password>

Defines the LAN password.

Parameters:
<Password> String containing the password.

Return values:
<Password>

Example: `SYST:LXI:PASS 'LXISet'`

SYSTem:REVision:FACTory

Resets the response to the `REV?` query to the factory default value.

For example, after a user string was defined using the `SYSTem:REVision:FACTory` on page 855 command. (`REV?` query available for HP emulation only, see `SYSTem:LANGuage` on page 897.)

Example: Define the system language:
`SYST:LANG '8563E'`
Set the response back to factory setting:
`SYS:REV:FACT`
Query the revision:
`REV?`
Response:
`920528`

Usage: Event

Manual operation: See "Reset Revision String to Factory Revision" on page 522

SYSTem:SHIMmediate <HW Update>

Determines when the remote commands that change hardware settings on the FSWX are executed.

Regardless of this setting, the firmware automatically sets the hardware when a sweep is started.

This setting is not changed by the preset function.

Parameters:
<HW Update> ONCE

Example:
```
SYST:SHIM:STAT ON
...
SYST:SHIM ONCE
```

Manual operation: See "Set Hardware Immediately" on page 519

SYSTem:SHIMmediate:STATe <State>

Determines when the remote commands that change hardware settings on the FSWX are executed.

Regardless of this setting, the firmware automatically sets the hardware when a sweep is started.

This setting is not changed by the preset function.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Remote commands that cause changes to the hardware are only executed when the `SYSTem:SHIMmediate` command is executed.

ON | 1
Remote commands are always executed immediately when they are received by the instrument.

*RST: 1

Example:
```
SYST:SHIM:STAT ON
...
SYST:SHIM ONCE
```

Manual operation: See "Set Hardware Immediately" on page 519

4.14.13.7 Checking the system configuration

The following commands are required to check the system configuration on the FSWX.

Useful commands for obtaining system information described elsewhere:

- `DIAGnostic:SERVice:SINFo?` on page 866
- `DIAGnostic:SERVice:CALibration:DATE` on page 818
- `DIAGnostic:SERVice:CALibration:DUE:DATE` on page 818
- `DIAGnostic:SERVice:CALibration:INTerval` on page 819

Remote commands exclusive to obtaining system information:

DIAGnostic:INFO:CCOunt?....857
DIAGnostic:SERVice:DATE....857
DEVice:INFO:HWBand?....858
DIAGnostic:SERVice:BIOSinfo?....858
DIAGnostic:SERVice:HWINfo?....859
DIAGnostic:SERVice:VERSinfo?....859
SYSTem:ERRor:CLEar:ALL....859
SYSTem:DFPRint....860
SYSTem:ERRor:CLEar:REMote....860
SYSTem:ERRor:EXTended....860
SYSTem:ERRor:LIST?....861
SYSTem:ERRor[:NEXT]?....861
SYSTem:FIRMware:UPDate....862
SYSTem:FORMat:IDENt....862
SYSTem:OPTion:LICense[:LIST]?....862
SYSTem:OSYStem?....863

DIAGnostic:INFO:CCOunt? <Relay>[, <Input>]

Queries how many switching cycles the individual relays have performed since they were installed.

Query parameters:

<Relay> See table below for an overview of supported parameters.

<Input> RFA | RFB
RF input connector

Return values:

<Cycles> Number of switching cycles.

Example: `DIAG:INFO:CCO? RF,RFA`

Usage: Query only

Manual operation: See " Relays Cycle Counter" on page 461

SCPI parameter	Hardware component
RF	RF input
ACDC	RF mechanical attenuation coupling

DIAGnostic:SERVice:DATE <Date>

Defines the last date and time the instrument was serviced (ISO 8601 format).

Parameters:

<Date>

Example: //Return last service date
`DIAG:SERV:DATE?`

Manual operation: See "Last Service Date" on page 455

DEVice:INFO:HWBand?

Prerequisite: zero span mode

Queries the frequency bands used for measurement by the FSWX hardware. The start frequency of each band is provided.

The bands are instrument-specific and depend on the currently defined RBW, VBW and YIG preselector state. The precise frequency bands are required to define correction data for the correct bands, in particular for frequency-drifting DUTs.

Return values:
<StartFreq>

Example:
```
//Set to zero span mode
FREQ:SPAN 0
//Set RBW
BAND:RES 1000000
//Set VBW
BAND:VID 10000
//Activate YIG filter
INP:FILT:YIG ON
//Query used hardware bands
DEV:INFO:HWB?
//Result:
//0,50000000,450000000,1000000000,3000000000,4000000000,5200000000,...
```

The used bands for this instrument and measurement setup are:
0 Hz to 49999999 Hz
50000000 Hz to 44999999
450000000 Hz to 999999999
1000000000 Hz to 2999999999
3000000000 Hz to 3999999999
4000000000 Hz to 5199999999
5200000000 Hz to ...

Usage: Query only

DIAGnostic:SERVice:BIOSinfo?

Queries the BIOS version of the CPU board.

Return values:
<BiosInformation> String containing the BIOS version.

Example:
```
DIAG:SERV:BIOS?
```
Returns the BIOS version.

Usage: Query only

DIAGnostic:SERVice:HWINfo?

Queries hardware information.

Return values:

<Hardware> String containing the following information for every hardware component.
<component>: name of the hardware component
<serial#>: serial number of the component
<order#>: order number of the component
<model>: model of the component
<code>: code of the component
<revision>: revision of the component
<subrevision>: subrevision of the component

Example: `DIAG:SERV:HWIN?`
Queries the hardware information.
`"FRONTEND|100001/003|1300.3009|03|01|00|00",`
`"MOTHERBOARD|123456/002|1300.3080|02|00|00|00",`
`...`

Usage: Query only

DIAGnostic:SERVice:VERSinfo?

Queries information about the hardware and software components.

Return values:

<Information> String containing the version of hardware and software components including the types of licenses for installed options.

Example: `DIAG:SERV:VERS?`
Queries the version information.
Response:

```
Instrument Firmware |1.10
BIOS |FSW Analyzer BIOS V1.03-1-32-4-3 IPC10
Image Version |1.2.0
PCI-FPGA |9.01
SA-FPGA |2.43
MB-FPGA |2.0.8.0
SYNTH-FPGA |3.9.0.0
REF-FPGA |3.4.0.0
Data Sheet Version |01.00
Time Control Management |active
Analog Demod K7| |permanent
```

Usage: Query only

SYSTem:ERRor:CLEar:ALL

Deletes all contents of the "System Messages" table.

Example: SYST:ERR:CLE:ALL

Manual operation: See "Clear All Messages" on page 460

SYSTem:DFPRint

Creates an *.xml file with information on installed hardware, software, image and FPGA versions. The *.xml file is stored under var/lib/rohde-schwarz/esmain/fswx/devicedata/xml/DeviceFootprint_* on the instrument. It is also output to the remote interface as binary data.

Return values:
<xxx> Contents of the XML file in binary format.

Example: SYST:DFPR?

Manual operation: See "Device Footprint" on page 455

SYSTem:ERRor:CLEar:REMote

Deletes all contents of the "Remote Errors" table.

Note: The remote error list is automatically cleared when the FSWX is shut down.

Example: SYST:ERR:CLE:REM

Manual operation: See "Clear Error List" on page 523

SYSTem:ERRor:EXTended <MessageType>[, <ChannelName>, <Message>, <Mode>]

This command queries all system messages, or all messages of a defined type, displayed in the status bar for a specific application instance.

Note: This command queries the strings displayed for manual operation. For remote programs, do not define processing steps depending on these results. Instead, query the results of the STATus:QUEStionable:EXTended:INFO status register, which indicates whether messages of a certain type have occurred (see "STATus:QUEStionable:EXTended:INFO register" on page 498).

Parameters:
<MessageType> ALL | SUCCess | INFO | WARNing | FATal | ERRor

<ChannelName> String containing the name of the application instance.
The parameter is optional. If you omit it, the command works for the currently active application instance.

<Message> String containing all messages of the selected type for the specified application instance. Each message is separated by a comma and inserted in parentheses. If no messages are available, empty parentheses are returned.

<Mode> SET | DEL

Example: `SYST:ERR:EXT? ALL`
Returns all messages for the currently active application, e.g. *"Message 1","Message 2"*.

Example: `SYST:ERR:EXT? FAT,'Spectrum2'`
Queries fatal errors in the 'Spectrum2' application. If none have occurred, the result is: *" "*.

SYSTem:ERRor:LIST? [<MessType>]

Queries the error messages that occur during FSWX operation.

Query parameters:

<MessType> SMSG | REMote

SMSG
(default) Queries the system messages which occurred during manual operation.

REMote
Queries the error messages that occurred during remote operation.
Note: The remote error list is automatically cleared when the FSWX is shut down.

Return values:

<SystemMessages> String containing all messages in the "System Messages" table.

<RemoteErrors> <Error_no> | <Description> | <Command> | <Date> | <Time>

Comma-separated list of errors from the "Remote Errors" table, where:
`<Error_no>`: device-specific error code
`<Description>`: brief description of the error
`<Command>`: remote command causing the error
`<Date>|<Time>`: date and time the error occurred

Example: `SYST:ERR:LIST? REM`

Usage: Query only

SYSTem:ERRor[:NEXT]?

This command queries the most recent error queue entry and deletes it.

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI. If the error queue is empty, the error number 0, "No error", is returned.

Example: `SYST:ERR:NEXT?`

Usage: Query only

SYSTem:FIRMware:UPDate <Directory>

Starts a firmware update using the `*.rsi` or `*.exe` files in the selected directory. The default path is the USB storage directory `run/media/instrument/usb/`. Change the path using the `MMEMory:CDIRectory` command.

You do not require administrator rights to update the firmware.

Setting parameters:
<Directory>

Manual operation: See "Firmware Update" on page 448

Example:

```
SYST:FIRM:UPD 'run/media/instrument/usb//FW_UPDATE'
```

Starts the firmware update from directory "`run/media/instrument/usb//FW_UPDATE`".

SYSTem:FORMat:IDENt <IDNFormat>

Selects the response format to the `*IDN?` query.

Parameters:

<IDNFormat>

LEGacy
Format is compatible to the R&S FSP/FSU/FSQ/FSG family.

NEW
FSWX format

*RST: not reset!

Example: `SYST:FORM:IDEN LEG`
Adapts the return value of *IDN? to the R&S FSP/FSU/FSQ family.

Manual operation: See "*IDN Format" on page 518

SYSTem:OPTion:LICense[:LIST]? [<Option>]

Queries the availability of floating licenses on all license servers configured on the FSWX.

Return values:

<Option> string values

Comma-separated list of strings for available options with a floating license.

<State> ON | OFF | OCCupy

State of the license

ON
Floating license enabled

OFF
Floating license disabled

OCCupy
Occupied license

<Days> The remaining time period that an occupied license is available.
Range: 1 to 7
Default unit: days

Example: Query which type of license is available for K100:
```
SYST:OPT:LIC? 'K100'
//Result: K100 floating
```

Example: Query which licenses are available for the FSWX:
```
SYST:OPT:LIC?
//Result:
B4,B5,B21,B114,K10 disabled,K91 floating,K91AC
floating,K91N disabled,K100 occupied
floating,K101 floating,K102 floating,K103
floating,K104 floating,K105 floating,K106
floating
```

Usage: Query only

Manual operation: See "License state (Edit)" on page 450
See "Enabling/disabling floating licenses" on page 451

SYSTem:OSYStem?

Queries the operating system used by the instrument.

Return values:
<Operating system>

Example:
```
SYST:OSYS?
//Result:
//'Linux'
```

Usage: Query only

4.14.13.8 Signal generator control commands

The remote commands required to control connected generators are described here.

CONFigure:GENerator:CONNection:CSTate? 863
CONFigure:GENerator:CONNection[:STATe] 864
CONFigure:GENerator:IPConnection:ADDRess 864

CONFigure:GENerator:CONNection:CSTate?

Queries the state of the connected signal generator.

Return values:
<ConnectionState> **UNKNown**
No signal generator connected

CONNected
Connection established

NCONnected
Connection could not be established, possibly due to an incompatible instrument or an invalid IP address

Example: `CONFigure:GENerator:CONNection:CSTate?`

Usage: Query only

Manual operation: See "Connection State" on page 442
See "Connection State" on page 511
See "Connection State" on page 524
See "Connection State" on page 1176

CONFigure:GENerator:CONNection[:STATe] <State>

Prerequisite: The IP address is specified.

Connects or disconnects the signal generator specified by `CONFigure:GENerator:IPConnection:ADDRess` on page 864.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Disconnects the generator.

ON | 1
Connects the generator.

*RST: 0

Example:
```
CONF:GEN:IPC:ADDR '192.168.114.90'
CONF:GEN:CONN:STAT ON
```

Usage: Asynchronous command

Manual operation: See "Connect" on page 442
See "Connect" on page 511
See "Test Connection" on page 525
See "Connect" on page 1176

CONFigure:GENerator:IPConnection:ADDRess <IPAddress>

The TCPIP address or computer name of the signal generator connected to the FSWX via LAN.

The IP address / computer name is maintained after a [PRESET], and is transferred between applications.

Parameters:

<IPAddress> IP address or computer name

Example: `CONF:GEN:IPC:ADDR '192.168.114.90'`

Manual operation: See "IP Address or Host Name" on page 524
See "IP Address or Host Name" on page 1175

4.14.13.9 Using service functions

DIAGnostic:SERVice:SFUNction....865
DIAGnostic:SERVice:SFUNction:LASTresult?....865
DIAGnostic:SERVice:SFUNction:RESults:DELete....866
DIAGnostic:SERVice:SFUNction:RESults:SAVE....866
DIAGnostic:SERVice:SINFo?....866
SYSTem:PASSword[:CENable]....867
SYSTem:PASSword:RESet....867

DIAGnostic:SERVice:SFUNction <ServiceFunction>
DIAGnostic:SERVice:SFUNction? <ServiceFunction>

Starts a service function.

The service functions are available after you have entered the level 1 or level 2 system password.

Parameters for setting and query:
<ServiceFunction> String containing the ID of the service function.
The ID of the service function is made up out of five numbers, separated by a point.
- function group number
- board number
- function number
- parameter 1 (see the Service Manual)
- parameter 2 (see the Service Manual)

Return values:
<Result>

Example:
```
DIAG:SERV:SFUN 'Function1'
DIAG:SERV:SFUN? 'Function2'
```

Manual operation: See "Service Function" on page 459
See "Execute" on page 459

DIAGnostic:SERVice:SFUNction:LASTresult?

Queries the results of the most recent service function you have used.

Return values:
<Result>

Example:
```
DIAG:SERV:SFUN:LAST?
```

Usage: Query only

Manual operation: See "Result List" on page 459

DIAGnostic:SERVice:SFUNction:RESults:DELete

Deletes the results in the output buffer for service functions you have used.

Example: `DIAG:SERV:SFUN:RES:DEL`

Usage: Event

Manual operation: See "Clear Results" on page 459

DIAGnostic:SERVice:SFUNction:RESults:SAVE [<FileName>]

Saves the results in the output buffer for service functions that you used to a file.

If no <FileName> parameter is provided, the results are stored to `var/lib/rohde-schwarz/esmain/fswx/results/Servicelog.txt`.

Note that if the buffer is empty, the function returns an error.

Parameters:

<FileName> String containing the path and filename.

Example: `DIAG:SERV:SFUN:RES:SAVE`

Manual operation: See "Save Results to File" on page 459

DIAGnostic:SERVice:SINFo?

Creates a `*.zip` file with important support information. The ZIP file contains the system configuration information ("device footprint"), the current EEPROM data and a screenshot of the screen display (if available).

This data is stored to the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user` directory on the instrument.

As a result of this command, the created filename (including the drive and path) is returned.

You can use the resulting filename information as a parameter for the `MMEM:COPY` command to store the file on the controller PC.

(See `MMEMory:COPY` on page 781)

If you contact the Rohde & Schwarz support to get help for a certain problem, send this file to the support to identify and solve the problem faster.

Return values:

<FileName> home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/<R&S Device ID>_<CurrentDate>_<CurrentTime>

String containing the drive, path and filename of the created support file, where the filename consists of the following elements:
<R&S Device ID>: The unique R&S device ID indicated in the "Versions + Options" information

(See Section 4.11.8.3, "Options and licensing", on page 448)
<CurrentDate>: The date on which the file is created (<YYYYMMDD>)
<CurrentTime>: The time at which the file is created (<HHMMSS>)

Usage: Query only

Manual operation: See "Create R&S Support Information File" on page 455

Example:

```
DIAG:SERV:SINF?
```

Result: "home/instrument//
home/instrument/.local/share/rohde-schwarz/es-main/fswx/user/FSWX-26_1348.0

```
MMEM:COPY
"home/instrument//home/instrument/.local/share/rohde-schwarz/es-main/fswx/u
```

```
"home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/
Debug/
home/instrument/.local/share/rohde-schwarz/es-main/fswx/user/FSWX-26_1348.0
```

SYSTem:PASSword[:CENable] <Password>

Provides a password for subsequent service functions.

Parameters:
<Password>

Example:
```
SYST:PASS:CEN '894129'
```

Manual operation: See "Password" on page 459

SYSTem:PASSword:RESet

Clears any previously provided password and returns to the most restrictive service level.

Manual operation: See "Password" on page 459

4.14.13.10 Remote commands for synchronizing parameters

The commands for manual operation are described in Section 4.11.7, "Synchronizing application configuration (parameter coupling)", on page 434.

- Predefined parameter coupling....868
- User-defined parameter coupling....873
- Generator coupling....881

Predefined parameter coupling

INSTrument:COUPle:ABIMpedance....868
INSTrument:COUPle:ACDC....868
INSTrument:COUPle:ATTen....869
INSTrument:COUPle:AUNit....869
INSTrument:COUPle:BANDwidth....869
INSTrument:COUPle:BWIDth....869
INSTrument:COUPle:CENTer....870
INSTrument:COUPle:DEMod....870
INSTrument:COUPle:GAIN....870
INSTrument:COUPle:IMPedance....871
INSTrument:COUPle:LIMit....871
INSTrument:COUPle:LLINes....871
INSTrument:COUPle:RLEVel....872
INSTrument:COUPle:SPAN....872
INSTrument:COUPle:VBW....872

INSTrument:COUPle:ABIMpedance <State>

Enables or disables synchronization of the amplitude baseband impedance configuration between measurement channels.

Parameters:

<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: NONE

Example: `INST:COUP:ABIM ALL`

INSTrument:COUPle:ACDC <State>

Enables or disables synchronization of the AC / DC Coupling state between measurement channels.

Parameters:

<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: ALL

Example: `INST:COUP:ACDC ALL`
Synchronizes the "AC/DC Coupling" parameter.

Manual operation: See "Synchronizing parameters across all application instances" on page 435

INSTrument:COUPle:ATTen <State>

Enables or disables synchronization of the attenuation and unit between measurement channels.

Parameters:

<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: ALL

Example: `INST:COUP:ATT ALL`
Synchronizes the attenuation.

Manual operation: See "Synchronizing parameters across all application instances" on page 435

INSTrument:COUPle:AUNit <State>

Enables or disables synchronization of the amplitude unit configuration between measurement channels.

Parameters:

<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: NONE

Example: `INST:COUP:AUN ALL`

Manual operation: See "Synchronizing parameters across all application instances" on page 435

INSTrument:COUPle:BANDwidth <State>
INSTrument:COUPle:BWIDth <State>

Turns synchronization of the resolution bandwidth (and filter type) between measurement channels on and off.

Parameters:

<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns on synchronization.

*RST: NONE

Example: `INST:COUP:BWID ALL`
Synchronizes the resolution bandwidth.

INSTrument:COUPle:CENTer <State>

Enables or disables synchronization of the frequency between measurement channels.

Parameters:
<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: ALL

Example: `INST:COUP:CENT ALL`
Synchronizes the center frequency.

Manual operation: See "Synchronizing parameters across all application instances" on page 435

INSTrument:COUPle:DEMod <State>

Enables or disables synchronization of the audio demodulator configuration between measurement channels.

Parameters:
<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: NONE

Example: `INST:COUP:DEM ALL`
Synchronizes the audio demodulator configuration.

INSTrument:COUPle:GAIN <State>

Enables or disables synchronization of the preamplifier configuration between measurement channels.

Parameters:
<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: NONE

Example: `INST:COUP:GAIN ALL`
Synchronizes the preamplifier configuration.

Manual operation: See "Synchronizing parameters across all application instances" on page 435

INSTrument:COUPle:IMPedance <State>

Enables or disables synchronization of the impedance configuration between measurement channels.

Parameters:
<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: NONE

Example: `INST:COUP:IMP ALL`

Manual operation: See "Synchronizing parameters across all application instances" on page 435

INSTrument:COUPle:LIMit <State>

Enables or disables synchronization of limit results between measurement channels.

Parameters:
<State> ALL | NONE

ALL
Turns on synchronization.
Limit lines have to be compatible to the x-axis and y-axis configuration for successful synchronization.

NONE
Turns off synchronization.

*RST: ALL

Example: `INST:COUP:LIM ALL`
Synchronizes the limit values.

Manual operation: See "Synchronizing parameters across all application instances" on page 435

INSTrument:COUPle:LLINes <State>

Enables or disables synchronization of the limit lines between measurement channels.

Parameters:
<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: NONE

INSTrument:COUPle:RLEVel <State>

Enables or disables synchronization of the reference level between measurement channels.

Parameters:

<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: NONE

Example: `INST:COUP:RLEV ALL`

Manual operation: See "Synchronizing parameters across all application instances" on page 435

INSTrument:COUPle:SPAN <State>

Enables or disables synchronization of the start and stop frequency between measurement channels.

Parameters:

<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: NONE

Example: `INST:COUP:SPAN ALL`
Synchronizes the start and stop frequency.

Manual operation: See "Synchronizing parameters across all application instances" on page 435

INSTrument:COUPle:VBW <State>

Enables or disables synchronization of the video bandwidth between measurement channels.

Parameters:

<State> ALL | NONE

ALL
Turns on synchronization.

NONE
Turns off synchronization.

*RST: NONE

Example: `INST:COUP:VBW ALL`
Synchronizes the video bandwidth.

Manual operation: See "Synchronizing parameters across all application instances" on page 435

User-defined parameter coupling

INSTrument:COUPle:USER<uc> 873
INSTrument:COUPle:USER<uc>:CHANnel:LIST? 875
INSTrument:COUPle:USER<uc>:ELEMent:LIST? 875
INSTrument:COUPle:USER<uc>:INFO 876
INSTrument:COUPle:USER<uc>:NEW? 877
INSTrument:COUPle:USER<uc>:NUMBers:LIST? 878
INSTrument:COUPle:USER<uc>:RELation 879
INSTrument:COUPle:USER<uc>:REMove 879
INSTrument:COUPle:USER<uc>:STATe 880
INSTrument:COUPle:USER<uc>:WINDow:LIST? 880

INSTrument:COUPle:USER<uc> <ChannelName>, <Window>, <Parameter>, <ChannelName>, <Window>, <Parameter>, <Direction>, <State>

Edits an existing user-defined coupling definition.

The parameters for this command are identical to `INSTrument:COUPle:USER<uc>:NEW?`. Note, however, that for `INSTrument:COUPling:USER<uc>`, the last two parameters (<Direction> and <State>) are **not optional**.

Note: Make sure to specify the right index number via the `USER` suffix.

Suffix:
<uc> Index of a user-defined parameter coupling. To obtain the list of indexes for currently defined coupling, see `INSTrument:COUPle:USER<uc>:NUMBers:LIST?`.

Parameters:
<ChannelName> String containing the name of an application instance or application type.

<Name>
To synchronize two specific application instances.

'All Spectrum'
To synchronize all spectrum application instances.

'All Analog Demod'
To synchronize all analog demodulation application instances.

'All Channels'
To synchronize all application instances, regardless of their type.

<Window> String containing the name of a measurement window.

<Name>
To synchronize a specific window (only possible in the Analog Demodulation application).

'All Windows'
To synchronize all measurement windows.

<Parameter> String containing the name of a synchronizable parameter.

<ChannelName> String containing the name of an application instance or application type.
The second application instance name is only necessary for synchronization between two specific application instances. If you synchronize all application instances of the same type or all application instances, the string has to be empty.

<Window> String containing the name of a measurement window.
The second window name is only necessary for synchronization between two specific application instances. If you synchronize all application instances of the same type or all application instances, the string has to be empty.

<Parameter> String containing the name of a synchronizable parameter.
The second parameter name is only necessary for synchronization between two specific application instances. If you synchronize all application instances of the same type or all application instances, the string has to be empty.

<Direction> LTOR | RTOL | BIDir

Selects the direction in which synchronization works.

BIDir
Changes of a parameter are applied both ways (from application instance 1 to application instance 2 and vice versa).

LTOR
Changes of a parameter are applied from application instance 1 to application instance 2, but not the other way around.

RTOL
Changes of a parameter are applied from application instance 2 to application instance 1, but not the other way around.

<State> ON | OFF | 0 | 1

Enables or disables the coupling

OFF | 0
Switches the coupling off

ON | 1
Switches the coupling on

*RST: 1

Example: `INST:COUP:USER3 'Spectrum1','All Windows','Attenuation','Spectrum 2','All Windows','Attenuation',BID,ON`
Synchronizes the attenuation between the application instances named 'Spectrum1' and 'Spectrum 2' in both directions and turns on the coupling.

Manual operation: See "Edit coupling definition" on page 438

INSTrument:COUPle:USER<uc>:CHANnel:LIST?

Queries the names of the application instances that can be synchronized.

Suffix:
<uc> irrelevant

Return values:
<SynchronizableChannels> Comma-separated list of strings
All application instances that can be synchronized.

Example: `INST:COUP:USER:CHAN:LIST?`
Result:
`'SPEC1','AD1','All Spectrum','All Channels','All Analog Demod'`

Usage: Query only

Manual operation: See "Channel 1 / Channel 2" on page 440

INSTrument:COUPle:USER<uc>:ELEMent:LIST? [<ChannelName>, <Parameter>]

Queries parameters that can be synchronized.

Suffix:
<uc> irrelevant

Query parameters:
<ChannelName> Optional SCPI parameter.
String containing the name of an application instance.

<Parameter> Optional SCPI parameter.
String containing the name of a parameter that you can synchronize.

Return values:
<SynchronizableParameters> Comma-separated list of parameters.

No parameters provided
Parameters that can be synchronized for all application instances

Application name provided
Parameters that can be synchronized for the selected application instance

Parameter and application name provided
Parameters that can be synchronized with the specified parameter for the selected application instance.

Example: `INST:COUP:USER:ELEM:LIST?`
Result: all parameters that can be coupled:
`'AC DC Coupling', 'Attenuation', 'Center Frequency', 'Display Lines', 'Frequency Marker 1',...`

Example: `INST:COUP:USER:ELEM:LIST? 'Spectrum'`
Result: all parameters that can be coupled in the 'Spectrum' application instance:
`'AC DC Coupling','Attenuation','Center Frequency','Display Lines',...`

Example: `INST:COUP:USER:ELEM:LIST? 'Spectrum','Attenuation'`
Result: all parameters that can be coupled to 'Attenuation' in the 'Spectrum' application instance:
`'Attenuation'`
(Attenuation is the only parameter that can be coupled to attenuation.)

Usage: Query only

Manual operation: See "Coupling Element 1 / Coupling Element 2" on page 440

INSTrument:COUPle:USER<uc>:INFO

Queries additional information about the specified user-defined parameter coupling.

Suffix:
<uc> Index of a user-defined parameter coupling. To obtain the list of indexes for currently defined coupling, see `INSTrument:COUPle:USER<uc>:NUMBers:LIST?`.

Return values:
<Information> String containing the message as displayed in the coupling manager.
If the coupling message contains no message, an empty string is returned.

Example: `INST:COUP:USER2:INFO?`
Queries possible information about the user coupling with index 2.
Result:
`'Only one limit line allowed'`

Manual operation: See "Info" on page 439

INSTrument:COUPle:USER<uc>:NEW? <ChannelName>, <Window>, <Parameter>, <ChannelName>, <Window>, <Parameter>, <Direction>, <State>

Creates a new user-defined parameter coupling.

After the new coupling has been created, the command returns the index number of the new coupling. Therefore, the command is implemented as a query.

Suffix:

<uc> irrelevant

Query parameters:

<ChannelName> String containing the name of an application instance or channel type.

<Name>
To synchronize two specific application instances.

'All Spectrum'
To synchronize all spectrum channels.

'All Analog Demod'
To synchronize all analog demodulation channels.

'All Channels'
To synchronize all channels, regardless of their type.

<Window> String containing the name of a measurement window.

<Name>
To synchronize a specific window (only possible in the Analog Demodulation application).

'All Windows'
To synchronize all measurement windows.

<Parameter> String containing the name of a synchronizable parameter.

<ChannelName> String containing the name of an application instance or application type.
The second application instance name is only necessary for synchronization between two specific application instances. If you synchronize all application instances of the same type or all application instances, the string has to be empty.

<Window> String containing the name of a measurement window.
The second window name is only necessary for synchronization between two specific application instances. If you synchronize all application instances of the same type or all application instances, the string has to be empty.

<Parameter> String containing the name of a synchronizable parameter.
The second parameter name is only necessary for synchronization between two specific application instances. If you synchronize all application instances of the same type or all application instances, the string has to be empty.

<Direction> LTOR | RTOL | BIDir

Optional: Selects the direction in which synchronization works.

BIDir
Changes of a parameter are applied both ways (from application instance 1 to application instance 2 and vice versa).

LTOR
Changes of a parameter are applied from application instance 1 to application instance 2, but not the other way around.

RTOL
Changes of a parameter are applied from application instance 2 to application instance 1, but not the other way around.

<State> ON | OFF | 0 | 1

Optional. Enables or disables coupling.

OFF | 0
Switches the coupling off

ON | 1
Switches the coupling on

*RST: 1

Return values:

<Index> Index number of the new user-defined coupling.
Note that the returned index numbers are not necessarily the same as the numbers shown in the user interface.

Example:
```
INST:COUP:USER:NEW? 'Spectrum1','All Windows','Attenuation','Spectrum2','All Windows','Attenuation',BID,ON
```
Result:
```
3
```
Synchronizes the attenuation between the application instances named 'Spectrum1' and 'Spectrum2' in both directions and turns on the coupling. Also returns the index number of the user-defined coupling.

Example:
```
INST:COUP:USER:NEW? 'All Spectrum','All Windows','Attenuation','','','',BID,ON
```
Result:
```
3
```
Synchronizes the attenuation between all Spectrum application instances in both directions and turns on the coupling. Also returns the index number of the user-defined coupling.

Usage: Query only

Manual operation: See "Parameter 1 / Parameter 2" on page 438
See "Add New User Coupling" on page 439

INSTrument:COUPle:USER<uc>:NUMBers:LIST?

Queries the index numbers of user-defined parameter couplings. The index numbers are used to refer to the specific coupling in remote commands with a `USER<uc>` suffix.

Suffix:
<uc> irrelevant

Return values:
<Index> Comma-separated list of strings
Index numbers of all available user-defined couplings
Note that the returned index numbers are not necessarily the same as those shown in the user interface.

Example: `INST:COUP:USER:NUMB:LIST?`
Result:
`'1','2','4'`
Number '3' is not returned, because a coupling with that index does not exist anymore.

Usage: Query only

Manual operation: See "Index" on page 438

INSTrument:COUPle:USER<uc>:RELation <Direction>

Selects the direction in which synchronization works.

Note that the command is not available if you synchronize over all application instances or all instances of the same application.

Suffix:
<uc> Index of a user-defined parameter coupling. To obtain the list of indexes for currently defined coupling, see `INSTrument:COUPle:USER<uc>:NUMBers:LIST?`.

Parameters:
<Direction> LTOR | RTOL | BIDir

BIDir
Changes of a parameter are applied both ways (from application instance 1 to application instance 2 and vice versa).

LTOR
Changes of a parameter are applied from application instance 1 to application instance 2, but not the other way around.

RTOL
Changes of a parameter are applied from application instance 2 to application instance 1, but not the other way around.

Example: `INST:COUP:USER:REL BID`
Selects bidirectional changes for the user-defined coupling with the index number 1.

Manual operation: See "Direction" on page 438

INSTrument:COUPle:USER<uc>:REMove [<Scope>]

Deletes a user-defined coupling mechanism.

Suffix:
<uc> Index of a user-defined parameter coupling. To obtain the list of indexes for currently defined coupling, see `INSTrument:COUPle:USER<uc>:NUMBers:LIST?`.

Parameters:
<Scope> **ALL**
Optional SCPI parameter, used instead of the <uc> suffix.
Deletes all user-defined couplings.

Example: `INST:COUP:USER3:REM`
Removes the user-defined coupling with the index number 3.

Manual operation: See "Delete coupling definition" on page 439
See "Delete All" on page 439

INSTrument:COUPle:USER<uc>:STATe <State>

Enables or disables the specified user-defined parameter coupling.

Suffix:
<uc> Index of a user-defined parameter coupling. To obtain the list of indexes for currently defined coupling, see `INSTrument:COUPle:USER<uc>:NUMBers:LIST?`.

Parameters:
<State> ON | OFF | 1 | 0

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INST:COUP:USER2:STAT ON`
Turns on the coupling with the index number 2.

Manual operation: See "State" on page 438

INSTrument:COUPle:USER<uc>:WINDow:LIST? [<ChannelName>, <Parameter>]

Prerequisite: "AM/FM/PM Analog Demod" application

Queries the measurement windows that can be synchronized with another application instance (or measurement window).

Suffix:
<uc> irrelevant

Query parameters:
<ChannelName> Optional SCPI parameter.
String containing the name of an application instance.

<Parameter> Optional SCPI parameter.
String containing the name of a parameter that you can synchronize.

Return values:
<SyncWindow> comma-separated list of strings

'All Windows'
All windows can be synchronized. This value is always returned if no parameters are provided with the command.

Comma-separated list of strings
Prerequisite: marker coupling (can be set independently of the measurement window)
String containing the names of the measurement windows that can be synchronized.

Example:
```
INST:COUP:USER:WIND:LIST?
```
Result:
```
'All Windows'
```

Example:
```
INST:COUP:USER:WIND:LIST? 'Analog Demod','Frequency Marker 1'
```
Result:
```
'All Windows','1','2','3','4','5','6'
```
The "Specifics for Window" list contains the entries "All Windows" and each of the windows 1 to 6. The frequency marker 1 can be synchronized in any or all of the windows in the 'Analog Demod' application instance.

Usage: Query only

Manual operation: See "Specifics for Window" on page 440

Generator coupling

INSTrument:COUPle:GENerator:CENTer:OFFSet 881
INSTrument:COUPle:GENerator:CENTer[:STATe] 882
INSTrument:COUPle:GENerator:RLEVel:OFFSet 882
INSTrument:COUPle:GENerator:RLEVel[:STATe] 882
INSTrument:COUPle:GENerator:STATe 883

INSTrument:COUPle:GENerator:CENTer:OFFSet <Frequency>

Defines a fixed offset to the center frequency of the FSWX for the coupled signal generator.

Requires the `INSTrument:COUPle:GENerator:STATe` and the `INSTrument:COUPle:GENerator:CENTer[:STATe]` to be ON.

Parameters:
<Frequency> Default unit: HZ

Example:
```
INST:COUP:GEN:STAT ON
INST:COUP:GEN:CENT:STAT ON
INST:COUP:GEN:CENT:OFFS 5
```

Manual operation: See "Generator Frequency Offset" on page 442

INSTrument:COUPle:GENerator:CENTer[:STATe] <State>

Couples the center frequency of the connected signal generator to the FSWX.

Requires the `INSTrument:COUPle:GENerator:STATe` to be ON.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
INST:COUP:GEN:STAT ON
INST:COUP:GEN:CENT:STAT ON
```

Manual operation: See "Center Frequency" on page 442

INSTrument:COUPle:GENerator:RLEVel:OFFSet <Level>

Defines a fixed offset to the reference level of the FSWX for the coupled signal generator.

Requires the `INSTrument:COUPle:GENerator:STATe` and the `INSTrument:COUPle:GENerator:RLEVel[:STATe]` to be ON.

Parameters:

<Level> Default unit: DB

Example:
```
INST:COUP:GEN:STAT ON
INST:COUP:GEN:RLEV:STAT ON
INST:COUP:GEN:RLEV:OFFS 5
```

Manual operation: See "Generator Reference Level Offset" on page 442

INSTrument:COUPle:GENerator:RLEVel[:STATe] <State>

Couples the reference level of the connected signal generator to the FSWX.

Requires the `INSTrument:COUPle:GENerator:RLEVel[:STATe]` to be ON.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
INST:COUP:GEN:STAT ON
INST:COUP:GEN:RLEV:STAT ON
```

Manual operation: See "Reference level" on page 442

INSTrument:COUPle:GENerator:STATe <State>

Enables or disables coupling between the FSWX and a connected signal generator.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
INST:COUP:GEN:STAT ON
```

Manual operation: See "Coupling State" on page 442

4.14.14 Using the status register

Except for the top-level (combined) status information, the status information is provided in a separate register for each application instance, as indicated in Figure 4-56. By default, a query always returns the information for the currently active application instance.

Input-specific status registers

Some information is also provided in separate registers for each input source, e.g. the RF A connector or a stream in a data file. In this case, you must define the input source as a suffix to the `STATus` keyword in the query. The suffix refers to the defined input sources in the order you define them for the application instance. If you omit the suffix, the first defined input source is queried (<ip>=1).

For more information on the contents of the status registers see:

- Remote control via SCPI on the internet
- "STATus:OPERation register" on page 495
- "STATus:QUEStionable:ACPLimit register" on page 497
- "STATus:QUEStionable:EXTended register" on page 498
- "STATus<ip>:QUEStionable:FREQuency register" on page 499
- "STATus:QUEStionable:LIMit register" on page 500
- "STATus:QUEStionable:LMARgin register" on page 500
- "STATus<ip>:QUEStionable:POWer register" on page 501

- "STATus:QUEStionable:TEMPerature register" on page 502
- "STATus:QUEStionable:TIMe register" on page 503
- "STATus:QUEStionable:TRANsducer register" on page 503

- General status register commands 884
- Reading out the CONDition part 884
- Reading out the EVENt part 885
- Controlling the ENABle part 886
- Controlling the negative transition part 887
- Controlling the positive transition part 888

4.14.14.1 General status register commands

STATus:PRESet 884
STATus:QUEue[:NEXT] 884

STATus:PRESet

Configures the status reporting system such that device-dependent events are reported at a higher level.

The command affects only the transition filter registers, the `ENABle` registers, and queue enabling:

- The `ENABle` parts of the `STATus:OPERation` and `STATus:QUEStionable...` registers are set to all 1's.
- The `PTRansition` parts are set all 1's, the `NTRansition` parts are set to all 0's, so that only positive transitions in the `CONDition` part are recognized.

The status reporting system is also affected by other commands, see Section 4.13.3, "Status reporting system", on page 491.

STATus:QUEue[:NEXT]

Queries the most recent error queue entry and deletes it.

Positive error numbers indicate sensor-specific errors. Negative error numbers are error messages defined by SCPI.

If the error queue is empty, the error number 0, "No error", is returned.

4.14.14.2 Reading out the CONDition part

STATus:QUEStionable:CONDition

Reads out the `CONDition` section of the top `STATus:QUEStionable` status register for all application instances, without deleting the contents.

STATus:OPERation:CONDition
STATus:QUEStionable:ACPLimit:CONDition [<ChannelName>]

STATus:QUEStionable:EXTended:CONDition [<ChannelName>]
STATus:QUEStionable:EXTended:INFO:CONDition [<ChannelName>]
STATus<ip>:QUEStionable:FREQuency:CONDition [<ChannelName>]
STATus:QUEStionable:LIMit<1|2|3|4>:CONDition [<ChannelName>]
STATus:QUEStionable:LMARgin<1|2|3|4>:CONDition [<ChannelName>]
STATus<ip>:QUEStionable:POWer:CONDition [<ChannelName>]
STATus:QUEStionable:SYNC:CONDition [<ChannelName>]
STATus:QUEStionable:TEMPerature:CONDition [<ChannelName>]
STATus:QUEStionable:TIME:CONDition [<ChannelName>]
STATus:QUEStionable:TRANsducer:CONDition [<ChannelName>]
STATus:<registry>:CONDition [<ChannelName>]

These commands read out the `CONDition` section of the status register.

The commands do not delete the contents of the `CONDition` section.

Suffix:
<ip> Input (where applicable)
See "Input-specific status registers" on page 883

<n> Window 1 to 16 (where applicable)

Parameters:
<ChannelName> String containing the name of the application instance.
The parameter is optional. If you omit it, the command works for the currently active application instance.

4.14.14.3 Reading out the EVENt part

STATus:QUEStionable[:EVENt]

Reads out and deletes the contents in the `EVENt` section of the top `STATus:QUEStionable` status register for all application instances.

STATus:OPERation[:EVENt]
STATus:QUEStionable:ACPLimit[:EVENt] [<ChannelName>]
STATus:QUEStionable:EXTended[:EVENt] [<ChannelName>]
STATus:QUEStionable:EXTended:INFO[:EVENt] [<ChannelName>]
STATus<ip>:QUEStionable:FREQuency[:EVENt] [<ChannelName>]
STATus:QUEStionable:LIMit<1|2|3|4>[:EVENt] [<ChannelName>]
STATus:QUEStionable:LMARgin<1|2|3|4>[:EVENt] [<ChannelName>]
STATus<ip>:QUEStionable:POWer[:EVENt] [<ChannelName>]
STATus:QUEStionable:SYNC[:EVENt] [<ChannelName>]
STATus:QUEStionable:TEMPerature[:EVENt] [<ChannelName>]
STATus:QUEStionable:TIME[:EVENt] [<ChannelName>]
STATus:QUEStionable:TRANsducer[:EVENt] [<ChannelName>]
STATus:<registry>[:EVENt] [<ChannelName>]

These commands read out the `EVENt` section of the status register.

At the same time, the commands delete the contents of the `EVENt` section.

Suffix:

<ip> Input (where applicable)
See "Input-specific status registers" on page 883

<n> Window 1 to 16 (where applicable)

Parameters:

<ChannelName> String containing the name of the application instance.
The parameter is optional. If you omit it, the command works for the currently active application instance.

4.14.14.4 Controlling the ENABle part

STATus:QUEStionable:ENABle <SummaryBit>

Controls the `ENABle` part of the top `STATus:QUEStionable` status register for all application instances.

The `ENABle` part is required to report "true" conditions in the `EVENt` part of the status register to the summary bit. If a bit value is "1" in the `ENABle` register and its associated `EVENt` bit transitions to "true", a positive transition occurs in the summary bit reported to the next higher level.

Parameters:

<SummaryBit> integer

Range: 0 to 65535

STATus:OPERation:ENABle <SummaryBit>
STATus:QUEStionable:ACPLimit:ENABle <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:EXTended:ENABle <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:EXTended:INFO:ENABle <SummaryBit>[, <ChannelName>]
STATus<ip>:QUEStionable:FREQuency:ENABle <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:LIMit<1|2|3|4>:ENABle <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:LMARgin<1|2|3|4>:ENABle <SummaryBit>[, <ChannelName>]
STATus<ip>:QUEStionable:POWer:ENABle <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:SYNC:ENABle <BitDefinition>[, <ChannelName>]
STATus:QUEStionable:TEMPerature:ENABle <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:TIME:ENABle <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:TRANsducer:ENABle <BitDefinition>[, <ChannelName>]
STATus:<registry>:ENABle <SummaryBit>[, <ChannelName>]

These commands control the `ENABle` part of a register.

The `ENABle` part is required to report "true" conditions in the `EVENt` part of the status register to the summary bit. If a bit value is "1" in the `ENABle` register and its associated `EVENt` bit transitions to "true", a positive transition occurs in the summary bit reported to the next higher level.

Suffix:

<ip> Input (where applicable)
See "Input-specific status registers" on page 883

<n> Window 1 to 16 (where applicable)

Parameters:

<SummaryBit> integer
Range: 0 to 65535

<ChannelName> String containing the name of the application instance.
The parameter is optional. If you omit it, the command works for the currently active application instance.

4.14.14.5 Controlling the negative transition part

STATus:QUEStionable:NTRansition <SummaryBit>

Controls the `negative transition` part of the top `STATus:QUEStionable` status register for all application instances.

If a status bit is set, a 1 to 0 transition occurs in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding `EVENt` register.

Parameters:

<SummaryBit> integer
Range: 0 to 65535

STATus:OPERation:PCALibration:NTRansistion <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:ACPLimit:NTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:EXTended:NTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:EXTended:INFO:NTRansition <SummaryBit>[, <ChannelName>]
STATus<ip>:QUEStionable:FREQuency:NTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:LIMit<1|2|3|4>:NTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:LMARgin<1|2|3|4>:NTRansition <SummaryBit>[, <ChannelName>]
STATus<ip>:QUEStionable:POWer:NTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:SYNC:NTRansition <BitDefinition>[, <ChannelName>]
STATus:QUEStionable:TEMPerature:NTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:TIME:NTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:TRANsducer:NTRansition <BitDefinition>[, <ChannelName>]
STATus:<registry>:NTRansition <SummaryBit>[, <ChannelName>]

These commands control the `negative transition` part of a register.

If a status bit is set, a 1 to 0 transition occurs in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding `EVENt` register.

Suffix:

<ip> Input (where applicable)
See "Input-specific status registers" on page 883

<n> Window 1 to 16 (where applicable)

Parameters:

<SummaryBit> integer
Range: 0 to 65535

<ChannelName> String containing the name of the application instance.
The parameter is optional. If you omit it, the command works for the currently active application instance.

4.14.14.6 Controlling the positive transition part

STATus:QUEStionable:PTRansition <SummaryBit>

Controls the `positive transition` part of the top `STATus:QUEStionable` status register for all application instances.

If a status bit is set, a 0 to 1 transition occurs in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding `EVENt` register.

Parameters:

<SummaryBit> integer
Range: 0 to 65535

STATus:OPERation:PTRansition <SummaryBit>
STATus:QUEStionable:ACPLimit:PTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:EXTended:PTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:EXTended:INFO:PTRansition <SummaryBit>[, <ChannelName>]
STATus<ip>:QUEStionable:FREQuency:PTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:LIMit<1|2|3|4>:PTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:LMARgin<1|2|3|4>:PTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:POWer:DCPNoise:PTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:SYNC:PTRansition <BitDefinition>[, <ChannelName>]
STATus:QUEStionable:TEMPerature:PTRansition <SummaryBit>[, <ChannelName>]
STATus:QUEStionable:TIME:PTRansition <SummaryBit>[, <ChannelName>]

STATus:QUEStionable:TRANsducer:PTRansition <BitDefinition>[, <ChannelName>]
STATus:<registry>:PTRansition <SummaryBit>[, <ChannelName>]

These commands control the `positive transition` part of a register.

If a status bit is set, a 0 to 1 transition occurs in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding `EVENt` register.

Suffix:

<ip> Input (where applicable)
See "Input-specific status registers" on page 883

<n> Window 1 to 16 (where applicable)

Parameters:

<SummaryBit> integer
Range: 0 to 65535

<ChannelName> String containing the name of the application instance.
The parameter is optional. If you omit it, the command works for the currently active application instance.

4.14.15 Commands for remote instrument operation

The following commands are required to shut down or reboot the FSWX from a remote PC.

SYSTem:CLOGging 889
SYSTem:REBoot 890
SYSTem:SHUTdown 890

SYSTem:CLOGging <State>

Enables or disables logging of remote commands.

Parameters:

<State> ON | OFF | 1 | 0

ON | 1
Stores all remote commands that have been sent to the instrument in a file.
The destination is `home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpiLog.<no.>`.
where <no.> is a sequential number
A new log file is started each time logging was stopped and is restarted.

OFF | 0

*RST: 0

Manual operation: See "I/O Logging" on page 518

SYSTem:REBoot

Reboots the instrument, including the operating system.

SYSTem:SHUTdown

Shuts down the instrument.

4.14.16 Recording SCPI commands automatically

Using the SCPI Recorder functions, you can create a SCPI script directly on the instrument and then export the script for use on the controller.

See alsoSection 4.13.4, "Automating tasks with remote command scripts", on page 504.

SYSTem:SRECorder[:AUTO]....890
SYSTem:SRECorder:CLEar....891
SYSTem:SRECorder:DATA[:ALL]?....891
SYSTem:SRECorder:EXPort....893
SYSTem:SRECorder:FORMat....894
SYSTem:SRECorder:SYNC....894
CONFigure:GENerator:RECording:COMBine....895

SYSTem:SRECorder[:AUTO] <State>

If enabled, the SCPI Recorder automatically records the required SCPI commands and parameter values for the settings and functions you use while operating the FSWX.

See Section 4.13.4, "Automating tasks with remote command scripts", on page 504.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:

```
//Enable automatic rcording
SYST:SREC:AUTO ON
//Include synchronization commands
SYST:SREC:SYNC ON
//Perform measurement task to record required commands
//...
//Display recorded commands
SYST:REC:DATA?
//Store commands to a file in python format
SYST:SREC:EXP PYTH, 'C:/TEMP/SCPI_EXAMPLE.py'
//Clear currently recorded commands
SYST:SREC:CLE
```

Manual operation: See "Start Recording / Stop Recording" on page 508

SYSTem:SRECorder:CLEar

Removes all recorded commands from the current SCPI command list.

Example:

```
SYST:SREC:CLE
```

Usage: Event

Manual operation: See "Remove All" on page 508

SYSTem:SRECorder:DATA[:ALL]?

Returns the currently recorded commands.

Return values:

<RecordedCommands> string

String containing the complete SCPI recording. Each individual command is introduced by a "#" character.

Example:

```
SYST:REC:DATA?
```

Usage: Query only

Manual operation: See "Current recording / script editor" on page 508
See "Copy" on page 508

Example:

Assume the following recorded commands:

```
*RST
*CLS
:SYST:DISP:UPD ON
:INIT:CONT OFF
:INST:CRE:NEW SANALYZER, 'Spectrum 2'
:INIT:CONT OFF
```

```
:CALC:MARK:FUNC:POW:SEL ACP
```

Result for SCPI format:

```
#*RST
#*CLS
#:SYST:DISP:UPD ON
#:INIT:CONT OFF
#:INST:CRE:NEW SANALYZER, 'Spectrum 2'
#:INIT:CONT OFF
#:CALC:MARK:FUNC:POW:SEL ACP
```

Result for PYTHon format:

```
# python script created by FSW: 24:08:2022 14:05:23
#import pyvisa as visa #def write_command(instrument, command) :
# instrument.write(command)
# return process_system_error(instrument)
#def write_query(instrument, command) :
# buffer = instrument.query(command)
# bSuccess = process_system_error(instrument)
# return bSuccess, buffer #def process_system_error(instrument) :
# bSuccess = True
# EsrErrorMask = 0x3C
# if ((get_esr(instrument) & EsrErrorMask) != 0) :
# print(instrument.query(":SYST:ERR?"))
# instrument.write("*CLS")
# bSuccess = False
# return bSuccess
#def get_esr(instrument) :
# esr = instrument.query("*ESR?")
# return int(esr)
#VisaResourceManager = visa.ResourceManager()
# connect to analyzer
#Analyzer = VisaResourceManager.open_resource("TCPIP::
10.111.0.161::inst0::INSTR")
#success = write_command( Analyzer, "*RST" )
#success = write_command( Analyzer, "*CLS" )
```

```
#success = write_command( Analyzer, ":SYST:DISP:UPD ON" )

#success = write_command( Analyzer, ":INIT:CONT OFF" )

#success = write_command( Analyzer, ":INST:CRE:NEW SANALYZER,
'Spectrum 2'" )

#success = write_command( Analyzer, ":INIT:CONT OFF" )

#success = write_command( Analyzer, ":CALC:MARK:FUNC:POW:SEL
ACP" )

# back to local mode

#success = write_command(Analyzer, "@LOC")

# cleanup #Analyzer.close()

#VisaResourceManager.close()
```

SYSTem:SRECorder:EXPort <Format>, <FileName>

Exports the current SCPI command list to the specified file and directory in the selected format. By default, the file is stored in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpirecordings` directory. Besides the recorded commands themselves, the exported script includes all format-specific header data required to execute the script using an external program on the controller.

Setting parameters:

<Format> SCPI | PYTHon | MATLab | CPLusplus | CVI | CSHarp

CSHarp
A commonly used general programming language for various applications (`*.cs`)

CPLusplus
A commonly used general programming language for various applications (`*.cpp`)

MATLab (Instrument Control Toolbox)
A programming environment, frequently used in signal processing and test and measurement applications (`*.m`)
You can use this format directly with the MATLAB© Toolkit.

CVI
An ANSI C programming environment designed for measurements and tests (`*.cvi`)
You can use this format directly with National Instruments LabWindows CVI.

SCPI
Represents SCPI base format, that is ASCII format, saved as a text file (`*.inp`); contains no additional header data
Use this format to load a recorded script back to the editor later.

PYTHon
A commonly used general programming language for various applications (`.py`)

<FileName> String containing the path and name of the file.

Example: `SYST:SREC:EXP PYTH, 'C:/TEMP/SCPI_EXAMPLE.py'`

Usage: Setting only

Manual operation: See "Create Script (export)" on page 509

SYSTem:SRECorder:FORMat <Format>

Defines whether the commands are recorded using the short or long SCPI notation.

Parameters:

<Format> SHORt | LONG

SHORt
The shortform of the keyword is used.
Example: `FREQ:CENT`

LONG
The entire keyword is used.
Example: `FREQuency:CENTer`

Example: `SYST:SREC:FORM SHOR`

Manual operation: See "Recording Format" on page 511

SYSTem:SRECorder:SYNC <State>

If enabled, additional commands are included in the script to synchronize the recorded commands when necessary. For instance, when a measurement is started, a `*WAI` command is inserted to ensure that the next command is only executed after the measurement has finished.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `SYST:SREC:SYNC ON`

Manual operation: See "Add Synchronization Commands" on page 511

CONFigure:GENerator:RECording:COMBine <State>

Records commands both from the FSWX and from a connected Rohde & Schwarz signal generator.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `CONF:GEN:REC:COMB ON`

Manual operation: See "Combined Recording of spectrum analyzer and R&S signal generator" on page 511

4.14.17 Emulating other instruments' commands

The FSWX analyzer family supports a subset of the GPIB commands of several HP and PSA instruments.

- Setting up instrument emulation....895
- Reference: GPIB commands of emulated HP models....899
- Reference: command set of emulated PSA models....927
- Reference: command set of emulated PXA models....931
- Command set for analog demodulation for emulated PXA models....933
- Command set for vector signal analysis (VSA) for emulated R&S FSE instruments 934

4.14.17.1 Setting up instrument emulation

The following commands are required to set up the use of commands to emulate other instruments.

Useful commands for emulating other instruments described elsewhere:

- `SYSTem:REVision:FACTory` on page 855

Remote commands exclusive to emulating other instruments:

SYSTem:HPCoupling....896
SYSTem:IFGain:MODE....896
SYSTem:HPADditional....896
SYSTem:LANGuage....897
SYSTem:PREamp....897
SYSTem:PSA:WIDeband....897
SYSTem:REVision[:STRing]....898
SYSTem:RSWeep....898

SYSTem:HPCoupling <CouplingType>

Prerequisite: An HP language is selected using `SYSTem:LANGuage` on page 897.

Controls the default coupling ratios in the HP emulation mode for:

- Span and resolution bandwidth (Span/RBW)
- Resolution bandwidth and video bandwidth (RBW/VBW)

For FSP (=FSW), the standard parameter coupling of the instrument is used. As a result, usually a shorter sweep time is used than for HP.

Parameters:

<CouplingType> HP | FSP

*RST: FSP

Example: `SYSTem:HPC HP`

Manual operation: See "Coupling" on page 522

SYSTem:IFGain:MODE <Mode>

Prerequisite: An HP language is selected using `SYSTem:LANGuage` on page 897.

Configures the internal IF gain settings in HP emulation mode due to the application needs. This setting is only considered for resolution bandwidth < 300 kHz.

Parameters:

<Mode> NORMal | PULSe

NORMal
Optimized for high dynamic range
Overload limit is close to reference level.

PULSe
Optimized for pulsed signals
Overload limit up to 10 dB above reference level.

*RST: NORM

Example: `SYST:IFG:MODE PULS`

Manual operation: See "IF Gain" on page 521

SYSTem:HPADditional <State>

Allows the use of HP commands *in addition to* SCPI commands for R&S FSP/FSQ/FSU emulation (see `SYSTem:LANGuage` on page 897).

Parameters:

<State> ON | OFF | 1 | 0

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Manual operation: See "HP Additional" on page 521

SYSTem:LANGuage <Language>

Selects the system language.

For details see Section 4.14.17.2, "Reference: GPIB commands of emulated HP models", on page 899.

Note: This command is also used to emulate previous Rohde & Schwarz signal and spectrum analyzers, making the `SYST:COMP` command obsolete.

Note: For R&S FSP/FSQ/FSU emulation, HP commands are not automatically also allowed. In this case, set `SYSTem:HPADditional` to `ON`.

Parameters:

<Language> "SCPI" | "8560E" | "8561E" | "8562E" | "8563E" | "8564E" | "8565E" | "8566A" | "8566B" | "8568A" | "8568A_DC" | "8568B" | "8568B_DC" | "8591E" | "8594E" | "71100C" | "71200C" | "71209A" | "PSA89600" | "PSA" | "PXA" | "R&S FSP" | "R&S FSU" | "R&S FSQ" | "R&S FSV" | "R&S FSEA" | "R&S FSEB" | "R&S FSEM" | "R&S FSEK" | "R&S FSW"

*RST: SCPI

Example: `SYST:LANG 'PSA'`
Emulates the PSA.

Manual operation: See "Language" on page 520

Note: If you use **"PSA89600"**, you must switch to an HP language first before returning to SCPI (in remote operation only). For the identical language "PSA", this intermediate step is not necessary.

SYSTem:PREamp <Option>

Prerequisites:

- FSU/FSQ emulation
- Optional preamplifier is used

This setting defines which option is returned when the `*OPT?` query is executed, depending on the used preamplifier.

Parameters:

<Option> B23 | B24

*RST: B23

Example: `SYST:PRE B23`

SYSTem:PSA:WIDeband <State>

Prerequisite: PSA89600 emulation

Defines which option is returned when the *OPT? query is executed, depending on the state of the wideband option.

Parameters:

<State> ON | OFF | HIGH

OFF
The option is indicated as "B7J"

ON
The 40 MHz wideband is used.
The option is indicated as "B7J, 140".

HIGH
The 80 MHz wideband is used.
The option is indicated as "B7J, 122".

*RST: OFF

Example: SYST:PSA:WID HIGH

Manual operation: See "Wideband" on page 521

SYSTem:REVision[:STRing] <Name>

Sets the response to the REV? query to the defined string (HP emulation only, see SYSTem:LANGuage on page 897).

Parameters:

<Name>

Example: Define the system language:
SYST:LANG '8563E'
Query the revision:
REV?
Response:
920528
Set the response to 'NewRevision':
SYST:REV:STR 'NewRevision'
Query the response:
SYST:REV:STR?
Response:
NewRevision

Manual operation: See "Revision String" on page 522

SYSTem:RSWeep <State>

Prerequisite: An HP language is selected using SYSTem:LANGuage on page 897

Controls a repeated sweep of the E1 and MKPK HI HP model commands (for details on the commands refer to Section 4.14.17.2, "Reference: GPIB commands of emulated HP models", on page 899). If the repeated sweep is OFF, the marker is set without sweeping before.

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

Example: `SYSTem:RSW ON`

Manual operation: See "Sweep Repeat" on page 521

4.14.17.2 Reference: GPIB commands of emulated HP models

The FSWX analyzer family supports a subset of the GPIB commands of HP models 8560E, 8561E, 8562E, 8563E, 8564E, 8565E, 8566A, 8566B, 8568A, 8568B and 8594E.

Despite the differences in system architecture and device features, the supported commands have been implemented in a way to ensure a sufficiently high degree of correspondence with the original.

This includes the support of syntax rules for not only newer device families (B and E models) but for the previous A family as well.

Usually, the selection of commands supported by the FSWX is sufficient to run an existing GPIB program without adaptation.

- Command set of models 8560E, 8561E, 8562E, 8563E, 8564E, 8565E, 8566A/B, 8568A/B, 8591E, 8594E, 71100C, 71200C, and 71209A 899
- Special features of the syntax parsing algorithms for 8566A and 8568A models 923
- Special behavior of commands 924
- Model-dependent default settings 925
- Data output formats 925
- Trace data output formats 926
- Trace data input formats 926
- GPIB status reporting 926

Command set of models 8560E, 8561E, 8562E, 8563E, 8564E, 8565E, 8566A/B, 8568A/B, 8591E, 8594E, 71100C, 71200C, and 71209A

As with the original units, the FSWX includes the command set of the A models in the command set of the B models.

The HP model 8591E is compatible to HP model 8594E, the HP models 71100C, 71200C, and 71209A are compatible to HP models 8566A/B.

Command	Supported subset	Function	Corresp. HP-Models	Status
A1	A1	Clear/Write A	HP 8566A/ HP 8568A	available
A2	A2	Max Hold A	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
A3	A3	View A	HP 8566A/ HP 8568A	available
A4	A4	Blank A	HP 8566A/ HP 8568A	available
ABORT [1)]	ABORT	Stop previous function	HP 856xE/ HP 8566B/HP 8568B/HP 8594E	available
ADD		Add	HP 8566B/ HP 8568B/ HP 8594E	available
ADJALL	ADJALL	Adjust all	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ADJCRT [2)]	ADJCRT	Adjust CRT	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ADJIF [2)]	ADJIF	Auto adjust IF	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AMB	AMB ON|OFF AMB 1|0 AMB?	Trace A – B -> Trace A	HP 856xE/ HP 8594E	available
AMBPL	AMBPL ON|OFF AMBPL 1|0 AMBPL?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AMPCORDATA	AMPCORDATA <freq>,<amp>,.. AMPCORDATA?	Amplitude Correction Data	HP 856xE	available
AMPCOR	AMPCOR ON|OFF AMPCOR 1|0 AMPCOR?	Amplitude Correction	HP 856xE	available
AMPCORSIZE	AMPCORSIZE?	Amplitude Correction Data Array Size	HP 856xE	available
AMPCORRCL	AMPCORRCL <numeric value>	Amplitude Correction Recall	HP 856xE	available

Command	Supported subset	Function	Corresp. HP-Models	Status
AMPCORSAVE	AMPCORSAVE <numeric value>	Amplitude Correction Save	HP 856xE	available
ANNOT	ANNOT ON|OFF ANNOT 1|0 ANNOT?	Annotation	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
APB	APB	Trace A + B -> Trace A	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AT	AT <numeric_value> DB | DM AT DN AT UP AT AUTO AT?	Attenuation	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AUNITS	AUNITS DBM | DBMV | DBUV | AUNITS?	Amplitude Units	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AUTOCPL	AUTOCPL	Coupling default	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
AXB	AXB	Exchange trace A and B	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
B1	B1	Clear/Write B	HP 8566A/ HP 8568A	available
B2	B2	Max Hold B	HP 8566A/ HP 8568A	available
B3	B3	View B	HP 8566A/ HP 8568A	available
B4	B4	Blank B	HP 8566A/ HP 8568A	available
BL	BL	Trace B – Display Line -> Trace B	HP 8566A/ HP 8568A	available
BML	BML	Trace B – Display Line -> Trace B	HP 856xE/ HP8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
BTC	BTC	Transfer Trace B -> C	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
BXC	BXC	Exchange Trace B and C	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
BLANK	BLANK TRA|TRB|TRC	Blank Trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
C1	C1	A-B off	HP 8566A/ HP 8568A	available
C2	C2	A-B -> A	HP 8566A/ HP 8568A	available
CA	CA	Couple Attenuation	HP 8566A/ HP 8568A	available
CAL [1)]	CAL ALL CAL ON CAL OFF	Start analyzer self-alignment	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
CF	CF <numeric_value> HZ|KHZ|MHZ|GHZ CF UP CF DN CF?	Center Frequency	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
CHANPWR	CHANPWR TRA|TRB, <numeric_value>,?	Channel Power Measurement	HP 856xE/ HP 8594E	available
CHPWRBW	CHPWRBW <numeric_value> HZ|KHZ|MHZ|GHZ	Channel Power Bandwidth	HP 856xE/ HP 8594E	available
CLRW	CLRW TRA|TRB|TRC	Clear/Write Trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
CLS [1)]	CLS	Clear all status bits	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
CONTS	CONTS		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
COUPLE	COUPLE AC|DC	Input coupling	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
CR	CR	Couple RBW	HP 8566A/ HP 8568A	available
CS	CS	Couple Step Size	HP 8566A/ HP 8568A	available
CT	CT	Couple SWT	HP 8566A/ HP 8568A	available
CTA		Convert to absolute units	HP 8566B/ HP 8568B/ HP 8594E	available
CV	CV	Couple VBW	HP 8566A/ HP 8568A	available
D1 [2)]	D1	Display Size normal	HP 8566A/ HP 8568A	available
DA [2)]	DA	Display address		available
DEMOD [1)]	DEMOD ON|OFF|AM| FM	AF Demodulator	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DEMODAGC [2)]	DEMODAGC ON|OFF|1| 0 DEMODAGC?	Demodulation AGC	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DEMODT	DEMODT <numeric_value> S|MS| US|SC DEMODT UP|DN DEMODT?	Demodulation time	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
DET	DET POS|SMP|NEG DET?	Detector	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DISPOSE [2)]	ONEOS | TRMATH | ONSWP | ALL | <numeric_value>			available
DIV		Divide	HP 8566B/ HP 8568B/ HP 8594E	available
DL	DL <numeric_value> DB|DM DL DN DL UP DL ON DL OFF DL?	Display Line	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DLE	DLE ON|OFF	Display Line enable	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DONE	DONE DONE?	Done query	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
DW [2)]	DW	Write to display and increment address		available
E1	E1	Peak Search	HP 8566A/ HP 8568A	available
E2	E2	Marker to Center Freq.	HP 8566A/ HP 8568A	available
E3	E3	Deltamarker Step Size	HP 8566A/ HP 8568A	available
E4	E4	Marker to Ref. Level	available	available
EDITDONE		limit line edit done	HP 856xE	available
EDITLIML		edit limit line	HP 856xE	available

Command	Supported subset	Function	Corresp. HP-Models	Status
ERR	ERR 250 cal level error ERR 300 LO unlock ERR 472 cal error digital filter ERR 473 cal error analog filter ERR 552 cal error log amp ERR 902 unscale tracking generator ERR 906 oven cold ERR 117 numeric unit error ERR 112 Unrecognized Command	Now some FSx errors are mapped to HP errors.	HP8568A HP856xE	not yet available
ERR?	ERR?	Error queue query	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not yet available
EX	EX	Exchange trace A and B	HP 8566A/ HP 8568A	available
FA	FA <numeric_value> HZ|KHZ|MHZ|GHZ FA UP FA DN FA?	Start Frequency	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
FB	FB <numeric_value> HZ|KHZ|MHZ|GHZ FB UP FB DN FB?	Stop Frequency	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
FDSP		Frequency display off	8560E 8561E 8562E 8563E 8564E 8565E	available
FOFFSET [1)]	FOFFSET <numeric_value> HZ|KHZ|MHZ|GHZ FOFFSET?	Frequency Offset	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
FREF	FREF INT|EXT	Reference Frequency	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
FS	FS	Full Span	HP 8566A/ HP 8568A	available
FUNCDEF		Define Function Function must be in one line between delimiters @	HP 8594E/ HP 856xE/ HP 8566B	available
GATE [1)]	GATE ON|OFF GATE 1|0		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GATECTL [1)]	GATECTL EDGE|LEVEL GATECTL?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GD [1)]	GD <numeric_value> US|MS|SC GD DN GD UP GD?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GL [1)]	GL <numeric_value> US|MS|SC GL DN GL UP GL?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GP [1)]	GP POS|NEG GP?		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
GRAT [2)]	GRAT ON|OFF	Graticule	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
I1	I1		HP 8566A/ HP 8568A	available
I2	I2		HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
ID	ID ID?	Identify	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
INZ [1)]	INZ 75 INZ 50 INZ?	Input Impedance	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
IP	IP	Instrument preset	HP 8566A/ HP 8568A	available
KEYDEF	KEYDEF	Key definition	HP 8566B/ HP 856xE/ HP 859xE	available
KEYEXEC	KEYEXEC	Key execute	HP 8566B	available
KS=	KS= <numeric_value> HZ|KHZ|MHZ|GHZ KS= DN KS= UP KS=?	Marker Frequency Counter Resolution	HP 8566A/ HP 8568A	available
KS/	KS/	Manual Peaking	HP 8566A/ HP 8568A	available
KS(	KS(	Lock register	HP 8566A/ HP 8568A	available
KS)	KS)	Unlock register	HP 8566A/ HP 8568A	available
KS91	KS91	Read Amplitude Error	HP 8566A/ HP 8568A	available
KSA	KSA	Amplitude Units in dBm	HP 8566A/ HP 8568A	available
KSB	KSB	Amplitude Units in dBmV	HP 8566A/ HP 8568A	available
KSC	KSC	Amplitude Units in dBuV	HP 8566A/ HP 8568A	available
KSD	KSD	Amplitude Units in V	HP 8566A/ HP 8568A	available
KSE	KSE <numeric_value>| <char data>@	Title mode	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
KSG	KSG KSG ON KSG <numeric_value>	Video Averaging on	HP 8566A/ HP 8568A	available
KSH	KSH	Video Averaging Off	HP 8566A/ HP 8568A	available
KSK		Marker to Next Peak	HP 8566A/ HP 8568A	available
KSL		Marker Noise off	HP 8566A/ HP 8568A	available
KSM		Marker Noise on	HP 8566A/ HP 8568A	available
KSO	KSO	Delta marker to span	HP 8566A/ HP 8568A	available
KSP	KSP <numeric_value>	HPIB address	HP 8566A/ HP 8568A	available
KSQ [2)]	KSQ	Band lock off	HP 8566A/ HP 8568A	available
KST	KST	Fast Preset	HP 8566A/ HP 8568A	available
KSV	KSV <numeric_value> HZ|KHZ|MHZ|GHZ KSV?	Frequency Offset	HP 8566A/ HP 8568A	available
KSW	KSW	Error Correction Routine	HP 8566A/ HP 8568A	available
KSX	KSX	Correction Values On	HP 8566A/ HP 8568A	available
KSY	KSY	Correction Values Off	HP 8566A/ HP 8568A	available
KSZ	KSZ <numeric_value> DB KSZ?	Reference Value Offset	HP 8566A/ HP 8568A	available
KSa	KSa	Normal Detection	HP 8566A/ HP 8568A	available
KSb	KSb	Pos Peak Detection	HP 8566A/ HP 8568A	available
KSd	KSd	Neg Peak Detection	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
KSe	KSe	Sample Detection	HP 8566A/ HP 8568A	available
KSg		CRT beam off		available
KSh		CRT beam on		available
KSj	KSj	View Trace C	HP 8566A/ HP 8568A	available
KSk	KSk	Blank Trace C	HP 8566A/ HP 8568A	available
KSl	KSl	Transfer B to C	HP 8566A/ HP 8568A	available
KSm	KSm	Graticule off	HP 8566A/ HP 8568A	available
KSn[2)]	KSn	Grid on	HP 8566A/ HP 8568A	available
KSo	KSn	Character display off	HP 8566A/ HP 8568A	available
KSp	KSp	Character display on	HP 8566A/ HP 8568A	available
KSr	KSr	Create service request	HP 8566A/ HP 8568A	available
KSt [2)]	KSt	Band lock on	HP 8566A/ HP 8568A	available
KSv [2)]	KSv	Signal ident on	HP 8566A/ HP 8568A	available
L0	L0	Display line off	HP 8566A/ HP 8568A	available
LB	LB <numeric_value>| <char data>@	Label	HP 8566A/ HP 8568A	available
LF	LF	Low frequency band pre-set	HP 8566A/ HP 8568A	available
LIMD		limit line delta	HP 856xE	available
LIMF		limit line frequency	HP 856xE	available
LIMIFAIL		limit fail query	HP 856xE	available
LIMIPURGE		purge limit line	HP 856xE	available
LIMIRCL		recall limit line	HP 856xE	available
LIMIREL		relative limit line	HP 856xE	available

Command	Supported subset	Function	Corresp. HP-Models	Status
LIMISAV		save limit line	HP 856xE	available
LIMITEST		limit line test	HP 856xE	available
LIML		lower limit line value	HP 856xE	available
LIMM		middle limit line value	HP 856xE	available
LIMTFL		flat limit line segment	HP 856xE	available
LIMTSL		slope limit line segment	HP 856xE	available
LIMU		upper limit line value	HP 856xE	available
LG	LG <numeric_value> DB | DM LG?	Amplitude Scale Log	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
LL [2)]	LL	Plot command	HP 8566A/ HP 8568A	available
LN	LN	Amplitude Scale Lin	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
M1	M1	Marker Off	HP 8566A/ HP 8568A	available
M2	M2 M2 <numeric_value> HZ|KHZ|MHZ|GHZ M2 DN M2 UP M2?	Marker Normal	HP 8566A/ HP 8568A	available
M3	M3 M3 <numeric_value> HZ|KHZ|MHZ|GHZ M3 DN M3 UP M3?	Delta Marker	HP 8566A/ HP 8568A	available
M4	M4 <numeric_value> HZ|KHZ|MHZ|GHZ	Marker Zoom	HP 8566A/ HP 8568A	available
MA	MA	Marker Amplitude	HP 8566A/ HP 8568A	available
MC0	MC0	Marker Count off	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
MC1	MC1	Marker Count on	HP 8566A/ HP 8568A	available
MDS	MDS	Measurement data size	HP 8566B	available
MEAS		Measurement status	HP 856xE	available
MF	MF MF?	Marker Frequency	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MINH[1)]	MINH TRC	Minimum Hold	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKA	MKA <numeric_value> MKA?	Marker Amplitude	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKACT	MKACT 1 MKACT?	Select the active marker	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available
MKBW [1)]	MKBW <numeric_value> MKBW ON MKBW OFF	N dB Down	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKD	MKD MKD <numeric_value> HZ|KHZ| MHZ|GHZ MKD DN MKD UP MKD ON MKD OFF MKD?	Delta Marker	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKDR	MKDR <numeric_value> HZ|KHZ| MHZ|GHZ| S|SC|MS|MSEC| USMKDR?	Delta Marker reverse	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
MKDR?		Delta Marker reverse query		available
MKF	MKF <numeric_value> HZ|KHZ|MHZ|GHZ MKF?	Set Marker Frequency	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKFC	MKFC ON|OFF	Frequency Counter on/off	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKFCR [1)]	MKFCR <numeric_value> HZ|KHZ| MHZ|GHZ MKFCR DN MKFCR UP MKFCR?	Frequency Counter Resolution	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKMIN	MKMIN	Marker -> Min	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKN	MKN MKN <numeric_value> HZ|KHZ|MHZ|GHZ MKN DN MKN UP MKN ON MKN OFF MKN?	Normal Marker	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKNOISE	MKNOISE ON|OFF MKNOISE 1|0 MKNOISE?	Noise Measurement	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKOFF	MKOFF MKOFF ALL	Marker off	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKP	MKP <numeric_value> MKP?	Marker position	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
MKPK	MKPK MKPK HI MKPK NH MKPK NR MKPK NL	Marker Search	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKPT	MKPT MKPT HI MKPT NH MKPT NR MKPT NL	Marker Peak Threshold	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKPX	MKPX <numeric_value> DB MKPX DN MKPX UP MKPX?	Peak Excursion	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKRL	MKRL	Ref Level = Marker Level	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKSP	MKSP	Delta marker to span	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKSS	MKSS	CF Stepsize = Marker Freq	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKT	MKT <numeric_value> S|MS|US|SC MKT?	MKF = fstart + MKT/ SWT*Span	HP 856xE/ HP 8594E	available
MKTRACE	MKTRACE TRA|TRB|TRC	Marker to Trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MKTRACK	MKTRACK ON|OFF MKTRACK 1|0 MKTRACK?	Signal Track	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
MKTYPE	MKTYPE AMP MK TYPE?	Marker type	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ML		Mixer level	HP 856xE	available
MOV	MOV TRA|TRB|TRC, TRA|TRB|T RC	Move Trace Contents	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
MPY		Multiply	HP 8566B/ HP 8568B/ HP 8594E	available
MT0	MT0	Marker Track Off	HP 8566A/ HP 8568A	available
MT1	MT1	Marker Track On	HP 8566A/ HP 8568A	available
MXMH	MXMH TRA|TRB	Maximum Hold	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
NORMALIZE	NORMALIZE	Normalize trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available available
NRL [1)]	NRL <numeric_value> DB | DM NRL?	Normalized Reference Level	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
NRPOS	NRPOS <numeric_value> NRL?	Normalize position	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
O1	O1	Format ASCII, Values 0 to 4095	HP 8566A/ HP 8568A	available
O2	O2	Format Binary, Values 0 to 4095	HP 8566A/ HP 8568A	available
O3	O3	Format ASCII	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
OA	OA	Output All	HP 8566A/ HP 8568A	available
OL	OL <80 characters> OL?	Output Learn String	HP 8566A/ HP 8568A	available
OT	OT	Output Trace Annotations	HP 8566A/ HP 8568A	available
PA	PA <numeric_value>, <numeric_value	Plot command	HP 8566A/ HP 8568A	available
PD	PD <numeric_value>, <numeric_value	Plot command	HP 8566A/ HP 8568A	available
PH_MKF		Spot frequency in Hz	HP 856xE	available
PH_FMIN		Min offset frequency to be measured	HP 856xE	available
PH_FMAX		Max offset frequency to be measured	HP 856xE	available
PH_MKA		Queries amplitude at the spot frequency	HP 856xE	available
PH_DRIFT		0: for stable signals, 1: for drifty	HP 856xE	available
PH_RLVL		Reference level for the log plot	HP 856xE	available
PH_SMTHV		Trace smoothing	HP 856xE	available
PH_VBR		Filtering	HP 856xE	available
PH_RMSPT		Number of data points to skip when doing the integration	HP 856xE	available
PH_RMSFL		Lower integration frequency in Hz	HP 856xE	available
PH_RMSFU		Upper integration frequency in Hz	HP 856xE	available
PH_EXIT		Quits phase noise	HP 856xE	available
PH_F_UDT		Updates internal frequency variables	HP 856xE	available
PH_LMT_L		Apply limits to PH_FMIN and PH_FMAX	HP 856xE	available
PH_MEAS		Generates log frequency plot	HP 856xE	available
PH_MKF_D		Updates the spot frequency	HP 856xE	available

Command	Supported subset	Function	Corresp. HP-Models	Status
PH_RMS		Requests the rms phase noise	HP 856xE	available
PH_RMSFT		Updates internal frequency variables	HP 856xE	available
PH_RMSX		Calculates the rms phase noise	HP 856xE	available
PH_SPOTF		Executes the spot frequency measurement	HP 856xE	available
PLOTORG [2)]	PLOTORG DSP|GRT	Plot command	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PLOTSRC [2)]	PLOTSRC ANNT|GRT| TRB| TRA|ALLDSP|GRT	Plot command	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PP	PP	Preselector Peaking	HP 8566A/ HP 8568A	available
PRINT [1)]	PRINT PRINT 1|0	Hardcopy	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PSDAC [2)]	PSDAC <numeric_value> PSDAC UP|DN	Preselector DAC value	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PSTATE [2)]	PSTATE ON|OFF|1|0	Protect the State	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
PU	PU	Pen Up	HP 8566A/ HP 8568A	available
PWRBW	PWRBW	Power Bandwidth	HP 8566B/ HP 859x/ HP 856xE	available
R1	R1	Set Status Bit Enable	HP 8566A/ HP 8568A	available
R2	R2	Set Status Bit Enable	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
R3	R3	Set Status Bit Enable	HP 8566A/ HP 8568A	available
R4	R4	Set Status Bit Enable	HP 8566A/ HP 8568A	available
RB	RB <numeric_value> HZ|KHZ|MHZ|GHZ RB DN RB UP RB AUTO RB?	Resolution Bandwidth	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RBR	RBR <numeric_value> RBR DN RBR UP RBR?	Resolution Bandwidth Ratio	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RC1…6	RC1…6	Recall Last State	HP 8566A/ HP 8568A	available
RCLS	RCLS <numeric_value>	Recall State Register	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RCLT	RCLT TRA|TRB, <number>	Recall Trace	HP856xE/ HP8594E	available
RESET	RESET	Instrument preset	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
REV	REV REV?	Firmware revision	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RL	RL <numeric_value> DB|DM RL DN RL UP RL?	Reference Level	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RLCAL	RLCAL <numeric_value> RL?	Reference Level Calibration	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
RCLOSCAL	RCLOSCAL	Recall Open/Short Average	HP 856xE/ HP 8594E	not available
RCLTHRU	RCLTHRU	Recall Thru	HP 856xE/ HP 8594E	not available
RLPOS [1)]	RLPOS <numeric_value> RLPOS DN RLPOS UP RLPOS?	Reference Level Position	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ROFFSET	ROFFSET <numeric_value> DB | DM ROFFSET?	Reference Level Offset	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
RQS	RQS	Service Request Bit mask	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
S1	S1	Continuous Sweep	HP 8566A/ HP 8568A	available
S2	S2	Single Sweep	HP 8566A/ HP 8568A	available
SADD		add a limit line segment	HP 856xE	available
SAVES	SAVES <numeric_value>	Save State Register	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SAVET	SAVET TRA|TRB,<number>	Save Trace	HP856xE/ HP8594E	available
SDEL		delete limit line segment	HP 856xE	available
SDON		limit line segment done	HP 856xE	available
SEDI		edit limit line segment	HP 856xE	available
SMOOTH	SMOOTH TRA|TRB|TRC, <number of points>	Smooth Trace	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SNGLS	SNGLS	Single Sweep	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
SQUELCH [2]	SQUELCH <numeric_value> DM | DB SQUELCH UP|DN SQUELCH ON|OFF	Squelch	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SP	SP <numeric_value> HZ|KHZ|MHZ|GHZ SP DN SP UP SP?	Span	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SRCNORM [1]	SRCNORM ON|OFF SRCNORM 1|0	Source Normalization	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available
SRCPOFS [1]	SRCPOFS <numeric_value> DB | DM SRCPOFS DN SRCPOFS UP SRCPOFS?	Source Power Offset	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available
SRCPWR [1]	SRCPWR <numeric_value> DB | DM SRCPWR DN SRCPWR UP SRCPWR ON SRCPWR OFF SRCPWR?	Source Power	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	not available
SS	SS <numeric_value> HZ|KHZ|MHZ|GHZ SS DN SS UP SS AUTO SS?	CF Step Size	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
ST	ST <numeric_value> US|MS|SC ST DN ST UP ST AUTO ST?	Sweep Time	HP 8566A/ HP 8568A/ HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
STB	STB	Status byte query	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
STOREOPEN	STOREOPEN	Store Open	HP 856xE/ HP 8594E	not available
STORESHORT	STORESHORT	Store Short	HP 856xE/ HP 8594E	not available
STORETHRU	STORETHRU	Store Thru	HP 856xE/ HP 8594E	not available
SUB		Subtract	HP 8566B/ HP 8568B/ HP 8594E	available
SUM		sum of trace amplitudes	HP 8566B/ HP 8568B/ HP 8594E	available
SV1…6	SV1…6	Save State	HP 8566A/ HP 8568A	available
SWPCPL [2)]	SWPCPL SA | SR SWPCPL?	Sweep Couple	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
SWPOUT [2)]	SWPOUT FAV|FAVA| RAMP SWPOUT?	Sweep Output	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
T0	T0	Threshold off	HP 8566A/ HP 8568A	available
T1	T1	Free Run Trigger	HP 8566A/ HP 8568A	available
T2 [2)]	T2	Line Trigger	HP 8566A/ HP 8568A	available
T3	T3	External Trigger	HP 8566A/ HP 8568A	available
T4	T4	Video Trigger	HP 8566A/ HP 8568A	available
TA	TA	Transfer A	HP 8566A/ HP 8568A	available

Command	Supported subset	Function	Corresp. HP-Models	Status
TACL	TACL?	Returns instantaneous measurement results. See TRACe<trace #>:IMMediate:LEVel? for full description.		not available
TBCL	TBCL?			
TCCL	TCCL?			
TACR	TACR?	Returns instantaneous measurement results. See TRACe<trace #>:IMMediate:LEVel? for full description.		not available
TBCR	TBCR?			
TCCR	TCCR?			
TB	TB	Transfer B	HP 8566A/ HP 8568A	available
TDF	TDF P TDF M TDF B TDF A TDF I	Trace Data Format	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TH	TH <numeric_value> DB|DM TH DN TH UP TH ON TH OFF TH AUTO TH?	Threshold	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
THE	THE ON| OFF	Threshold Line enable	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TIMEDSP [1)]	TIMEDSP ON|OFF TIMEDSP 1|0 TIMEDSP?	Time Display	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TM	TM FREE|VID|EXT|LINE[2)] TM?	Trigger Mode	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TM LINE [2)]	TM LINE	Trigger Line	HP 8566B	available

Command	Supported subset	Function	Corresp. HP-Models	Status
TRA	TRA B TRA A TRA I	Transfer A	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TRB	TRB B TRB A TRB I	Transfer B	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TRSTAT	TRSTAT?	Trace State Query	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
TS	TS	Take Sweep	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
UR [2)]	UR	Plot Command	HP 8566A/ HP 8568A	available
VARDEF	VARDEF	Variable definition, arrays are not supported	HP 8566B/ HP 8568B/ HP 8594E	available
VAVG	VAVG VAVG TRA|TRB|TRC	Video Averaging	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
VB	VB <numeric_value> HZ|KHZ|MHZ|GHZ VB DN VB UP VB AUTO VB?	Video Bandwidth	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
VBR [1)]	VBR <numeric_value> VBR DN VBR UP VBR?	Video Bandwidth Ratio	HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available
VIEW	VIEW TRA|TRB|TRC		HP 856xE/ HP 8566B/ HP 8568B/ HP 8594E	available

Command	Supported subset	Function	Corresp. HP-Models	Status
VTL	VTL <numeric_value> DB|DM VTL DN VTL UP VTL?	Video Trigger Level	HP 856xE/ HP 8594E	not available
1) HP 8594E only				
2) Command is accepted without error message, but is ignored				

Special features of the syntax parsing algorithms for 8566A and 8568A models

The command syntax is very different for models A and B. Different names are assigned to identical instrument functions, and the command structure likewise differs considerably between models A and models B.

The command structure for models A is as follows:

```
<command>::= <command
code>[<SPC>][<data>|<step>][<SPC>][<delimiter>][<command
code>]…<delimiter>
```

```
<data>::= <Value>[<SPC>][<units
code>][<SPC>][<delimiter>][<SPC>][<data>]…
```

```
<step>::= UP|DN
```

where

`<command code>` = see Table "Supported Commands"

`<Value>` = integer or floating-point numerical value

`<units code>` = DM | -DM | DB | HZ | KZ | MZ | GZ | MV | UV | SC | MS | US

`<delimiter>` = <CR> | <LF> | <,> | <;> | <ETX>

`<SPC>` = 32_{10}

`<ETX>` = 3_{10}

Command sections given in [ ] are optional.

The FSWX GPIB hardware differs from that used in the HP analyzers. Therefore, the following constraint exists:

`<LF>| <EOI>` are still used as delimiters since the GPIB hardware is able to identify them. The other delimiters are identified and evaluated during syntax analysis.

Special behavior of commands

Command	Known Differences
ABORT	Does not automatically set the command complete bit (bit 4) in the status byte. An additional DONE is required for that purpose.
ANNOT	Only frequency axis annotation is affected.
AT	AT DN/UP: Step size
CAL	The CAL commands do not automatically set the command complete bit (bit 4) in the status byte. An additional DONE command is required for that purpose.
CF	Default value, range, step size
CR	Default ratio Span/RBW
CT	Formula for coupled sweep time
CV	Default ratio RBW/VBW
DET	DET? returns SAMP instead of SMP on the FSWX. DET does not automatically set the command complete bit (bit 4) in the status byte. An additional DONE is required for that purpose.
ERR?	Deletes the error bit in the status register but always returns a '0' in response.
FA	Default value, range, step size
FB	Default value, range, step size
ID	Query of instrument ID. The instrument ID defined in "SETUP > Network + Remote > GPIB > Identification String" is returned.
M2	Default value, range, step size
M3	Default value, range, step size
MKACT	Only marker 1 is supported as the active marker.
MKBW	Default value
MKPT	Step size
MKPX	Step size
OL?	Storage of instrument settings: 80 characters are returned as information on the instrument settings. The contents of the 80 characters returned does not correspond to the original data contents of the 8566A/8568A family.
OL	Readout of instrument settings: The 80 characters read using `OL?` are accepted as information on the corresponding instrument settings. The contents of the 80 characters read does not correspond to the original data contents of the 8566A/8568A family.
RB	Default value, range, step size
RL	Default value, step size

Command	Known Differences
RLPOS	Adapts the position of the reference level even if the tracking generator normalization is not active.
RQS	Supported bits: 1 (Units key pressed) 2 (End of Sweep) 3 (Device error) 4 (Command complete) 5 (Illegal command)

Model-dependent default settings

If you switch the GPIB language to an 85xx model, the GPIB address is automatically switched to 18, provided that the default address of the FSWX (20) is still set. If a different value is set, this value is maintained. Upon return to SCPI, this address remains unchanged.

The following table shows the default settings obtained after a change of the GPIB language and for the commands IP, KST and RESET:

Model	# of Trace Points	Start Freq.	Stop Freq.	Ref Level	Input Coupling
8566A/B	1001	2 GHz	22 GHz	0 dBm	AC
8568A/B	1001	0 Hz	1.5 GHz	0 dBm	AC
8560E	601	0 Hz	2.9 GHz	0 dBm	AC
8561E	601	0 Hz	6.5 GHz	0 dBm	AC
8562E	601	0 Hz	13.2 GHz	0 dBm	AC
8563E	601	0 Hz	26.5 GHz	0 dBm	AC
8564E	601	0 Hz	40 GHz	0 dBm	AC
8565E	601	0 Hz	50 GHz	0 dBm	AC
8594E	401	0 Hz	3 GHz	0 dBm	AC

Stop frequency

The stop frequency given in the table can be limited to the corresponding frequency range of the FSWX.

Command LF sets the stop frequency for 8566A/B to a maximum value of 2 GHz.

Test points (trace points)

The number of trace points is switched over only upon transition to the REMOTE state.

Data output formats

For the SCPI and IEEE488.2 standards, the output formats for numerical data are flexible to a large extent. The output format for the HP units, by contrast, is accurately defined concerning the number of digits. The memory areas for reading instrument

data have therefore been adapted accordingly in the remote control programs for instruments of this series.

Therefore, in response to a query, the FSWX returns data of the same structure as that used by the original instruments; this applies in particular to the number of characters returned.

Two formats are currently supported when trace data is output: Display Units (command O1) and physical values (command O2, O3 or TDF P). As to the "Display Units" format, the level data of the FSWX is converted to match the value range and the resolution of the 8566/8568 series. Upon transition to the **REMOTE** state, the FSWX is reconfigured such that the number of test points (trace points) corresponds to that of the 85xx families (1001 for 8566A/B and 8568A/B, 601 for 8560E to 8565E, 401 for 8594E).

Trace data output formats

All formats are supported for trace data output: display units (command O1), display units in two byte binary data (command O2 or TDF B and MDS W), display units in one-byte binary data (command O4 or TDF B and MDS B) and physical values (commands O3 or TDF P). With format "display units", the level data is converted into the value range and resolution of the 8566/8568 models. On transition to REMOTE state, the number of trace points are reconfigured to be conform to the selected instrument model (1001 for 8566A/B and 8568 A/B, 601 for 8560E to 8565E, 401 for 8594E).

Trace data input formats

Trace data input is only supported for binary data (TDF B, TDF A, TDF I, MDS W, MDS B).

GPIB status reporting

The assignment of status bits by commands R1, R2, R3, R4, RQS is supported.

The STB command and the serial poll respond with an 8-bit value with the following assignment:

Bit enabled by RQS	Description
0	not used (value 0)
1	Units key pressed
2	End of Sweep
3	Device Error
4	Command Complete
5	Illegal Command
6	Service Request
7	not used (value 0)

Bits 0 and 7 are not used and always have the value 0.

Note that the FSWX reports any key pressed on the front panel rather than only the unit keys if bit 1 was enabled.

Another difference is the behavior of bit 6 when using the STB? query. On the HP analyzers, this bit monitors the state of the SRQ line on the bus. On the FSWX, this is not possible. Therefore, this bit is set as soon as one of the bits 1 to 5 is set. It is not reset by performing a serial poll.

4.14.17.3 Reference: command set of emulated PSA models

The FSWX analyzer family supports a subset of the GPIB commands of PSA89600 and ESA instruments.

Despite the differences in system architecture and device features, the supported commands have been implemented in a way to ensure a sufficiently high degree of correspondence with the original.

Usually, the selection of commands supported by the FSWX is sufficient to run an existing GPIB program without adaptation.

Supported 89600 commands
*CAL?
*CLS
*ESE
*ESR?
*IDN?
*IST?
*OPC
*OPT?
*PCB
*PRE
*PSC
*RST
*SRE
*STB?
*TRG
*TST?
*WAI
:CALibration:AUTO OFF|ON|ALERt
:CALibration:TCORrections AUTO|ON|OFF
:CONFigure:WAVeform

Supported 89600 commands
:DIAGnostic:EABY ON|OFF
:DIAGnostic:LATCh:VALue <numeric>
:DIAGnostic:LATCh:SELect <string>
:DISPlay:ANNotation:TITLe:DATA <string>
:DISPlay:ENABle OFF|ON
:DISPlay:WINDow:TRACe:Y:[SCALe]:PDIVision <numeric>
:DISPlay:WINDow:TRACe:Y:[SCALe]:RLEVel <numeric>
:DISPlay:WINDow:TRACe:Y:[SCALe]:RLEVel:OFFSet <numeric>
:DISPlay:WINDow:TRACe:Y[:SCALe]:SPACing LINear|LOGarithmic|LDB
:FORMat:BORDer NORMal|SWAPped
:FORMat[:DATA] ASCii|REAL|UINT|MATLAB,<numeric>
:INITiate:CONTinuous OFF|ON
:INITiate[:IMMediate]
:INSTrument:CATalog?
:INSTrument:NSELect <numeric>
:MMEMory:CATalog? <dir_name>
:MMEMory:COPY <'file_name1'>,<'file_name2'>
:MMEMory:DATA <'file_name'>,<definite_length_block>
:MMEMory:DELete <'file_name'>
:MMEMory:LOAD:STATe 1,<'file_name'>
:MMEMory:LOAD:TRACe 1,<'file_name'>
:MMEMory:MDIRectory <'dir_name'>
:MMEMory:MOVE <'file_name1'>,<'file_name2'>
:MMEMory:STORe:STATe 1,<'file_name'>
:MMEMory:STORe:TRACe <numeric>,<'file_name'>
:READ:WAVform?
[:SENSe]:CORRection:CSET:All[STATe] <booleon>
[:SENSe]:FREQuency:CENTer <numeric>
[:SENSe]:FREQuency:STARt <numeric>
[:SENSe]:FREQuency:STOP <numeric>
[:SENSe]:FREQuency:SPAN <numeric>
[:SENSe]:POWer:ATTenuation <numeric>
[:SENSe]:ROSCillator:EXTernal:FREQuency <numeric>

Supported 89600 commands
[:SENSe]:ROSCillator:OUTPut OFF|ON
[:SENSe]:ROSCillator:SOURce INTernal|EXTernal|EAUTo
[:SENSe]:SPECtrum:TRIGger:SOURce EXTernal<1|2>|IF|IMMediate
[:SENSe]:WAVeform:ADC:RANGe P6
[:SENSe]:WAVeform:APER?
[:SENSe]:WAVeform:AVERage:TACount <numeric>
[:SENSe]:WAVeform:BWIDth:ACTive?
[:SENSe]:WAVeform:BWIDth:TYPE FLAT|GAUSsian
[:SENSe]:WAVeform:IFGain <numeric>
[:SENSe]:WAVeform:IFPath NARRow|WIDE
[:SENSe]:WAVeform:NCPTrace ON|OFF
[:SENSe]:WAVeform:PDIT ON|OFF
[:SENSe]:WAVeform:SRATe <numeric>
[:SENSe]:WAVeform:SWEep:TIME <numeric>
[:SENSe]:WAVeform:TRIGger:EOFFset?
[:SENSe]:WAVeform:TRIGger:INTerpolation ON|OFF
[:SENSe]:WAVeform:TRIGger:SOURce EXTernal<1|2>|IF|IMMediate
:STATus:QUEStionable:CONDition?
:STATus:QUEStionable:ENABle <number>
:STATus:QUEStionable:NTRansition <number>
:STATus:QUEStionable:PTRansition <number>
:STATus:QUEStionable[:EVENt]?
:STATus:QUEStionable:CALibration:CONDition?
:STATus:QUEStionable:CALibration:ENABle <number>
:STATus:QUEStionable:CALibration:NTRansition <number>
:STATus:QUEStionable:CALibration:PTRansition <number>
:STATus:QUEStionable:CALibration[:EVENt]?
:STATus:QUEStionable:FREQuency:CONDition?
:STATus:QUEStionable:FREQuency:ENABle <number>
:STATus:QUEStionable:FREQuency:NTRansition <number>
:STATus:QUEStionable:FREQuency:PTRansition <number>
:STATus:QUEStionable:FREQuency[:EVENt]?
:STATus:QUEStionable:INTegrity:CONDition?

Supported 89600 commands
:STATus:QUEStionable:INTegrity:ENABle <number>
:STATus:QUEStionable:INTegrity:NTRansition <number>
:STATus:QUEStionable:INTegrity:PTRansition <number>
:STATus:QUEStionable:INTegrity[:EVENt]?
:STATus:OPERation:CONDition?
:STATus:OPERation:ENABle <integer>
:STATus:OPERation:NTRansition <integer>
:STATus:OPERation:PTRansition <integer>
:STATus:OPERation[:EVENt]?
:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <integer>
:SYSTem:DATE <year>,<month>,<day>
:SYSTem:ERRor[:NEXT]?
:SYSTem:KLOCK?
:SYSTem:MESSage <string>
:SYSTem:PRESet
:SYSTem:TIME <hour>,<minute>,<second>
:SYSTem:VERSion?
:TRACe:COPY <src_trace>,<dest_trace>
:TRACe[:DATA] TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6, <definite_length_block> | <comma_separated_ASCII_data>
:TRACe:MODE WRITe|MAXHold|MINHold|VIEW|BLANk
:TRIGger[:SEQuence]:DELay <numeric>
:TRIGger[:SEQuence]:DELay:STATe OFF|ON|0|1
:TRIGger[:SEQuence]:EXTermal:DELay <numeric>
:TRIGger[:SEQuence]:EXTermal:LEVel <numeric>
:TRIGger[:SEQuence]:EXTermal:SLOPe POSitive|NEGative
:TRIGger[:SEQuence]:HOLDoff <numeric>
:TRIGger[:SEQuence]:IF:DELay <numeric>
:TRIGger[:SEQuence]:IF:LEVel <numeric>
:TRIGger[:SEQuence]:IF:SLOPe POSitive|NEGative
:TRIGger[:SEQuence]:SLOPe POSitive|NEGative
:TRIGger[:SEQuence]:SOURce IMMediate|VIDeo|EXTernal<1|2>

Supported 89600 commands
:TRIGger[:SEQuence]:VIDeo:LEVel <numeric>
:TRIGger[:SEQuence]:VIDeo:LEVel:FREQuency <freq>

4.14.17.4 Reference: command set of emulated PXA models

The FSWX analyzer family supports a subset of the GPIB commands of PXA instruments.

Despite the differences in system architecture and device features, the supported commands have been implemented in a way to ensure a sufficiently high degree of correspondence with the original.

In many cases the selection of commands supported by the FSWX is sufficient to run an existing GPIB program without adaptation.

Table 4-71: Supported PXA commands

ABORt
CALCulate:MARKer:AOFF
CALCulate:MARKer[1]|2|...12:MAXimum
CALCulate:MARKer[1]|2|...12:MAXimum:LEFT
CALCulate:MARKer[1]|2|...12:MAXimum:NEXT
CALCulate:MARKer[1]|2|...12:MAXimum:RIGHt
CALCulate:MARKer[1]|2|...12:MINimum
CALCulate:MARKer[1]|2|...12:MODE POSition | DELTa | FIXed | OFF
CALCulate:MARKer[1]|2|...12:MODE[?] SPAN | BAND
CALCulate:MARKer[1]|2|...12[:SET]:CENTer
CALCulate:MARKer[1]|2|...12[:SET]:RLEVel
CALCulate:MARKer[1]|2|...12[:SET]:STARt
CALCulate:MARKer[1]|2|...12[:SET]:STOP
CALCulate:MARKer[1]|2|...12:STATe[?] OFF | ON | 0 | 1
CALCulate:MARKer[1]|2|...12:X[?] <freq | time>
CALCulate:MARKer[1]|2|...12:X:POSition[?] <real>
CALCulate:MARKer[1]|2|...4:X:SPAN
CALCulate:MARKer[1]|2|...4:X:STARt
CALCulate:MARKer[1]|2|...4:X:STOP
CALCulate:MARKer[1]|2|...12:Y[?] <real>
CALibration[:ALL][?]
CALibration:AUTO[?] ON | PARTial | OFF | ALERt

CALibration:AUTO:ALERt[?] TTEMperature | DAY | WEEK | NONE
CALibration:AUTO:MODE[?] ALL | NRF
CALibration:AUTO:TIME:OFF?
CONFigure? SAN
DISPlay:WINDow[1]:TRACe:Y[:SCALe]:RLEVel[?] <real>
DISPlay:WINDow[1]:TRACe:Y[:SCALe]:RLEVel:OFFSet[?] <rel_ampl>
DISPlay:WINDow[1]:TRACe:Y[:SCALe]:SPACing LINear|LOGarithmic|LDB
INITiate:CONTinuous[?] OFF | ON | 0 | 1
INITiate[:IMMediate]
INPut:COUPling[?] AC | DC
MMEMory:CATalog? [<directory_name>]
MMEMory:CDIRectory[?] [<directory_name>]
MMEMory:COPY <string>, <string>[, <string>, <string>]
MMEMory:DATA[?] <file_name>, <data>
MMEMory:DELete <file_name>[, <directory_name>]
MMEMory:LOAD:STATe 1, <filename>
MMEMory:MDIRectory <directory_name>
MMEMory:MOVE <string>, <string>[, <string>, <string>]
MMEMory:RDIRectory <directory_name>
MMEMory:STORe:STATe 1, <filename>
[:SENSe]:AVERage:COUNt[?] <integer>
[:SENSe]:AVERage[:STATe][?] ON | OFF | 1 | 0
[:SENSe]:AVERage:TYPE[?] RMS | LOG | SCALar[:SENSe]:AVERage:TYPE?
[:SENSe]:BANDwidth|BWIDth[:RESolution][?] <freq>
[:SENSe]:BANDwidth|BWIDth[:RESolution]:AUTO[?] OFF | ON | 0 | 1
[:SENSe]:BANDwidth|BWIDth:VIDeo[?] <freq>
[:SENSe]:BANDwidth|BWIDth:VIDeo:AUTO[?] OFF | ON | 0 | 1
[:SENSe]:BANDwidth|BWIDth:VIDeo:RATio[?] <real>
[:SENSe]:BANDwidth|BWIDth:VIDeo:RATio:AUTO[?] OFF | ON | 0 | 1
[:SENSe]:CORRection:CSET:All[STATe] <booleon>
[:SENSe]:DETector:AUTO[?] ON | OFF | 1 | 0
[:SENSe]:FREQuency:CENTer[?] <freq>
[:SENSe]:FREQuency:CENTer:STEP:AUTO[?] OFF | ON | 0 | 1
[:SENSe]:FREQuency:OFFSet[?] <freq>

[:SENSe]:FREQuency:SPAN[?] <freq>
[:SENSe]:FREQuency:SPAN:FULL
[:SENSe]:FREQuency:STARt[?] <freq>
[:SENSe]:FREQuency:STOP[?] <freq>
[:SENSe]:POWer[:RF]:ATTenuation[?] <rel_ampl>
[:SENSe]:POWer[:RF]:ATTenuation:AUTO[?] OFF | ON | 0 | 1
[:SENSe]:SWEep:POINts? <integer>
[:SENSe]:SWEep:TIME? <time>
[:SENSe]:SWEep:TIME:AUTO? OFF | ON | 0 | 1
TRIGger[:SEQuence]:EXTernal2:DELay[?] <time>
TRIGger[:SEQuence]:EXTernal1:DELay[?] <time>
TRIGger[:SEQuence]:EXTernal2:DELay:STATe[?] OFF | ON | 0 | 1
TRIGger[:SEQuence]:EXTernal1:DELay:STATe[?] OFF | ON | 0 | 1
TRIGger[:SEQuence]:EXTernal2:LEVel[?] <level>
TRIGger[:SEQuence]:EXTernal1:LEVel[?] <level>
TRIGger[:SEQuence]:EXTernal2:SLOPe[?] POSitive | NEGative
TRIGger[:SEQuence]:EXTernal1:SLOPe[?] POSitive | NEGative
TRIGger[:SEQuence]:IF:LEVel[?]
TRIGger[:SEQuence]:IF:SLOPe[?] NEGative | POSitive
TRIGger[:SEQuence]:SOURCe EXTernal | IMMediate | VIDeo | LINE | EXTernal1 | EXT1 | EXTernal2 | EXT2 | RFBurst | FRAMe
TRIGger[:SEQuence]:VIDeo:DELay[?] <time>
TRIGger[:SEQuence]:VIDeo:DELay:STATe[?] OFF | ON | 0 | 1
TRIGger[:SEQuence]:VIDeo:LEVel[?] <ampl>
TRIGger[:SEQuence]:VIDeo:SLOPe[?] POSitive | NEGative

[SENSe:] see also [SENSe<ip>]

4.14.17.5 Command set for analog demodulation for emulated PXA models

The FSWX supports a subset of the GPIB commands of PXA instruments for Analog Demodulation measurements.

Despite the differences in system architecture and device features, the supported commands have been implemented in a way to ensure a sufficiently high degree of correspondence with the original.

In many cases the selection of commands supported by the FSWX is sufficient to run an existing GPIB program without adaptation.

Table 4-72: Supported PXA commands for Analog Demodulation

CONFigure:AM
CONFigure:AM:NDEFault
DISPlay:AM:WINDow:TRACe:Y[:SCALe]:RLEVel <real>
READ:AM?
FETCh:AM?
[SENSe]:AM:DWSWeep:TIME <real>

4.14.17.6 Command set for vector signal analysis (VSA) for emulated R&S FSE instruments

The FSWX supports a subset of the GPIB commands of the R&S FSE for vector signal analysis (VSA).

Despite the differences in system architecture and device features, the supported commands have been implemented in a way to ensure a sufficiently high degree of correspondence with the original.

In many cases the selection of commands supported by the FSWX is sufficient to run an existing GPIB program without adaptation.

Table 4-73: Supported R&S FSE commands for vector signal analysis (VSA)

CALCulate{1|2}:MARKer{m}:FUNCtion:DDEMod:RESult?
CALCulate{1|2}:TLINe{1|2} <real>
CALCulate{1|2}:TLINe{1|2}:STATe <bool>
[SENSe]:DDEMod:SEARch:SYNC:OFFSet <real>
[SENSe]:DDEMod:SEARch:SYNC:PATTern <pattern>
[SENSe]:DDEMod:SEARch:PULSe:STATe <bool>
[SENSe]:DDEMod:SEARch:TIME <real>
[SENSe]:DDEMod:FILTer:REFerence
[SENSe]:DDEMod:PRESet[:STANdard]
[SENSe]:TCAPture:LENGth <real>
TRIGger[:SEQuence]:LEVel:VIDeo <real>

4.15 List of commands (General functionality)

[SENSe:] see also [SENSe<ip>] 933
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] 676
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO 677
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:ADJust:RLEVel:STATe 829
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:CATalog? 829

[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:CLEar 830
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:INSert 830
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:MAGNitude[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:PHASe[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:REMove 832
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:SELect 832
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:SIZE? 833
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:LOAD 834
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:PRESet 834
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:REFResh 834
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:CATalog? 836
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:CLEar 836
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:INSert 837
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:MOVE 838
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:PORTs:FROM 838
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:PORTs:TO 839
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:REMove 839
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:SELect 840
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:SIZE? 841
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:STATe 841
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:STATe 842
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:STORe 843
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:ADJust:RLEVel:STATe 829
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:CATalog? 829
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:CLEar 830
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:INSert 830
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:MAGNitude[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:PHASe[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:REMove 832
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:SELect 832
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:SIZE? 833
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:LOAD 834
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:PRESet 834
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:REFResh 834
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:CATalog? 836
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:CLEar 836
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:INSert 837
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:MOVE 838
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:PORTs:FROM 838
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:PORTs:TO 839
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:REMove 839
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:SELect 840
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:SIZE? 841
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:SLISt<sli>:STATe 841
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:STATe 842
[SENSe:]CORRection:FRESponse<ip>:INPut:USER:STORe 843
[SENSe:]CORRection:FRESponse<ip>:USER:ADJust:RLEVel:STATe 829
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:CATalog? 829
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:CLEar 830
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:FREQuency? 830

[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:MAGNitude? 830
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:DATA:PHASe? 830
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:INSert 830
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:MAGNitude[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:PHASe[:STATe] 831
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:REMove 832
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SELect 832
[SENSe:]CORRection:FRESponse<ip>:USER:FLISt<fli>:SIZE? 833
[SENSe:]CORRection:FRESponse<ip>:USER:FSTate 833
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:FREQuency? 834
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:MAGNitude? 834
[SENSe:]CORRection:FRESponse<ip>:USER:IQ:DATA:PHASe? 834
[SENSe:]CORRection:FRESponse<ip>:USER:LOAD 834
[SENSe:]CORRection:FRESponse<ip>:USER:PRESet 834
[SENSe:]CORRection:FRESponse<ip>:USER:PSTate 840
[SENSe:]CORRection:FRESponse<ip>:USER:SCOPe 835
[SENSe:]CORRection:FRESponse<ip>:USER:SCOVered? 835
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:CATalog? 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:CLEar 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:FREQuency<spi>? 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:MAGNitude<spi>? 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:DATA:PHASe<spi>? 836
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:INSert 837
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:MOVE 838
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:PORTs:FROM 838
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:PORTs:TO 839
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:REMove 839
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SELect 840
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:SIZE? 841
[SENSe:]CORRection:FRESponse<ip>:USER:SLISt<sli>:STATe 841
[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:FREQuency? 842
[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:MAGNitude? 842
[SENSe:]CORRection:FRESponse<ip>:USER:SPECtrum:DATA:PHASe? 842
[SENSe:]CORRection:FRESponse<ip>:USER:STATe 842
[SENSe:]CORRection:FRESponse<ip>:USER:STORe 843
[SENSe:]CORRection:FRESponse<ip>:USER:VALid? 843
[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe] 822
[SENSe:]CORRection:TRANsducer:CATalog? 823
[SENSe:]CORRection:TRANsducer:COMMent 823
[SENSe:]CORRection:TRANsducer:DATA 824
[SENSe:]CORRection:TRANsducer:DELete 824
[SENSe:]CORRection:TRANsducer:SCALing 824
[SENSe:]CORRection:TRANsducer:SELect 824
[SENSe:]CORRection:TRANsducer:UNIT 825
[SENSe:]CORRection:TRANsducer[:STATe] 825
[SENSe:]DEMod:SQUelch:LEVel 749
[SENSe:]DEMod:SQUelch[:STATe] 749
[SENSe:]EFRontend:IDN? 574
[SENSe:]EFRontend<f>:SELFtest:RESult? 578
[SENSe:]EFRontend<f>:SELFtest? 578

[SENSe:]PMETer:MATH:MINuend....605
[SENSe:]PMETer:MATH:RESult?....606
[SENSe:]PMETer:MATH:SUBTrahend....606
[SENSe:]PMETer:MATH[:STATe]....605
[SENSe:]PMETer<p>:DCYCle:VALue....600
[SENSe:]PMETer<p>:DCYCle[:STATe]....600
[SENSe:]PMETer<p>:FREQuency....601
[SENSe:]PMETer<p>:FREQuency:LINK....601
[SENSe:]PMETer<p>:MTIMe....602
[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt....602
[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe]....602
[SENSe:]PMETer<p>:ROFFset[:STATe]....603
[SENSe:]PMETer<p>:SOFFset....603
[SENSe:]PMETer<p>:TRIGger:DTIMe....606
[SENSe:]PMETer<p>:TRIGger:HOLDoff....606
[SENSe:]PMETer<p>:TRIGger:HYSTeresis....607
[SENSe:]PMETer<p>:TRIGger:LEVel....607
[SENSe:]PMETer<p>:TRIGger:SLOPe....608
[SENSe:]PMETer<p>:TRIGger[:STATe]....608
[SENSe:]PMETer<p>:UPDate[:STATe]....604
[SENSe:]PMETer<p>[:STATe]....603
[SENSe:]POWer:NCORrection....614
[SENSe:]PROBe<pb>:ID:PARTnumber?....591
[SENSe:]PROBe<pb>:ID:SRNumber?....591
[SENSe:]PROBe<pb>:SETup:ATTRatio....592
[SENSe:]PROBe<pb>:SETup:CMOFfset....592
[SENSe:]PROBe<pb>:SETup:DMOFfset....593
[SENSe:]PROBe<pb>:SETup:MODE....593
[SENSe:]PROBe<pb>:SETup:NAME?....594
[SENSe:]PROBe<pb>:SETup:NMOFfset....594
[SENSe:]PROBe<pb>:SETup:PMODe....594
[SENSe:]PROBe<pb>:SETup:PMOFfset....595
[SENSe:]PROBe<pb>:SETup:STATe?....596
[SENSe:]PROBe<pb>:SETup:TYPE?....596
[SENSe:]ROSCillator:EXTernal:FALLback....811
[SENSe:]ROSCillator:EXTernal:FREQuency....810
[SENSe:]ROSCillator:EXTernal:FREQuency:MODE....810
[SENSe:]ROSCillator:LBWidth....812
[SENSe:]ROSCillator:OSYNc....813
[SENSe:]ROSCillator:OUTPut<o>....812
[SENSe:]ROSCillator:SOURce....809
[SENSe:]ROSCillator:SOURce:EAUTo?....811
[SENSe:]ROSCillator:TRANge....812
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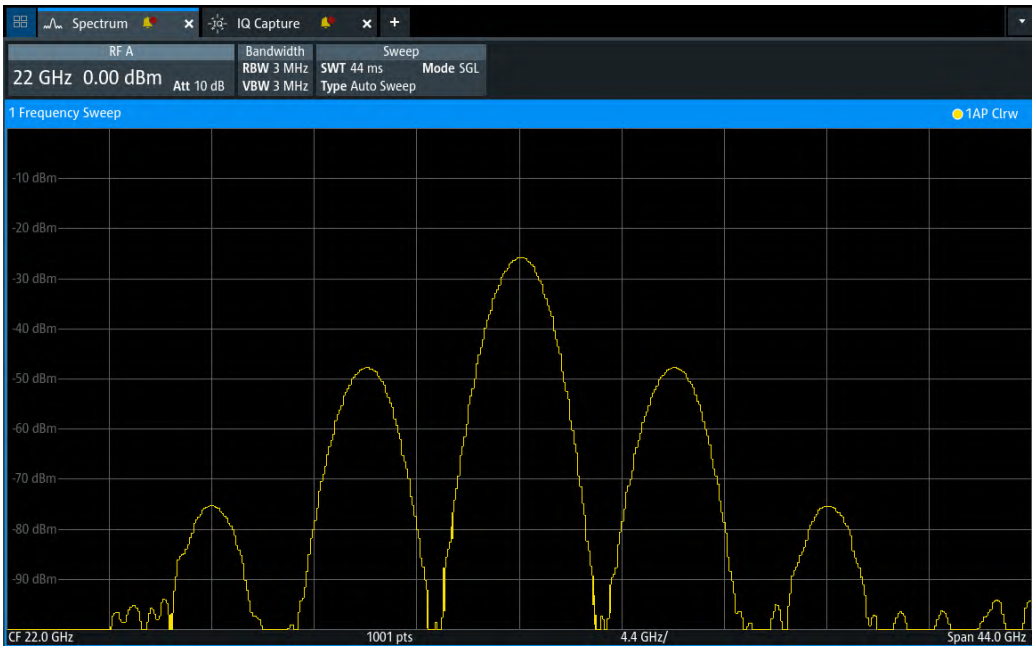
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5 Spectrum analyzer

5.1 Welcome to the Spectrum application

The FSWX provides a basic spectrum analyzer application as part of the base unit. The application provides various RF measurements based on common frequency sweeps. You can also export the trace results to a file for analysis in another application.



This section describes the functionality that the application provides, including remote control operation.

All functions not discussed here are general functionality.

For more information, see Section 4, "General functionality", on page 102.

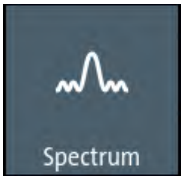
5.1.1 Starting the Spectrum application

To activate the Spectrum application

1. Select [Mode].

   A dialog box opens that contains all applications currently available on your FSWX.

2. Select "Spectrum".



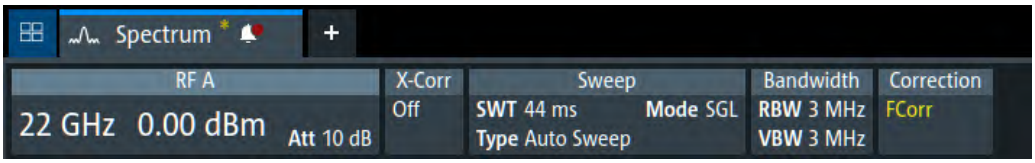
A new application instance opens for the "Spectrum" application.

A basic frequency sweep measurement starts immediately with the default settings.

You configure the "Spectrum" application in the "Overview" dialog box, which is displayed when you select "Overview" from any menu. See Section 5.2.1, "Configuration overview", on page 957.

5.1.2 Application-specific display information

Beneath the application name, important settings for the application instance are displayed in the application info panel. If you double-click a setting in the application info panel, the corresponding settings dialog box or links to the corresponding settings are displayed.



The application info panel shows the following information for the "Spectrum" application:

RF settings per input source (RF A/B)..... 954
X-Corr..... 955
Trigger..... 955
Sweep..... 955
Bandwidth..... 956
Correction..... 956

RF settings per input source (RF A/B)
For each RF input, the following settings are displayed.

- "Center Frequency"
- "Reference level"
- "Att": Overall mechanical and electronic RF attenuation
- "SAN: Att": Analyzer attenuation when using an (optional) external frontend
- "ExtFE: Att": External frontend attenuation when measuring external frontend input.
- "PA": The preamplifier is enabled. / Data compensation is performed using data from the (optional) external preamplifier.
- "LPN": Low phase noise signal path is enabled. ("Spectrum" application only)
- "YIG": The YIG preselector is enabled.
- "DC": DC coupling is used for the input.

If an overload occurs at one of the RF input connectors, the corresponding RF input label is highlighted red.



X-Corr

- State: If at least one trace uses the "RMS X-Corr" detector, the state is indicated as "On".
  For more information, see Section 4.1.5.2, "RMS X-Corr detector", on page 161.
- "X-Corr Fct": Cross-correlation factor
  Indicates the number of cross-correlation operations that the application performs during a single measurement.
  For more information, see Section 4.1.5.1, "Sweep time and X-Corr Factor", on page 157.

Note: Select the "X-Corr" area in the application info panel to display all cross-correlation settings in one dialog box. See Section 5.2.5, "X-Corr configuration", on page 973.

Trigger

Trigger source

- "EXT": External
- "POW": Power (+trigger bandwidth)
- "PSE": Power sensor
- "SQL": Squelch
- "TIM": Time
- "VID": Video

Sweep

The following sweep values are displayed for each input source:

- "SWT": Sweep time
  If the sweep time does not correspond to the value for automatic coupling, a bullet is displayed in front of the field. The color of the bullet turns red if the sweep time is set below the value for automatic coupling. In addition, the UNCAL flag is shown. In this case, the sweep time must be increased.
- "Type"
  Selected sweep mode type:
  – "Auto FFT": automatically selected FFT sweep mode
  – "Auto Sweep": automatically selected swept sweep mode
  – "Sweep": manually selected frequency sweep mode
  – "FFT": manually selected FFT sweep mode
- "Meas Time"/"AQT": Measurement (acquisition) time, calculated from analysis bandwidth and number of samples (for statistics measurements)
- "Mode": Sweep mode
  – "SGL": single sweep mode
  – "CONT": continuous sweep mode
- Sweep count ("x/y"): The current signal count for measurement tasks that involve a specific number of subsequent sweeps

Bandwidth

- "RBW" (<filter_type>): Resolution bandwidth; if a filter other than the normal 3-dB filter is used, the filter type is also indicated:
  – "CHAN"
  – "5-POL"
  – "RRC"

  See "Filter Type (expert parameter)" on page 972.
- "VBW": Video bandwidth
  "(LIN)" indicates the logarithmic amplifier in front of the video filter is bypassed to process linear detector samples.
- "Inp:ExtFe" "IF High" / "IF Low" / "Spur optimized" / "EVM optimized" / <IF frequency range>
  An optional external frontend is active; the used frequency band configuration is indicated for reference.
  See "Frequency Band Configuration" on page 215.

Correction

If applicable, the following correction values are displayed for each input source:

- "Ref Lev Offset"
- "Freq Offset": A frequency offset ≠ 0 Hz is set.
- "75 Ω": The input impedance of the instrument is set to 75 Ω.
- "IFCorr": IF cable correction for an active optional external frontend is enabled and a valid correction file is available.
- "ExtDev": An optional external frontend is active with an external device connected to it, or a correction file for the external device is loaded and active.
- "TDF": a transducer factor is enabled

5.2 Common measurement settings

Basic measurement settings that are common to many measurement tasks are described here. If you are performing a specific measurement task, be sure to check the specific RF measurement description for settings that deviate from these common settings.

- Configuration overview 957
- Frequency and span configuration 958
- Amplitude and vertical axis configuration 963
- Bandwidth, filter and sweep settings 967
- X-Corr configuration 973
- Trigger settings 974
- Adjusting settings automatically 981
- Optimizing measurements 984

5.2.1 Configuration overview



Access: all menus

Throughout the application instance configuration, an overview of the most important currently defined settings is provided in the "Overview".

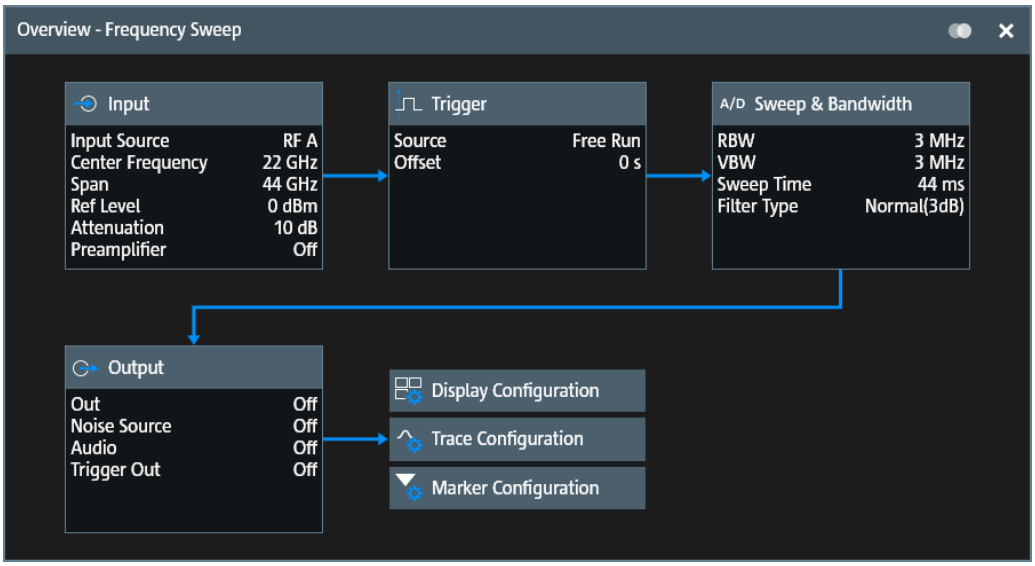


Figure 5-1: Configuration overview for a frequency sweep in Spectrum application

In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialogs. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire application instance from input over processing to output and analysis by stepping through the dialogs as indicated in the "Overview".

The overview is specific to the individual measurements. The "Overview" for the default frequency sweep in the "Spectrum" application provides quick access to the following configuration dialogs (listed in the recommended order of processing):

1. Input settings
   See Section 4.2, "Receiving data input and providing data output", on page 168.
2. Trigger settings
   See Section 4.4, "Trigger settings", on page 258
3. Sweep & Bandwidth
   See Section 5.2.4, "Bandwidth, filter and sweep settings", on page 967
4. Output settings
   See Section 4.2.6, "Signal output", on page 231
5. Display configuration
   See Section 4.7, "Laying out the result display", on page 277
6. Trace configuration
   See Section 5.4.4, "Trace evaluation", on page 1215

7. Marker configuration
   See Section 5.4.1, "Marker settings", on page 1182

To configure settings

► Select any button in the "Overview" to open the corresponding dialog box.
Select a setting in the application info panel to change a specific setting.

For step-by-step instructions on configuring "Spectrum" application measurements, see Section 5.3.1.2, "How to perform a basic sweep measurement", on page 987.

Preset application instance
Select "Preset Application" in the "Overview" to restore all measurement settings *in the current application instance* to their default values.

Note:
Do not confuse the "Preset Application" button with the [Preset] *key*. The [Preset] key restores the entire instrument to its default values, and thus closes *all application instances* on the FSWX (except for the default application instance).

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 791

Specifics for
The application instance can contain several windows for different results. Thus, the settings indicated in the "Overview" and configured in the dialogs vary depending on the selected window.

Select an active window from the "Specifics for" selection list that is displayed in the "Overview" and in all window-specific configuration dialogs.

The "Overview" and dialogs are updated to indicate the settings for the selected window.

5.2.2 Frequency and span configuration

The frequency and span settings define the scope of the signal and spectrum to be analyzed with the FSWX.

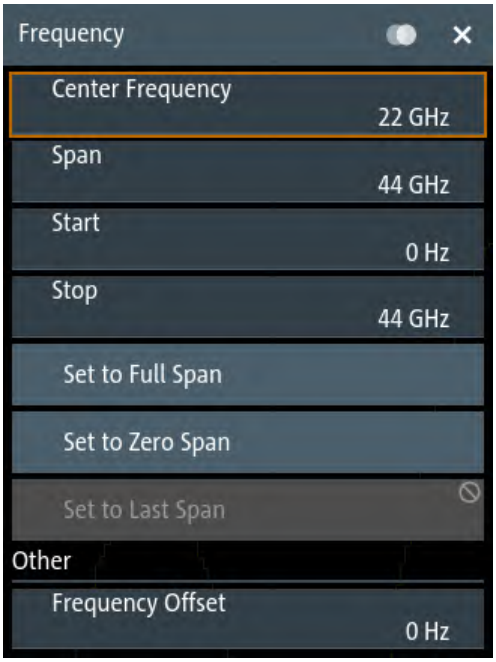
For background information, see Section 4.3.1, "Impact of the frequency and span settings", on page 236.

- Frequency and span settings 958
- Signal tracking configuration 962
- How to define the frequency range 963
- How to move the center frequency through the frequency range 963

5.2.2.1 Frequency and span settings

Access: "Overview" > "Frequency"

For more information, see Section 5.2.2.3, "How to define the frequency range", on page 963.



Center Frequency 959
Frequency Offset 959
Start/ Stop 960
Center Frequency Stepsize 960
Span 961
Set to Full Span 961
Set to Zero Span 961
Set to Last Span 961

Center Frequency
Defines the center frequency of the signal in Hertz.

The allowed range of values for the center frequency is:

$f_{min} \leq f_{center} \leq f_{max}$

f_{min} and f_{max} depend on the instrument model and are defined in the specifications document.

Remote command:
`[SENSe<ip>:]FREQuency:CENTer` on page 612

Frequency Offset
Shifts the displayed frequency range along the x-axis by the defined offset.

This parameter has no effect on the instrument's hardware, on the captured data, or on data processing. It is simply a manipulation of the final results in which absolute frequency values are displayed. Thus, the x-axis of a spectrum display is shifted by a constant offset if it shows absolute frequencies. However, if it shows frequencies relative to the signal's center frequency, it is not shifted.

You can use a frequency offset to correct the display of a signal that is downconverted externally, for example by an external mixer.

The allowed values range from -1 THz to +1 THz. The default setting is 0 Hz.

Remote command:
[SENSe<ip>:]FREQuency:OFFSet on page 612

Start/ Stop
Defines the start and stop frequencies.

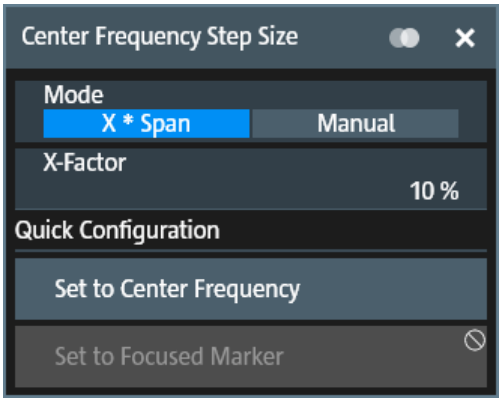
The following range of values is allowed:

$f_{min} \leq \mathbf{f_{start}} \leq \mathbf{f_{stop}} \leq f_{max}$

f_{min} and f_{max} depend on the instrument model and are defined in the specifications document.

Remote command:
[SENSe<ip>:]FREQuency:STARt on page 1417
[SENSe<ip>:]FREQuency:STOP on page 1418

Center Frequency Stepsize



Defines the step size by which the center frequency increases or decreases when you select the arrow keys. When you use the rotary knob, the center frequency changes in smaller steps (1/10 the size as for the arrow keys).

You can either define a fixed value, or couple the step size to the resolution bandwidth.

For more information, see Section 4.3.1.2, "Stepping through the frequency range - center frequency step size", on page 237.

"X*RBW"/ "X*Span" / "X*ABW"
Sets the step size for the center frequency to a specified factor of the RBW, span or analysis bandwidth, depending on the type of measurement. Define the "X-Factor" as a percentage of the parameter value.
Values between 1 % and 100 % in steps of 1 % are allowed. The default setting is 10 %.

Remote command:
[SENSe:]FREQuency:CENTer:STEP:LINK on page 1416
[SENSe<ip>:]FREQuency:CENTer:STEP:LINK:FACTor on page 1416

"Manual" Sets the step size to a fixed value. Enter the step size in the "Manual Step Size" field.

Remote command:
[SENSe<ip>:]FREQuency:CENTer:STEP on page 1415

"Set to Center Frequency"
Sets the step size to the value of the center frequency. The step size is no longer coupled to the resolution bandwidth. The used value is indicated in the "Manual Step Size" field.

"Set to Focused Marker"
This setting is only available if a marker is enabled.
Sets the step size to the value of the focused marker. The step size is no longer coupled to the resolution bandwidth. The used value is indicated in the "Manual Step Size" field.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:CSTep on page 1414

Span
Defines the frequency span that is swept during a single measurement. The center frequency remains unchanged when you change the span. The following range is allowed:

$0 \leq f_{span} \leq f_{max}$

f_{max} depends on the instrument model and is defined in the specifications document.

For more information, see Section 4.3.1.1, "Defining the scope of the measurement - frequency range", on page 237.

Remote command:
[SENSe<ip>:]FREQuency:SPAN on page 1417

Set to Full Span
Sets the span to the full frequency range of the FSWX as defined in the specifications document. This setting is useful for overview measurements.

Remote command:
[SENSe<ip>:]FREQuency:SPAN:FULL on page 1417

Set to Zero Span
Sets the span to 0 Hz (zero span). The x-axis becomes the time axis with the grid lines corresponding to 1/10 of the current sweep time ("SWT").

For more information, see "Zero Span" on page 987.

Remote command:
FREQ:SPAN 0Hz, see [SENSe<ip>:]FREQuency:SPAN on page 1417

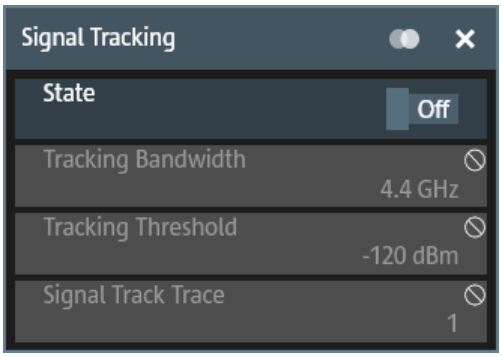
Set to Last Span
Sets the span to the previous value. Using this function you can switch between an overview measurement and a detailed measurement quickly.

Remote command:
[SENSe<ip>:]FREQuency:SPAN on page 1417

5.2.2.2 Signal tracking configuration

Access: "Overview" > "Frequency" > "Signal Tracking" tab

Defines the settings for signal tracking. These settings are not available for zero span measurements.



For details, see Section 4.3.1.3, "Keeping the center frequency stable - signal tracking", on page 237.

Signal Tracking State 962
Tracking Bandwidth 962
Tracking Threshold 962
Signal Track Trace 962

Signal Tracking State
If enabled, after each sweep, the FSWX searches for the frequency with the highest power level within a specified bandwidth on the specified Signal Track Trace. It then sets the center frequency to that frequency.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:STRack[:STATe]` on page 1418

Tracking Bandwidth
The bandwidth around the center frequency that the FSWX searches for the maximum power level.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:STRack:BANDwidth` on page 1419

Tracking Threshold
If the signal level does not pass this threshold, the center frequency is not changed.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:STRack:THReshold` on page 1419

Signal Track Trace
Defines the trace that the FSWX checks for maximum power levels.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:STRack:TRACe` on page 1420

5.2.2.3 How to define the frequency range

The following step-by-step instructions demonstrate how to configure the frequency and span settings. For details on individual functions and settings see Section 5.2.2.1, "Frequency and span settings", on page 958.

The remote commands required to perform these tasks are described in Section 5.5.2.1, "Defining the frequency and span", on page 1413.

To configure the frequency and span

1. To display the "Frequency" dialog box, do one of the following:
   - Select "Frequency" from the "Overview".
   - Select [Freq] > "Frequency Configuration".
   - Select [Span] > "Frequency Configuration".
2. Define the frequency range using one of the following methods:
   - Define the "Center Frequency" and "Span".
   - Define the "Start Frequency" and "Stop Frequency".
   - To perform a measurement in the time domain, define the "Center Frequency" and select "Set to Zero Span".
   - To perform an overview measurement over the entire available frequency range, select "Set to Full Span".
   - To return to the previously set frequency range, select "Set to Last Span".

5.2.2.4 How to move the center frequency through the frequency range

Sometimes it is useful to move the center frequency through a larger frequency range, for example from one harmonic to another.

1. Select [Freq] > "Center Frequency Stepsize".
2. Define the size by which the center frequency increases or decreases in each step. Enter a manual or relative value, or set the step size to the current center frequency or marker value. To move from one harmonic to the next, set the step size to the center frequency or marker value.
3. Select "Center Frequency".
4. Use the arrow keys to move the center frequency through the available frequency range in discrete steps.

5.2.3 Amplitude and vertical axis configuration

In the "Spectrum" application, a basic measurement determines the signal levels for a specified frequency range or during a specified measurement time. As a result, the levels or amplitudes are displayed on the vertical (y-)axis. The specified frequency range or the measurement time is displayed on the horizontal (x-)axis.

For background information, see Section 4.3.2, "Impact of the vertical axis settings", on page 238.

The amplitude settings are described in Section 4.2.1.6, "Amplitude settings", on page 179.

- Scale configuration....964
- How to optimize the amplitude display....966

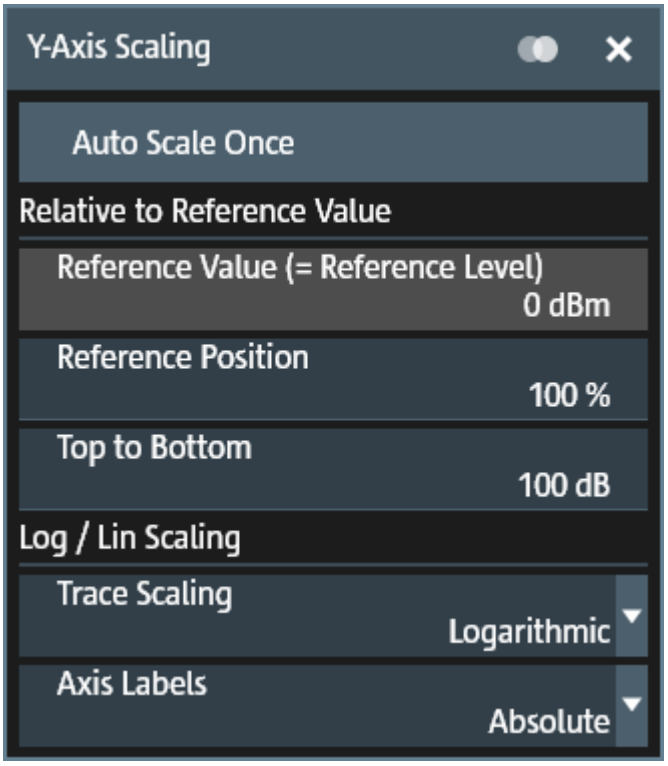
5.2.3.1 Scale configuration

The individual scaling settings that affect the vertical axis are described here.

Access: "Overview" > "Amplitude" > "Scale" tab

Or: [Ampt / Scale] > "Scale Config"

The remote commands required to define these settings are described in Section 5.5.2.3, "Scaling the Y-axis", on page 1429.



Auto Scale Once....965
Reference Value....965
Reference Position....965
Top to Bottom Scaling....965
Trace Scaling....965
Axis Labels....966

Auto Scale Once
Automatically determines the optimal range and reference level position to be displayed for the current measurement settings.

The display is only adjusted once; it is not adjusted again if the measurement settings change.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE` on page 1429

Reference Value
Defines a reference value for relative y-axis scaling in the currently selected diagram. By default, this value defines the maximum value of the y-axis (see "Reference Position" on page 965).

In "Auto" mode, the FSWX selects the optimal reference level for the current measurement settings.

In "Manual" mode, define a fixed value manually.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]` on page 1429

Reference Position
Defines the position of the reference value, i.e. the position of the maximum AD converter value on the level axis in percent.

0 % corresponds to the lower and 100 % to the upper limit of the diagram.

Values from -120 % to +280 % are supported.

Larger values are useful for:
- Small scales, such as a power range of 10 dB or 20 dB
- Low signal levels, for example 60 dB below the reference level

In these cases, large reference position values allow you to see the trace again.

For spectrograms, this value defines the position of the reference value within the span covered by the color map. In this case, the value is defined in percent. 0 % corresponds to the maximum (right end) of the color map. 100 % corresponds to the minimum (left end) of the color map.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 1430

Top to Bottom Scaling
Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]` on page 1429

Trace Scaling
Defines the scaling method for the y-values of the trace.

For more information, see Section 4.3.2, "Impact of the vertical axis settings", on page 238.

"Logarithmic" Logarithmic scaling (only available for logarithmic units - dB..., and A, V, Watt)

"Linear with Unit" Linear scaling in the unit of the measured signal.

"Linear Percent" Linear scaling in percentages from 0 to 100. The values are always relative to the Reference Value.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing` on page 1431

Axis Labels
Defines the labeling method for a logarithmic y-axis. For a linear y-axis, values are always relative to the Reference Value.

For more information, see Section 4.3.2, "Impact of the vertical axis settings", on page 238.

"Absolute" The labeling of the level lines uses absolute values in logarithmic units: dB..., and A, V, Watt.

"Relative" The scaling is in dB, relative to the Reference Value.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]` on page 1429

5.2.3.2 How to optimize the amplitude display

This section gives you some advice on how to optimize the display of the measured signal amplitudes depending on the required evaluation.

To optimize overview results

1. Perform a measurement with the default settings to get an impression of the values to expect.
2. Use the "Perform Auto Level" function ([Auto Set] menu) to optimize the reference level.
3. Use the "Auto Scale Once" function (Auto Set menu) to optimize the scaling.

To determine a precise level at a specific point in the signal

1. Reduce the "Range" of the y-axis to a small area around the required level. If necessary, change the "Reference Position" so the required range remains visible.
2. Select "Scale Configuration" > "Expert settings" > "Trace Scaling": "Linear".

   Now you can set a marker at the point in question and read the result.

To detect a spurious signal close to the noise floor

1. Set the "RF Attenuation Mode" to "Manual".

2. Reduce the "RF Attenuation Overall" to lower the noise floor.
3. Select "Scale Configuration" > "Expert settings" > "Trace Scaling": "Logarithmic".
4. Select "Axis Labels": "Relative".

   Now you can determine if any spurious levels of a certain size are visible.

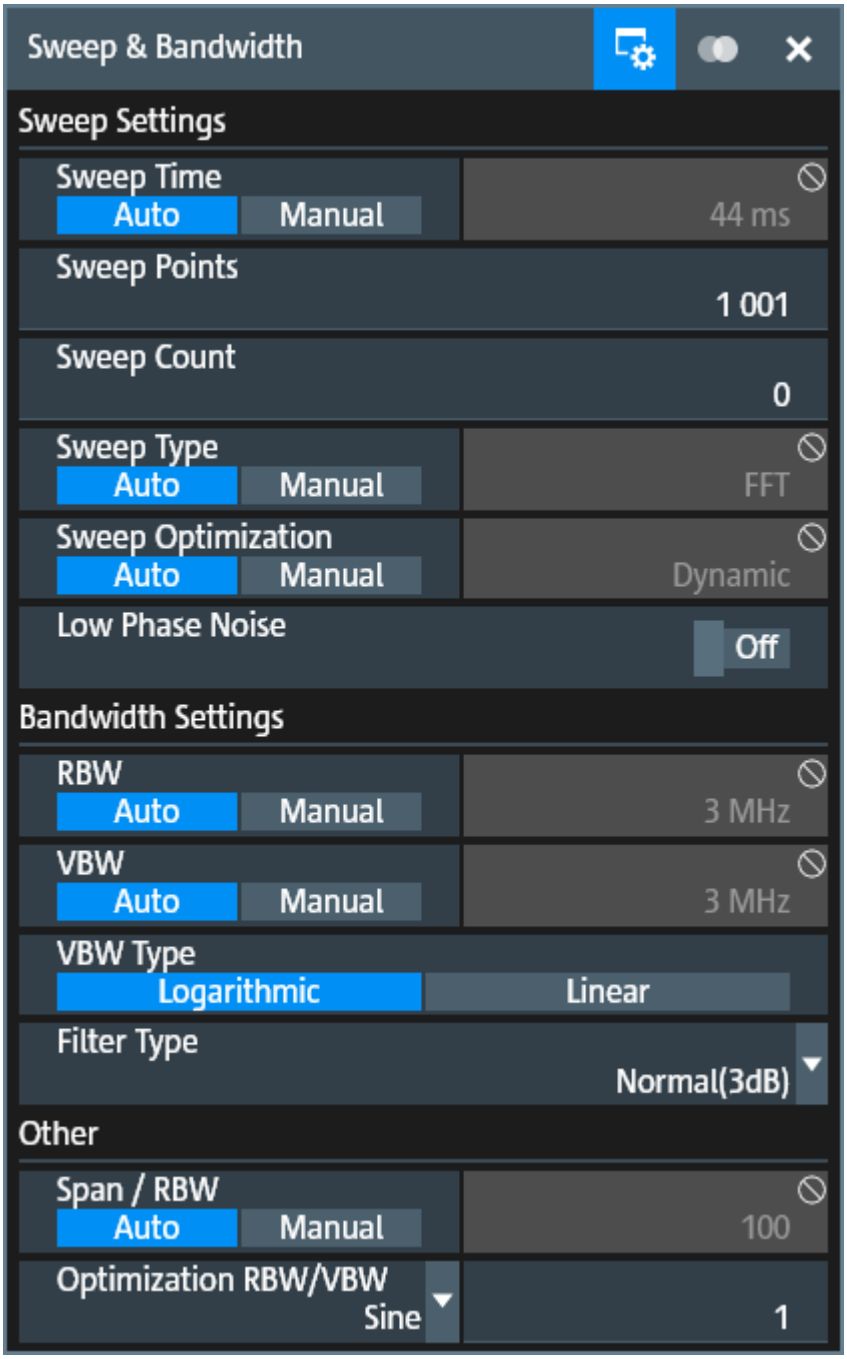
5.2.4 Bandwidth, filter and sweep settings

Access: "Overview" > "Bandwidth"

These parameters define how the data is measured: how much data is collected internally and which filters are used.

The remote commands required to define these settings are described in Section 5.5.2.2, "Configuring bandwidth and sweep settings", on page 1420.

How to perform a basic sweep measurement is described in Section 5.3.1.2, "How to perform a basic sweep measurement", on page 987.



See also Section 4.6, "Running measurements", on page 267.

Sweep Time Mode / Sweep Time....969
Sweep Points....969
Sweep Count....969
Sweep Type (expert parameter)....970
Sweep Optimization (expert parameter)....970
X-Corr Factor....970
Low Phase Noise (expert parameter)....971
RBW Mode/RBW Manual....971

VBW Mode / VBW Manual....971
Filter Type (expert parameter)....972
Span/RBW (expert parameter)....972
Optimization RBW/VBW (expert parameter)....972

Sweep Time Mode / Sweep Time
Defines the duration of a single sweep, during which the FSWX measures the defined number of sweep points.

In "Auto" mode, the "Sweep Time" is coupled to the following other settings. If you change any of these settings, the FSWX automatically adjusts the "Sweep Time".

- "X-Corr Factor"
- Span (not zero span)
- Video bandwidth (VBW)
- Resolution bandwidth (RBW)

In "Manual" mode, enter the "Sweep Time" value. Allowed values depend on the ratio of span / RBW and RBW / VBW. For details, refer to the specifications document. Numeric input is always rounded to the nearest possible value.

For more information, see Section 4.3.3.7, "How long the data is measured: sweep time", on page 246.

Note:
The "Sweep Time" only indicates how long the FSWX captures data. The time that the FSWX requires to process the captured data can be considerably longer, in particular for FFT mode.

Remote command:
`[SENSe:]SWEep:TIME:AUTO` on page 1427
`[SENSe<ip>:]SWEep:TIME` on page 1427

Sweep Points
Defines the number of measured values to be collected during one sweep.

Values from 101 to 100001 are supported. The default value is 1001 sweep points.

For details, see Section 4.3.3.8, "How much data is measured: sweep points and sweep count", on page 246.

Remote command:
`[SENSe:]SWEep[:WINDow<n>]:POINts` on page 1426

Sweep Count
Defines the number of sweeps to be performed in single sweep mode. Values from 0 to 200000 are allowed. For the values 0 or 1, one sweep is performed.

If the trace modes "Average", "Max Hold" or "Min Hold" are set, this value also determines the number of averaging or maximum search procedures.

In continuous sweep mode, if "Sweep Count" = 0 (default), averaging is performed over 10 sweeps. For "Sweep Count" =1, no averaging, maximum or minimum search operations are performed.

For details, see Section 4.3.3.8, "How much data is measured: sweep points and sweep count", on page 246.

For spectrogram displays, the "Sweep Count" determines how many sweeps are combined in one frame in the spectrogram. That is, how many sweeps the FSWX performs to plot one trace in the spectrogram result display.

For details, see "Working with spectrograms" on page 290.

Remote command:
[SENSe<ip>:]SWEep:COUNt on page 1425
[SENSe<ip>:]AVERage<n>:COUNt on page 675

Sweep Type (expert parameter)
Determines whether a sweep or an FFT is performed.

"Auto" Automatically sets the fastest available sweep type for the current measurement (sweep or FFT). Auto mode is set by default.

"Sweep" In the standard sweep mode, the local oscillator is set to provide the spectrum quasi analog from the start to the stop frequency.

"FFT" The FFT sweep samples on a defined frequency value and transforms it to the spectrum by fast Fourier transform (FFT, see also Section 4.3.3.5, "How data is measured: the sweep type", on page 244).

FFT is not available in the following cases:
- When using 5-Pole filters or RRC filters

In these cases, frequency sweep is used.

Remote command:
[SENSe:]SWEep:TYPE on page 1428

Sweep Optimization (expert parameter)
In FFT mode, several FFT analysis steps are required to cover the entire measurement span. The span that a single FFT analysis step covers is called *subspan*. You cannot define the subspan directly, but the FSWX can optimize it according to measurement requirements.

For details, see "Optimization" on page 244.

"Dynamic" Optimizes the dynamic range by using the narrowest possible subspan (depending on the RBW).

"Speed" Optimizes the sweep rate by using the widest possible subspan (depending on the RBW).

"Transient" Recommended mode for measurements on highly transient signals in spectrum analysis. It increases the measurement speed with a trade-off in dynamic range.

"Ultimate" Uses a medium-sized subspan to obtain a compromise between a large dynamic range and a fast sweep rate.

Remote command:
[SENSe:]SWEep:OPTimize on page 1426

X-Corr Factor
Indicates the number of sweep samples that are cross-correlated to determine a single sweep point if the "RMS X-Corr" detector is used.

See also Section 4.1.5.2, "RMS X-Corr detector", on page 161.

Remote command:
[SENSe<ip>:]SWEep:XFACtor on page 1428

Low Phase Noise (expert parameter)
Enables or disables a signal path that is optimized for a lower IF to improve phase noise for RF frequencies larger than 9 GHz. As a result, image rejection can be reduced.

In some cases, this signal path is chosen by default, for example for analysis bandwidths larger than 1 GHz.

This setting is only available in the "Spectrum" application and only for single RF input.

Remote command:
INPut<ip>:LPNoise[:STATe] on page 555

RBW Mode/RBW Manual
Defines the resolution bandwidth. The available resolution bandwidths are defined in the specifications document. Numeric input is always rounded to the nearest possible bandwidth.

In "Auto" mode, the resolution bandwidth is coupled to the selected span (for span > 0). If the span changes, the resolution bandwidth is automatically adjusted.

In "Manual" mode, enter the resolution bandwidth value. A green bullet appears next to the "RBW" display in the application panel.

For a list of supported values, see the specifications document.

For more information, see Section 4.3.3.1, "Separating signals by selecting an appropriate resolution bandwidth", on page 241.

Note: Restrictions.
Some additional Gaussian filters are provided for special measurements, such as 5G NR spurious emissions measurements. They are only available if you enter the value manually, not using the rotary knob or stepping through the filter values. They are not supported by all applications. For these particular filters, gating is also possible. The following values indicate the 3-dB filter width:

- 51 kHz
- 150 kHz
- 250 kHz
- 400 kHz
- 450 kHz
- 6 MHz
- 8 MHz

Remote command:
[SENSe<ip>:]BANDwidth[:RESolution] on page 1420
[SENSe<ip>:]BANDwidth[:RESolution]:AUTO on page 1421

VBW Mode / VBW Manual
Defines the video bandwidth. The available video bandwidths are defined in the specifications document. Numeric input is always rounded to the nearest possible bandwidth.

In "Auto" mode, the video bandwidth is coupled to the resolution bandwidth. If the resolution bandwidth changes, the video bandwidth is automatically adjusted.

In "Manual" mode, enter the video bandwidth value. A green bullet appears next to the "VBW" display in the application panel.

For a list of supported values, see the specifications document.

If an RMS trace detector is active, VBW settings are not available.

For more information, see Section 4.3.3.2, "Smoothing the trace using the video bandwidth", on page 242.

Remote command:
`[SENSe<ip>:]BANDwidth:VIDeo:AUTO` on page 1422
`[SENSe<ip>:]BANDwidth:VIDeo` on page 1422
`[SENSe<ip>:]BANDwidth:VIDeo:TYPE` on page 1423

Filter Type (expert parameter)
Defines the filter type used for the measurement.

The following filter types are available:

- "Normal (3dB)"
- "Channel"
- "RRC" (not available for sweep type "FFT")
- "5-Pole" (not available for sweep type "FFT")

For more information, see Section 4.3.3.6, "Which data can pass: filter types", on page 245.

Remote command:
`[SENSe<ip>:]BANDwidth[:RESolution]:TYPE` on page 1422

Span/RBW (expert parameter)
Defines the coupling ratio of the span to the resolution bandwidth if the "Resolution Bandwidth Mode" is set to "Auto".

In "Auto" mode, the RBW is set to span/100.

This coupling ratio is the default setting of the FSWX.

In "Manual" mode, enter the ratio value in the range from 1 to 10000.

For more information, see Section 4.3.3.4, "Coupling span and RBW", on page 243.

Remote command:
`[SENSe<ip>:]BANDwidth[:RESolution]:RATio` on page 1421

Optimization RBW/VBW (expert parameter)
Sets the coupling ratio between the resolution bandwidth and the video bandwidth if the "Video BW Mode" is set to "Auto".

For more information, see Section 4.3.3.3, "Coupling VBW and RBW", on page 243.

"Sine"	"Video Bandwidth Manual" = "Resolution Bandwidth Manual" This is the default setting for the coupling ratio RBW/VBW and is recommended if sinusoidal signals are to be measured.
"Pulse"	"Video Bandwidth Manual" = 10 x "Resolution Bandwidth Manual" or "Video Bandwidth Manual" = 10MHz (= max. VBW) Recommended for pulse signals

"Noise" "Video Bandwidth Manual" = "Resolution Bandwidth Manual"
Recommended for noise measurements

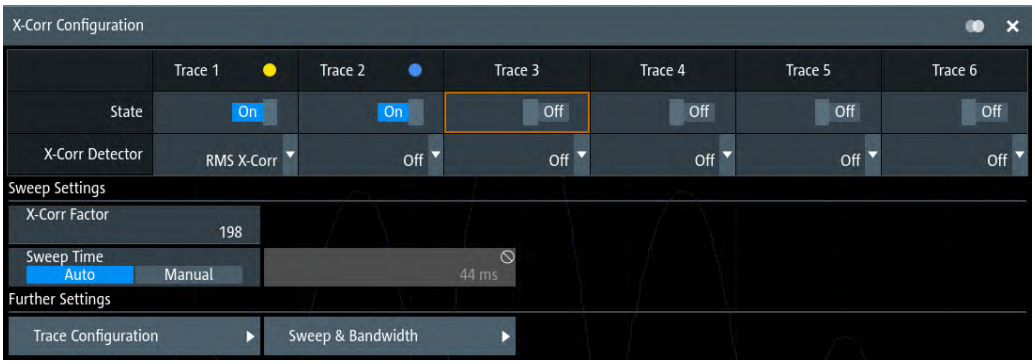
"Manual" The coupling ratio is defined manually.
The RBW/VBW ratio can be set in the range of 0.001 to 1000.

Remote command:
`[SENSe<ip>:]BANDwidth:VIDeo:RATio` on page 1423

5.2.5 X-Corr configuration

Access: application info panel > "X-Corr"

The parameters for cross-correlation using the "RMS X-Corr" detector are combined in the "X-Corr Configuration" dialog.



For more information on cross-correlation, see Section 4.1.5.2, "RMS X-Corr detector", on page 161.

Trace State....973
X-Corr Detector....973
X-Corr Factor....973
Sweep Time Mode / Sweep Time....974

Trace State
Enables or disables the trace in the selected display.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 669

X-Corr Detector
Enables or disables the "RMS X-Corr" trace detector for the selected trace. If disabled, the default trace detector is applied to an active trace.

For more information, see Section 4.1.5.2, "RMS X-Corr detector", on page 161

Remote command:
`[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]` on page 676

X-Corr Factor
Indicates the number of sweep samples that are cross-correlated to determine a single sweep point if the "RMS X-Corr" detector is used.

See also Section 4.1.5.2, "RMS X-Corr detector", on page 161.

Remote command:
[SENSe<ip>:]SWEep:XFACtor on page 1428

Sweep Time Mode / Sweep Time
Defines the duration of a single sweep, during which the FSWX measures the defined number of sweep points.

In "Auto" mode, the "Sweep Time" is coupled to the following other settings. If you change any of these settings, the FSWX automatically adjusts the "Sweep Time".

- "X-Corr Factor"
- Span (not zero span)
- Video bandwidth (VBW)
- Resolution bandwidth (RBW)

In "Manual" mode, enter the "Sweep Time" value. Allowed values depend on the ratio of span / RBW and RBW / VBW. For details, refer to the specifications document. Numeric input is always rounded to the nearest possible value.

For more information, see Section 4.3.3.7, "How long the data is measured: sweep time", on page 246.

Remote command:
[SENSe:]SWEep:TIME:AUTO on page 1427
[SENSe<ip>:]SWEep:TIME on page 1427

5.2.6 Trigger settings

Triggering means to capture the interesting part of the signal. Choosing the right trigger type and configuring all trigger settings correctly allows you to detect various incidents in your signals.

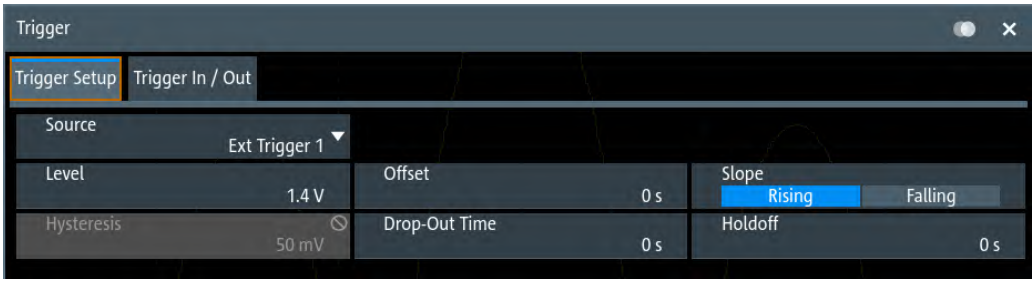
For background information, see Section 4.3.4, "Conditional measurement start: trigger settings", on page 247 and Section 4.3.4.8, "Selective data capture: gated measurements", on page 252.

Configuring trigger output is described in Section 4.2.7, "Receiving and providing trigger signals", on page 233.

- Trigger setup 974
- How to determine the required trigger parameters 979
- How to configure a triggered measurement 979

5.2.6.1 Trigger setup

Access: "Overview" > "Trigger/Gate"



For step-by-step instructions on configuring triggered measurements, see Section 4.4.3, "How to configure a triggered measurement", on page 263.

Trigger Source....975
└ Free Run....975
└ Ext Trigger1 to 4....976
└ Video....976
└ Power....976
└ I/Q Power....977
└ Time....977
└ Power Sensor....977
Trigger Level....977
Repetition Interval....977
Trigger Offset....978
Slope....978
Hysteresis....978
Drop-Out Time....978
Trigger Holdoff....978
Correct TPIS....979

Trigger Source
Selects the trigger source. If you select a trigger source other than "Free Run", the trigger source is indicated in the application panel.

For more information, see Section 4.3.4.1, "Initiating a measurement: trigger source", on page 247.

Note: When triggering is enabled, the squelch function is automatically disabled.

For an active external frontend, only external triggers, I/Q power triggers and (periodic) time triggers are supported as trigger sources. See "Activate External Frontend / External Frontend Activated" on page 213.

Remote command:
"Trigger Source" on page 259

Free Run ← Trigger Source
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

In the "Spectrum" application, "Free Run" is the default trigger source setting.

Remote command:
`TRIG:SOUR IMM`

Ext Trigger1 to 4 ← Trigger Source
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified "Trigger Level".

"Ext Trigger 1"
Trigger signal from the "Trigger 1 Input" connector.

"Ext Trigger 2"
Trigger signal from the "Trigger 2 In / Out" connector.
Note: You must configure the connector for input in the trigger input/ output settings.

See Section 4.2.7.1, "Trigger input/output settings", on page 234.

"Ext Trigger 3"
Trigger signal from the "Trigger 3 Input" connector.

"Ext Trigger 4"
Trigger signal from the "Trigger 4 In / Out" connector.
Note: You must configure the connector for input in the trigger input/ output settings.

See Section 4.2.7.1, "Trigger input/output settings", on page 234.

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`

Video ← Trigger Source
Defines triggering by the video signal, i.e. the filtered and detected version of the input signal (the envelope of the IF signal), as displayed on the screen.

Define a trigger level from 0 % to 100 % of the diagram height. The absolute trigger level is indicated by a horizontal trigger line in the diagram, which you can also move graphically to change the trigger level.

A fixed hysteresis of ±5 % of the specified trigger value (in V) is applied to the video trigger level automatically and cannot be changed.

Video mode is only available in the time domain, and not for I/Q-based data.

Remote command:
`TRIG:SOUR VID`

Power ← Trigger Source
The FSWX starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger threshold depends on the defined trigger level, and on the RF attenuation and preamplification. A reference level offset, if defined, is also considered. The trigger bandwidth at the intermediate frequency depends on the RBW and sweep type. For details on available trigger levels and trigger bandwidths, see the instrument specifications document.

For measurements on a fixed frequency (e.g. zero span or I/Q measurements), the third IF represents the center frequency.

This trigger source is only available for RF input.

Note: Note that in "Auto" sweep type mode, due to a possible change in sweep types, the trigger bandwidth can vary considerably for the same RBW setting.

Remote command:
TRIG:SOUR POW

I/Q Power ← Trigger Source
This trigger source is only available for I/Q measurements and in applications that process I/Q data.

Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

The trigger bandwidth corresponds to the analysis bandwidth setting for I/Q data acquisition.

Remote command:
TRIG:SOUR IQP

Time ← Trigger Source
Triggers in a specified Repetition Interval.

Remote command:
TRIG:SOUR TIME

Power Sensor ← Trigger Source
Uses an external power sensor as a trigger source. This option is only available if a power sensor is connected and configured.

For a power sensor trigger, you define the trigger level in the power sensor settings.

For more information, see Section 4.2.3.2, "Power sensor settings", on page 193.

Remote command:
TRIG:SOUR PSE

Trigger Level
Defines the trigger level for the specified trigger source.

For details on supported trigger levels, see the specifications document.

For gated measurements using a coupled trigger, the trigger level setting also defines the gating trigger level.

Remote command:
TRIGger<ip>[:SEQuence]:LEVel:POWer on page 632
TRIGger[:SEQuence]:LEVel[:EXTernal<tp>] on page 631
TRIGger[:SEQuence]:LEVel:VIDeo on page 632

Repetition Interval
Defines the repetition interval for a time trigger.

The shortest interval is 2 ms.

Set the repetition interval to the exact pulse period, burst length, frame length or other repetitive signal characteristic. If you cannot set the required interval with the available granularity, configure a multiple of the interval that is supported. Thus, the trigger remains synchronized to the signal.

Remote command:
TRIGger[:SEQuence]:TIME:RINTerval on page 635

Trigger Offset
Defines the time offset between the trigger event and the start of the sweep.

For more information, see Section 4.3.4.2, "Pretrigger and posttrigger: trigger offset", on page 248.

Offset > 0:	Start of the sweep is delayed
Offset < 0:	Sweep starts earlier (pretrigger) Only possible for zero span and if gated trigger is disabled. The maximum allowed range is limited by the sweep time: $Pretrigger_{max}$ = $sweep\ time_{max}$

Remote command:
`TRIGger[:SEQuence]:HOLDoff` on page 630

Slope
Defines whether triggering occurs when the signal rises to the trigger level or falls down to it.

This setting is available for all trigger sources except time.

Remote command:
`TRIGger[:SEQuence]:SLOPe` on page 633

Hysteresis
Defines the distance in dB to the trigger level that the trigger source must exceed before the next trigger event occurs. Setting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step size of 1 dB.

For more information, see Section 4.3.4.3, "Avoiding unwanted triggers by level: trigger hysteresis", on page 248.

Remote command:
`TRIGger<ip>[:SEQuence]:POWer:HYSTeresis` on page 633

Drop-Out Time
Defines the time that the input signal must stay below the trigger level before triggering again.

For more information, see Section 4.3.4.4, "Stabilizing triggers in pulsed signals: trigger dropout time", on page 249.

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 630

Trigger Holdoff
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

For more information, see Section 4.3.4.5, "Reducing the number of triggers in time: Trigger holdoff", on page 250.

Remote command:
TRIGger[:SEQuence]:POWer:HOLDoff on page 632

Correct TPIS
If enabled, the trigger event is set to the actual trigger point within the sample (TPIS).
See also Section 4.3.4.7, "Determining the exact trigger point - TPIS", on page 252.

This setting is available for all trigger sources except "Free Run".

Remote command:
TRIGger[:SEQuence]:CTPis on page 629

5.2.6.2 How to determine the required trigger parameters

The following step-by-step instructions demonstrate how to determine the required trigger parameters manually.

1. Select "Overview" > ""Trigger/Gate"".
2. Determine the parameters that you want to use to define the trigger and gate conditions from the preview diagram, for example:
   - The length of a burst or slot
   - The upper or lower power level of a pulse
   - The maximum noise level
   - The power level or time at which a certain incident occurs
3. 

   Set the transparency of the dialog box so that you can see the results of the measurement in the background.
4. Try out different trigger settings as described in How to configure a triggered measurement.
   Check the effect of the current settings on the main measurement in the background.
5. If the results are as you expected, close the dialog box to keep the changes. Otherwise, correct the settings as necessary.

5.2.6.3 How to configure a triggered measurement

A triggered measurement starts only when the trigger conditions are fulfilled. The following step-by-step instructions demonstrate how to configure a triggered measurement manually.

For remote operation, see Section 4.14.7, "Configuring triggered and gated measurements", on page 629.

To define a time trigger

A time trigger initiates measurements in a regular time interval.

1. Select "Overview" > "Trigger/Gate".
2. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "Time".
3. Define the "Repetition interval", the time after which a new measurement is started.

To define an external trigger

An external trigger provides a trigger signal from a connected device.



For information on how to configure a power sensor to provide an external trigger to the FSWX, see "How to configure a power sensor as an external (PSE) trigger" on page 201.

1. Connect an external device that provides the trigger signal to one of the "Trigger Input" connectors on the FSWX.
   For details on the connectors, see Section 3.4, "Instrument tour", on page 31.
2. For "Trigger Input / Output" connectors, define their use for input:
   a) Select "Overview" > ""Trigger/Gate"" > "Trigger In / Out".
   b) Select Trigger Connector Direction: "Input".
3. Select "Overview" > ""Trigger/Gate"" > "Trigger Setup".
4. Define the "Trigger Source" = "External".
5. Configure the external trigger as described for the other power triggers.

To define a power trigger

A power trigger initiates measurements when the signal reaches a specific level.

1. Select "Overview" > ""Trigger/Gate"" > "Trigger Setup".
2. Define the "Trigger Source" = "Power".
   Alternatively, define "Trigger Source" = "Video". The video signal corresponds to the envelope of the IF signal. It data is processed by the resolution and video filters and the selected detector.
3. Define which RF "Input" connector provides the trigger signal. You can only select an active input connector (see).
4. Define the "Trigger Level": the power level at which the measurement starts.
   For a "Video" trigger source, you can move the level line graphically to define the level. If you define the value numerically, enter a percentage of the full diagram height as the level.
5. Define whether the signal must cross the trigger level on a falling or on a rising edge ("Slope") to trigger the measurement.
6. To start the measurement with a time delay, define a "Trigger Offset".

7. To reject triggers due to noise or jittering in the signal, define a "Hysteresis" that is larger than the expected noise or jittering. After the previous trigger, the signal must exceed this threshold before the next level crossing triggers a new measurement.
8. To skip multiple triggers in a burst, define a "Holdoff" time that must pass between two triggers. Define a holdoff time that is slightly larger than the burst.

To define a trigger sequence

A trigger sequence initiates measurements only when two combined trigger events occur in a defined order.

1. Select "Overview" > ""Trigger/Gate"".
2. Select "Trigger Sequence": "Trigger a->b" (with or without a "Reset on Timeout").
3. Optionally, define a timeout after trigger a ("Reset on Timeout"). If the timeout is exceeded, the trigger sequence is reset and waits for another trigger a.
4. To define a minimum time span between trigger a and trigger b, define a "Trigger b Delay".
5. To start the measurement with a time delay, define a "Trigger Offset".
6. To skip multiple triggers in a burst, define a "Holdoff" time that must pass between trigger b and the next trigger a. Define a holdoff time that is slightly larger than the burst.
7. In the "Trigger Setup a" tab, define the remaining trigger parameters for the first trigger, as described in the previous procedures.
8. In the "Trigger Setup b" tab, define the remaining trigger parameters for the second trigger, as described in the previous procedures.

5.2.7 Adjusting settings automatically

Access: [Auto Set]

The FSWX can adjust some settings automatically according to the current measurement settings. To do so, it performs a measurement. You can configure this measurement.

For an active external frontend, automatic settings are not available. See "Activate External Frontend / External Frontend Activated" on page 213.

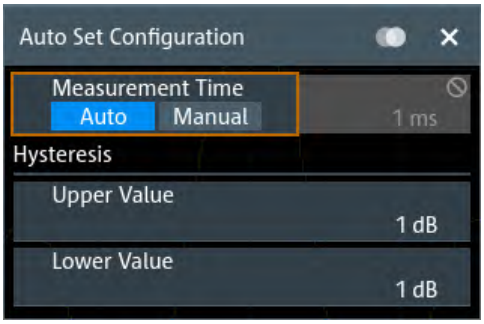
Adjusting settings automatically during triggered measurements

When you select an auto adjust function, the FSWX performs a measurement to determine the optimal settings. If you select an auto adjust function for a triggered measurement, you are asked how you want the FSWX to behave:

- (Default:) The measurement for adjustment waits for the next trigger.
- The measurement for adjustment starts without waiting for a trigger.
  The trigger source is temporarily set to "Free Run". After the measurement is completed, the original trigger source is restored. The trigger level is adjusted as follows for "Power" triggers:
  <Trigger level> = <Reference level> - 15 dB

Remote command:

`[SENSe<ip>:]ADJust:CONFigure:TRIGger` on page 643



Setting the reference level automatically (Perform Auto Level)..... 982
Adjusting the center frequency automatically (Perform Auto Frequency)..... 982
Adjusting all determinable settings automatically (Perform Auto All)..... 983
Measurement Time Mode / Measurement Time..... 983
Upper Level / Lower Level Hysteresis..... 983
Perform Phase & Time Self-Alignment..... 984

Setting the reference level automatically (Perform Auto Level)

To determine the required reference level, the FSWX performs a level measurement on the selected input connector.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

You can change the measurement time for the level measurement, if necessary.

See "Measurement Time Mode / Measurement Time" on page 266.

Remote command:

`[SENSe<ip>:]ADJust:LEVel` on page 644

Adjusting the center frequency automatically (Perform Auto Frequency)

The FSWX adjusts the center frequency automatically.

The optimum center frequency is the frequency with the highest signal-to-noise ratio in the frequency span. As this function uses the signal counter, it is intended for use with sinusoidal signals.

For more information, see Section 5.4.3.2, "Measuring a precise frequency (signal count marker)", on page 1196.

This function is not available during signal tracking.

For more information, see Section 4.3.1.3, "Keeping the center frequency stable - signal tracking", on page 237.

Remote command:
[SENSe<ip>:]ADJust:FREQuency on page 644

Adjusting all determinable settings automatically (Perform Auto All)
The FSWX adjusts all possible settings automatically according to the current measurement settings, including:

- "Perform Auto Frequency"
- "Perform Auto Level"

Remote command:
[SENSe<ip>:]ADJust:ALL on page 641

Measurement Time Mode / Measurement Time
Defines the duration of the measurement to determine the optimal settings.

In "Auto" mode, the measurement time is reset to the default value.

In "Manual" mode, define the measurement duration in seconds.

Note: The maximum measurement duration depends on the currently selected measurement and the installed (optional) hardware. Thus, the measurement duration that the FSWX actually requires to determine the automatic settings can be shorter than the value you define here.

Remote command:
[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation:MODE on page 642
[SENSe<ip>:]ADJust:CONFigure:LEVel:DURation on page 641

Upper Level / Lower Level Hysteresis
When the FSWX adjusts the reference level automatically using the "Perform Auto Level" function, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis.

The "Upper Value" defines an upper threshold that the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

The "Lower Value" defines a lower threshold that the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Remote command:
[SENSe<ip>:]ADJust:CONFigure:HYSTeresis:UPPer on page 643
[SENSe<ip>:]ADJust:CONFigure:HYSTeresis:LOWer on page 642

Perform Phase & Time Self-Alignment
Self-aligns the FSWX signal paths in phase and time. The measured values are then used as a reference for subsequent measurements. Alignment is important for phase-aligned or time-aligned measurements on multiple signal paths, such as phase difference or group delay between different inputs. Phase and time self-alignment requires a successful general self-alignment on the instrument.

This function is only available for applications that support multi-input.

Perform phase and time self-alignment after:
- Switching application instances
- Changing the frequency for any of the RF inputs
- Changing the reference level or other amplitude settings for any of the RF inputs
- Changing the sampling rate or analysis bandwidth

Remote command:
`[SENSe<ip>:]ADJust:PTIMe` on page 644

5.2.8 Optimizing measurements

5.2.8.1 Minimizing the measurement duration

If you want to minimize the measurement duration, try the following methods to optimize the measurement:

- Reduce the **span** of the measurement to the relevant parts of the signal only.
- Increase the **RBW** to minimize the measurement time. However, consider the requirements of the standard if you need to measure according to standard.
- Take advantage of the **sweep optimization mode** in the sweep settings if you do not require the larger dynamic range (see "Sweep Optimization (expert parameter)" on page 970).
- Reduce the **sweep time** and thus the amount of data to be captured and calculated. However, consider the requirements regarding the standard deviation.
- To obtain better average power results in less time, use an **RMS detector (or peak detector) with a higher sweep time** instead of trace averaging. Furthermore, enforce the use of the **sweep type "FFT"**, as opposed to "Auto". In "Sweep" mode, the averaging effect of the RMS detector can be less efficient.
- When performing multiple measurements, use **multiple application instances** to switch between measurements rather than changing the settings within one application instance repeatedly.
  Take advantage of the **"Sequencer"** function to switch between multiple measurements automatically or continuously (see also Section 4.1.1.2, "Running a sequence of measurements - the Sequencer concept", on page 103).

Additional information

An application note discussing measurement speed optimization is available from the Rohde & Schwarz website:

1EF90: Speeding up Spectrum Analyzer Measurements

5.2.8.2 Improving averaging results

To obtain better average power results in less time, use an **RMS detector (or peak detector) with a higher sweep time** instead of trace averaging. Furthermore, enforce the use of the **sweep type "FFT"**, as opposed to "Auto". In "Sweep" mode, the averaging effect of the RMS detector can be less efficient.

In FFT mode, FFTs are calculated per bin and combined using the RMS detector. For trace averaging, on the other hand, the local oscillator must be switched repeatedly for each trace, which takes additional time.

Generally, a higher **sweep time** leads to more data to be averaged and thus stabilizes the results. In FFT mode, a higher sweep time means more FFTs are calculated and combined per bin.

Thus, in the same capture time, the FFT mode with an RMS detector can provide better results than an averaged trace.

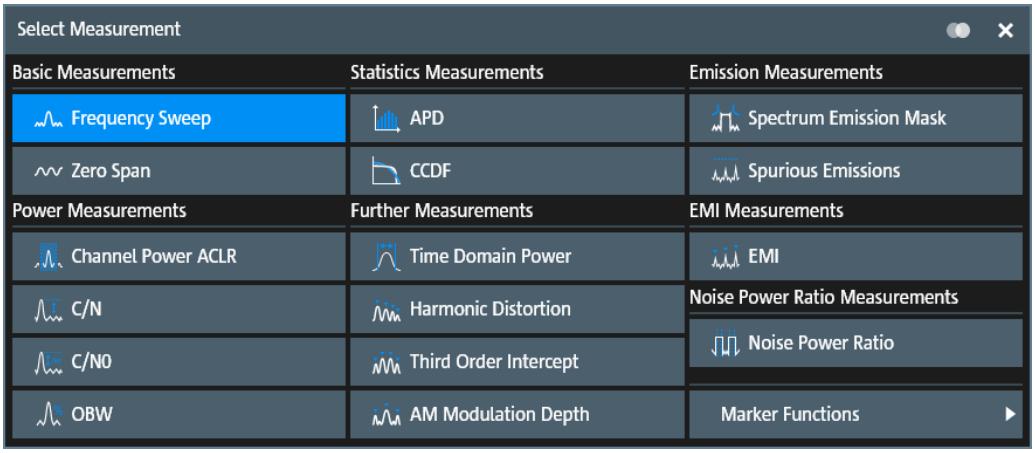
5.3 RF measurements

Access: "Overview" > "Select Measurement"

Or: [Meas]

The FSWX provides various different measurement functions for RF input. Note that not all RF functions are available in all applications.

- "Basic measurements" - measure the spectrum of your signal or watch your signal in the time domain
- "Statistic measurements" - evaluate the spectral distribution of the signal
- "Emission measurements" - detect unwanted signal emission
- "Power measurements" - calculate the powers involved in modulated carrier signals
- "Further measurements" - provide characteristic values of the signal
- "Noise Power Ratio Measurements" - determine the ratio of noise power to signal power
- "Marker Functions" - measurements performed using special markers, see Section 5.4.3, "Marker (measurement) functions", on page 1193



The measurement function determines which settings, functions and evaluation methods are available in the FSWX. The various measurement functions are described in detail here.

When you select a measurement function, the measurement is started with its default settings immediately and the corresponding measurement configuration menu is displayed. You can display the measurement configuration menu at any time by selecting [Meas Config].

The easiest way to configure measurements is using the configuration "Overview", see Section 4.1.3, "Configuration overview", on page 114.

5.3.1 Basic measurements

Basic measurements are common sweeps in the time or frequency domain which provide an overview of the basic input signal characteristics.

In the following cases, the FSWX performs a basic frequency sweep:

- When you switch on the instrument.
- When you preset the instrument.
- When you switch off all measurement functions.

Use the general measurement settings to configure the measurement, e.g. via the "Overview".

See Section 4.1.3, "Configuration overview", on page 114.

5.3.1.1 Basic measurement types

Frequency Sweep 987
Zero Span 987

Frequency Sweep
A common frequency sweep of the input signal over a specified span. Can be used for general purposes to obtain basic measurement results such as peak levels and spectrum traces. The "Frequency" menu is displayed. "Frequency Sweep" is the default measurement if no other function is selected.

Various other measurements are based on the common frequency sweep, but require additional configuration of sweep spans or amplitude limits, for example.

Examples for frequency sweep measurements are:
- "Channel Power ACLR"
- Carrier-to-noise ("C/N", "C/N_0")
- Occupied bandwidth ("OBW")
- "Spectrum Emission Mask" (SEM)
- "Spurious Emissions"
- "Third Order Intercept" (TOI)
- "AM Modulation Depth"

Remote command:
`[SENSe<ip>:]FREQuency:MODE` on page 1230
`[SENSe<ip>:]FREQuency:STARt` on page 1417, `[SENSe<ip>:]FREQuency:STOP` on page 1418
`INITiate<n>[:IMMediate]` on page 647
`INITiate<n>:CONTinuous` on page 646

Zero Span
A sweep in the time domain at the specified (center) frequency, i.e. the frequency span is set to zero. The display shows the time on the x-axis and the signal level on the y-axis, as on an oscilloscope. On the time axis, the grid lines correspond to 1/10 of the current sweep time.

Most result evaluations can also be used for zero span measurements. However, some functions (e.g. markers) work slightly differently and some are not available. If so, the function descriptions mention the restrictions.

Remote command:
`[SENSe<ip>:]FREQuency:SPAN` on page 1417
`INITiate<n>[:IMMediate]` on page 647
`INITiate<n>:CONTinuous` on page 646

5.3.1.2 How to perform a basic sweep measurement

The following step-by-step instructions demonstrate how to perform basic sweep measurements.



For remote operation, see Section 5.5.3.1, "Programming example: performing a basic frequency sweep", on page 1432.

To perform one or more single sweeps

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. Configure the frequency and span to measure ("Frequency Configuration" dialog box, see Section 5.2.2, "Frequency and span configuration", on page 958).
2. Configure the number of sweeps to perform in a single measurement ("Sweep Configuration" dialog box, see "Sweep Count" on page 969).
3. If necessary, configure how to process the signal internally ("Bandwidth Configuration" dialog box, see "Sweep Type (expert parameter)" on page 970).
4. If necessary, configure a trigger for the measurement ("Trigger / Gate Configuration" dialog box.
   See Section 4.4, "Trigger settings", on page 258
5. Define how to evaluate the results for display ("Trace Configuration" dialog box, see Section 4.8.1, "Trace configuration", on page 278).
6. If necessary, configure the vertical axis of the display ("Amplitude Configuration" dialog box, see Section 4.2.1.6, "Amplitude settings", on page 179).
7. To start the measurement, select one of the following:
   - [Run Single]
   - Sweep > "Run Single Sweep"

   The FSWX performs the defined number of sweeps, then stops the measurement. While the measurement is running, the [Run Single] key is highlighted.
8. To abort the measurement, select [Run Single] again.

   The key is no longer highlighted. The results are not deleted until a new measurement is started.
9. To repeat the same number of sweeps without deleting the last trace, select Run Single > "Continue Single Sweep".

To start continuous sweeping

1. To average the trace or search for a maximum over more (or less) than 10 sweeps, configure the "Sweep/Average Count" ("Sweep Configuration" dialog box, see "Sweep Count" on page 969).
2. To start the measurement, select one of the following:
   - [Run Cont]
   - Sweep > "Continuous Sweep"

   After the FSWX completes each sweep, it starts a new one automatically. While the measurement is running, the [Run Cont] key is highlighted.
3. To stop the measurement, select [Run Cont] again.

The key is no longer highlighted. The results are not deleted until a new measurement is started.

5.3.1.3 Measurement examples - measuring a sinusoidal signal

One of the most common measurement tasks that can be handled using a signal analyzer is determining the level and frequency of a signal. When measuring an unknown signal, you can usually start with the presettings.

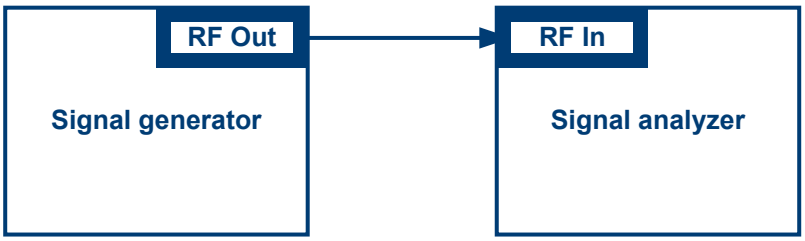


Figure 5-2: Test setup

Test setup

1. Configure the signal generator (e.g. R&S SMW):
   - "Frequency": *128 MHz*
   - "Level": *-30 dBm*
2. **NOTICE!** Signal levels exceeding 30 dBm can damage the RF attenuator or the input mixer. When calculating the expected power level, consider the total power of all occurring signals.

   If you measure signals higher than +30 dBm (=1 W), insert a power attenuator before the RF input of the analyzer.
3. Connect the RF output of the signal generator to the RF input of the FSWX.

- Measuring the level and frequency using markers.....989
- Measuring the signal frequency using the signal counter.....991

Measuring the level and frequency using markers

You can easily determine the level and frequency of a sinusoidal signal using the marker function. The FSWX always displays the measured amplitude and frequency at the marker position.

The uncertainty of the frequency measurement depends on:

- The reference frequency of the FSWX
- The resolution of the marker frequency display
- The number of sweep points

1. Select [Preset] to reset the instrument.
2. Connect the signal to measure to the "RF A | B" connector on the FSWX.

3. Set the "Center Frequency" to *128 MHz*.
4. Reduce the "Frequency Span" to *1 MHz*.

   Note: Coupled settings. In the default state, some functions are coupled. When you define the frequency span, the following settings are automatically adjusted:
   - The resolution bandwidth
   - The video bandwidt
   - The sweep time
5. Select [Marker] to enable marker 1.

   Marker 1 is automatically set to the maximum of the trace. The level and frequency values measured at the marker position are displayed in the marker information at the top of the display.

   Note: Performing a peak search. When you enable a marker, it automatically performs the peak search function.
   If a marker was already active, select [Peak Search] or [Marker To] > "Peak" to set the currently active marker to the maximum of the displayed signal.

Increasing the frequency resolution

The frequency resolution of the marker is determined by the resolution of the trace. A trace consists of 1001 trace points. If the frequency span is 1 MHz, each trace point represents a span of approximately 1 kHz. This frequency span corresponds to a maximum uncertainty of +/- 0.5 kHz.

You can increase the resolution of the trace by reducing the frequency span or by using more sweep points.

Reducing the frequency span to 10 kHz

► Reduce the "Frequency Span" to *10 kHz*.

The resolution of the trace is now approximately 10 Hz (10 kHz span / 1001 trace points). The precision of the marker frequency display increases to approximately ±5 Hz.

Setting the reference level

The reference level is the level at the upper limit of the diagram. To achieve the widest dynamic range possible for a spectrum measurement, use the entire level span of the FSWX. In other words, ideally, the highest level that occurs in the signal is located at the top edge of the diagram (= reference level) or directly beneath it.

Low reference levels

If the selected reference level is lower than the highest signal that occurs in the spectrum, the signal path in the FSWX is overloaded.

In this case, the message "IFOVLD" is displayed in the status bar.

In the default state, the value of the reference level is 0 dBm. If the input signal is -30 dBm, you can reduce the reference level by 30 dB without overloading the signal path.

Reducing the reference level by 30 dB

► Set the "Reference level" to *-30 dBm*.

The maximum of the trace is near the maximum of the measurement diagram. The displayed noise does not increase substantially. Thus, the distance between the signal maximum and the noise display (=dynamic range) increases.

Setting the reference level with the help of a marker

You can also use a marker to shift the maximum value of the trace directly to the top edge of the diagram. If the marker is located at the maximum level of the trace (as in this example), you can move the reference level to the marker level as follows:

► Select [Marker To] > "Set Ref Level to Marker Level".

The reference level is set to the current marker level.

Measuring the signal frequency using the signal counter

The built-in signal counter allows you to measure the frequency more accurately than with a marker. The FSWX stops the frequency sweep at the marker and measures the frequency of the signal at the marker position (see also Section 5.4.3.2, "Measuring a precise frequency (signal count marker)", on page 1196).

In the following example, the precise frequency of the generator at 128 MHz is shown using the marker.

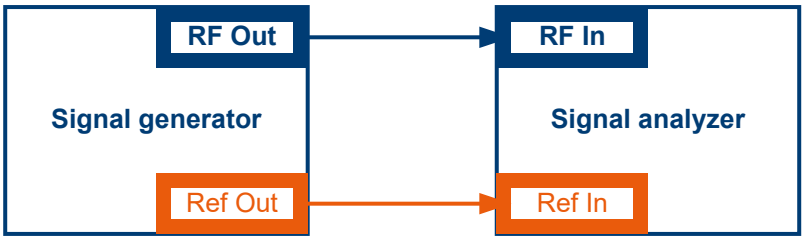


Figure 5-3: Test setup

Prerequisite

Precise frequency measurements require a precise reference frequency. Therefore, the FSWX uses an external reference frequency from a signal generator. Connect the signal generator's "Ref Out" connector to the analyzer's "Ref In" connector.

1. Select [Preset] to reset the instrument.
2. Set the "Center Frequency" to *128 MHz*.
3. Set the "Frequency Span" to *1 MHz*.

4. Select Setup > "Reference" > "Reference Output 1/2" to enable the external reference frequency.
5. Select [Marker] to enable marker 1.

   Marker 1 is automatically set to the maximum of the trace. The level and the frequency of the marker are displayed in the marker results in the diagram or the marker table.
6. Select [Marker Function] > "Signal Count" to enable the signal counter.

   The result of the signal counter is displayed in the marker results.
7. If necessary, increase the resolution of the signal counter by selecting "Resolution" (in the "Signal Count" menu).

Prerequisites for using the internal signal counter

To obtain a correct result when measuring the frequency with the internal signal counter, an RF sinusoidal signal or a spectral line must be available. The marker must be located more than 25 dB above the noise level to ensure that the specified measurement accuracy is adhered to.

5.3.1.4 Measurement example – measuring levels at low S/N ratios

The minimum signal level that a signal analyzer can measure is limited by its intrinsic noise. Small signals can be swamped by noise and therefore cannot be measured. For signals that are just above the intrinsic noise, the accuracy of the level measurement is influenced by the intrinsic noise of the FSWX.

The displayed noise level of a signal analyzer depends on:

- The analyzer's noise figure
- The RF attenuation
- The reference level
- The resolution bandwidth
- The video bandwidth
- The detector

For details see:

- Section 4.3.2.2, "Sensitivity of the hardware: RF attenuation", on page 239
- Section 4.3.2.1, "Expected input levels: Reference level", on page 238
- Section 4.3.3.1, "Separating signals by selecting an appropriate resolution bandwidth", on page 241
- Section 4.3.3.2, "Smoothing the trace using the video bandwidth", on page 242
- "Mapping samples to sweep points with the trace detector" on page 278

This measurement example shows the different factors affecting the S/N ratio.

Table 5-1: Signal generator settings (e.g. R&S SMW)

"Frequency"	128 MHz
"Level"	-95 dBm

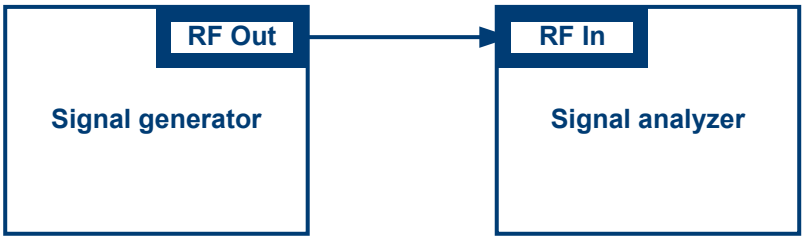


Figure 5-4: Test setup

1. Preset the FSWX.
2. Set the "Center Frequency" to *128 MHz*.
3. Set the "Frequency Span" to *100 MHz*.
4. Set the "Reference level" to *-30 dBm*.

   The FSWX measures the signal with the auto peak detector. The signal is hidden in the intrinsic noise of the analyzer.

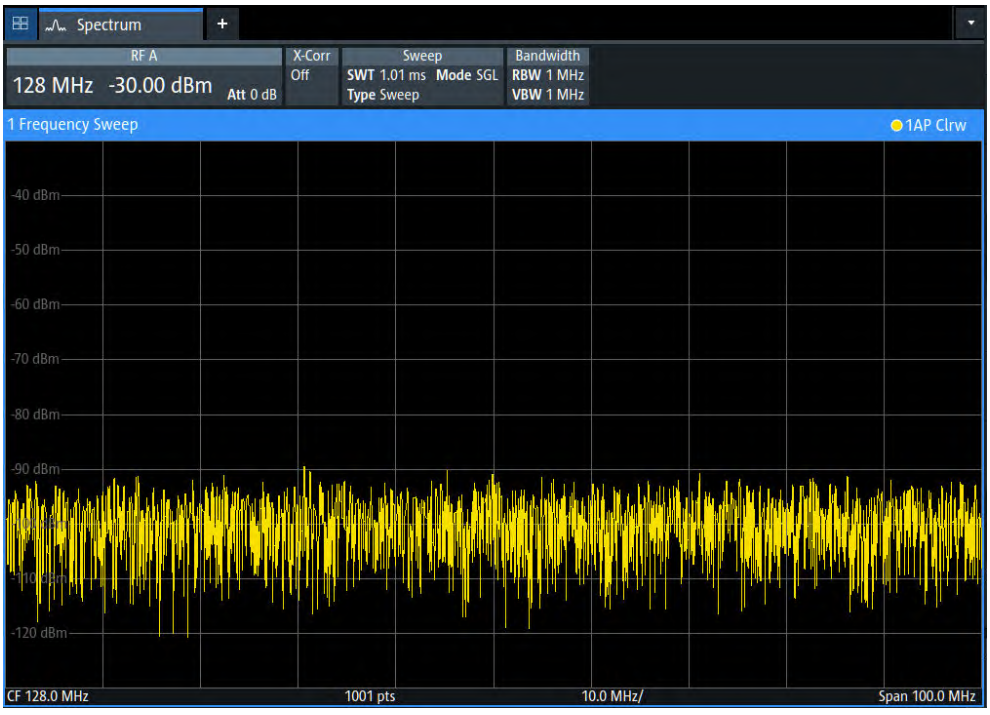


Figure 5-5: Sine-wave signal with low S/N ratio

5. To suppress noise spikes, average the trace. In the "Trace Configuration" dialog, set the "Mode" to "Average" (see "Analyzing several traces - trace mode" on page 285).

The traces of consecutive sweeps are averaged. To perform averaging, the FSWX automatically switches on the sample detector. The RF signal, therefore, can be more clearly distinguished from noise.

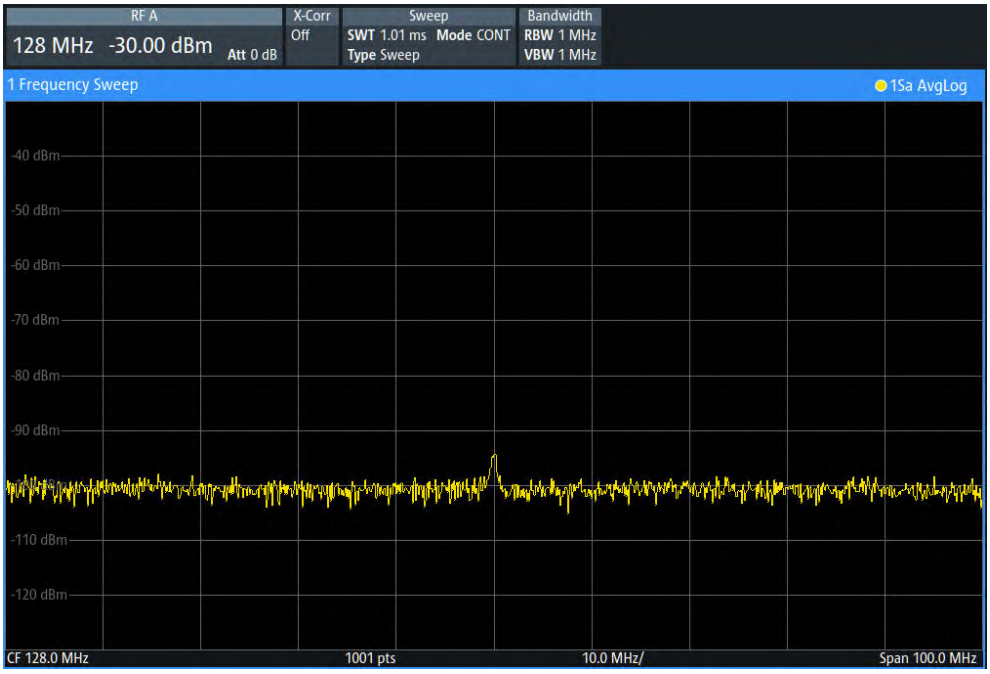


Figure 5-6: RF sine-wave signal with low S/N ratio with an averaged trace

6. Instead of trace averaging, you can select a video filter that is narrower than the resolution bandwidth.

   a) In the "Trace Configuration" dialog, set the trace mode back to "Clear Write".
   b) In the "Bandwidth Configuration" dialog, set the "Video Bandwidth Manual" to *10 kHz*.

   You can distinguish the RF signal from noise more clearly.

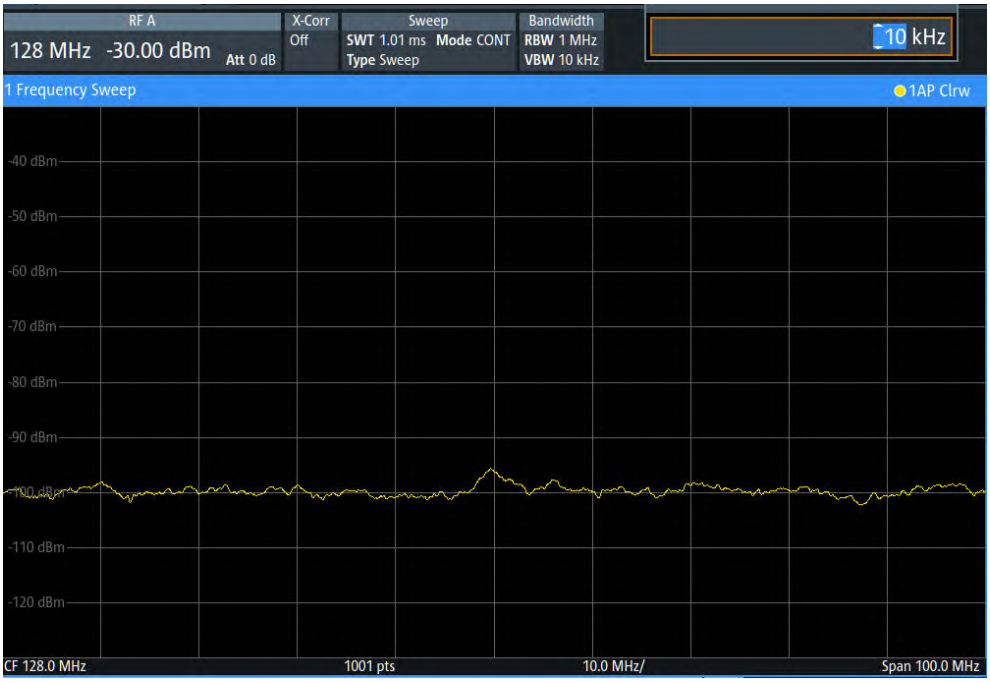


Figure 5-7: RF sine-wave signal with low S/N ratio with a smaller video bandwidth

7. When you reduce the resolution bandwidth by a factor of 10, the noise is reduced by 10 dB. Set the "Resolution Bandwidth Manual" to *100 kHz*.

   The displayed noise is reduced by approximately 10 dB. Therefore, the signal emerges from noise by about 10 dB. Compared to the previous setting, the video bandwidth has remained the same. However, it has increased relative to the reduced resolution bandwidth. The averaging effect of the video bandwidth is therefore reduced. The trace becomes noisier.

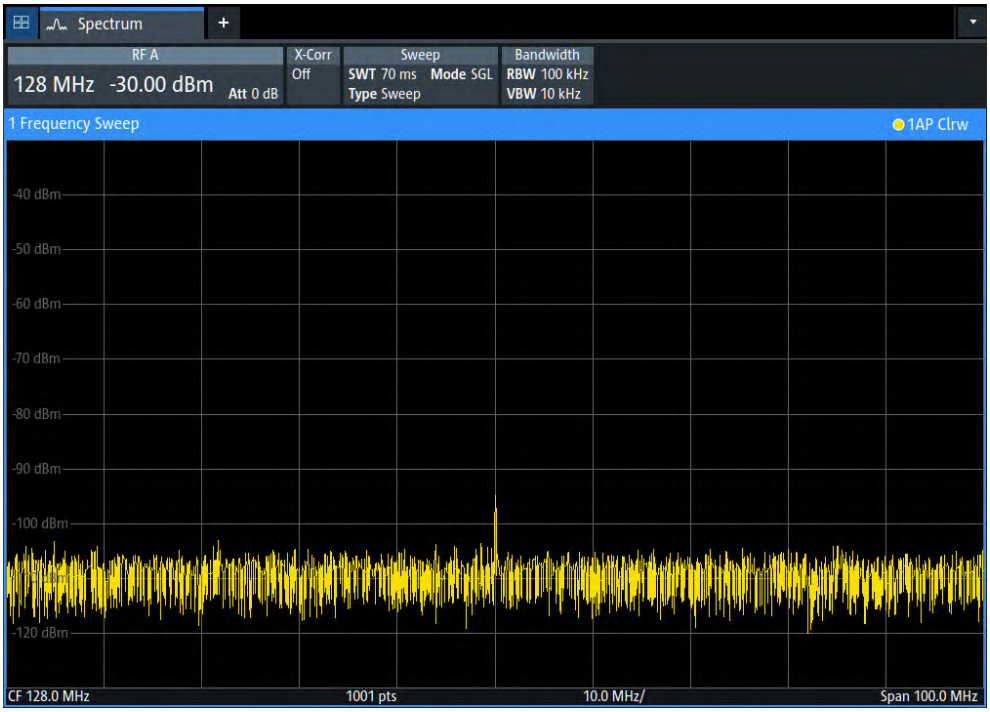


Figure 5-8: Reference signal at a smaller resolution bandwidth

5.3.1.5 Measurement examples - measuring signal spectra with multiple signals

- Separating signals by selecting the resolution bandwidth..... 996
- Measuring the modulation depth of an AM-modulated carrier in the frequency domain..... 1000
- Measuring AM-modulated signals.....1001

Separating signals by selecting the resolution bandwidth

A basic feature of a signal and spectrum analyzer is the ability to separate the spectral components of a mixture of signals. The resolution at which the individual components can be separated is determined by the resolution bandwidth. If you select a resolution bandwidth that is too large, it can become impossible to distinguish between spectral components. They are displayed as a single component (see also Section 4.3.3.1, "Separating signals by selecting an appropriate resolution bandwidth", on page 241).

Two signals with the same amplitude can be resolved if the resolution bandwidth is smaller than or equal to the frequency spacing of the signal. If the resolution bandwidth is equal to the frequency spacing, the spectrum display shows a level drop of 3 dB precisely in the center of the two signals. Decreasing the resolution bandwidth makes the level drop larger, which thus makes the individual signals clearer.

In this measurement example, we analyze two signals with a level of -30 dBm each, and a frequency spacing of 30 kHz.

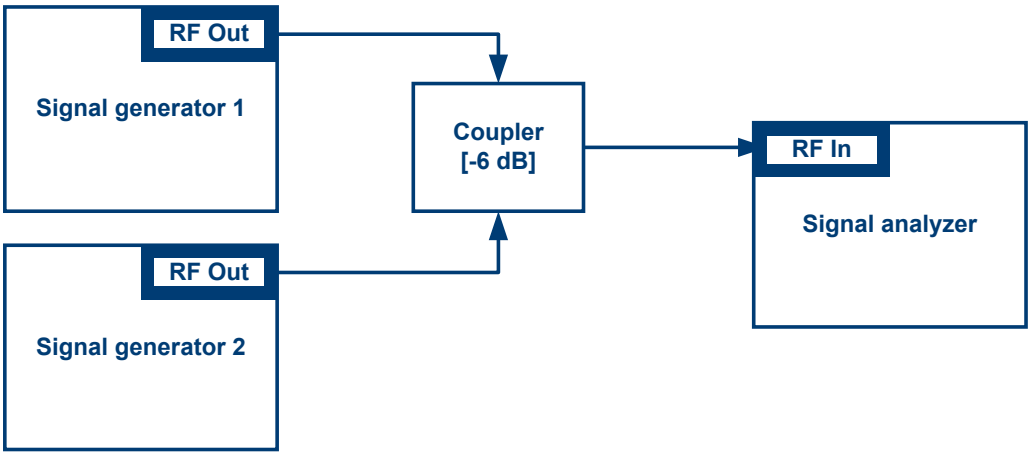


Figure 5-9: Test setup

Table 5-2: Signal generator settings (e.g. R&S SMW)

	Level	Frequency
Signal generator 1	-30 dBm	128.00 MHz
Signal generator 2	-30 dBm	128.03 MHz

1. Select [Preset] to reset the instrument.
2. Set the "Center Frequency" to *128.015 MHz*.
3. Set the "Frequency Span" to *300 kHz*.
4. Set the "Resolution Bandwidth Manual" to *30 kHz*.
5. Set the "Video Bandwidth Manual" to *1 kHz*.

   Note: Larger video bandwidths. The video bandwidth is set to 1 kHz to make the level drop in the center of the two signals clearly visible. At larger video bandwidths, the video voltage that results from envelope detection is not sufficiently suppressed. Thus, additional voltages are visible in the trace, in the transition area between the two signals. Figure 5-10 shows the result of measuring two equally-leveled RF sinusoidal signals with an RBW that corresponds to the frequency spacing of the signals.

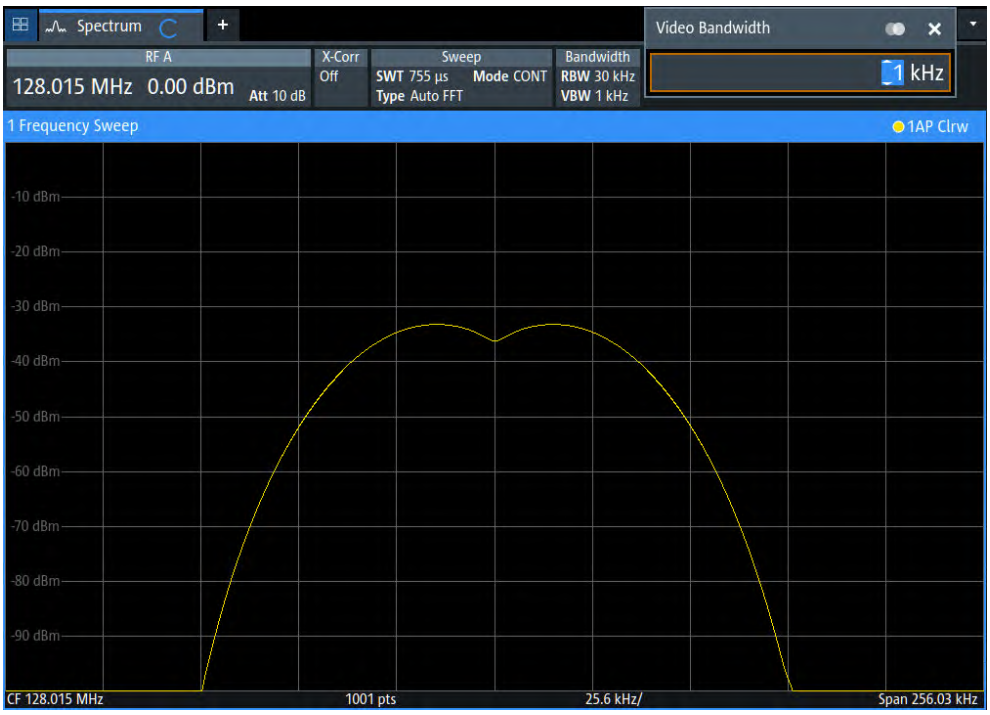


Figure 5-10: Measurement of two equally-leveled RF sinusoidal signals

Matching generator and FSWX frequencies

The level drop is located exactly in the center of the display only if the generator frequencies match the frequency display of the FSWX exactly. To achieve exact matching, the frequencies of the generators and the FSWX must be synchronized.

6. Set the "Resolution Bandwidth Manual" to *100 kHz*.

   It is no longer possible to distinguish the two generator signals clearly. Figure 5-11 shows the result of measuring two equally-leveled RF sinusoidal signals with an RBW that is larger than their frequency spacing.

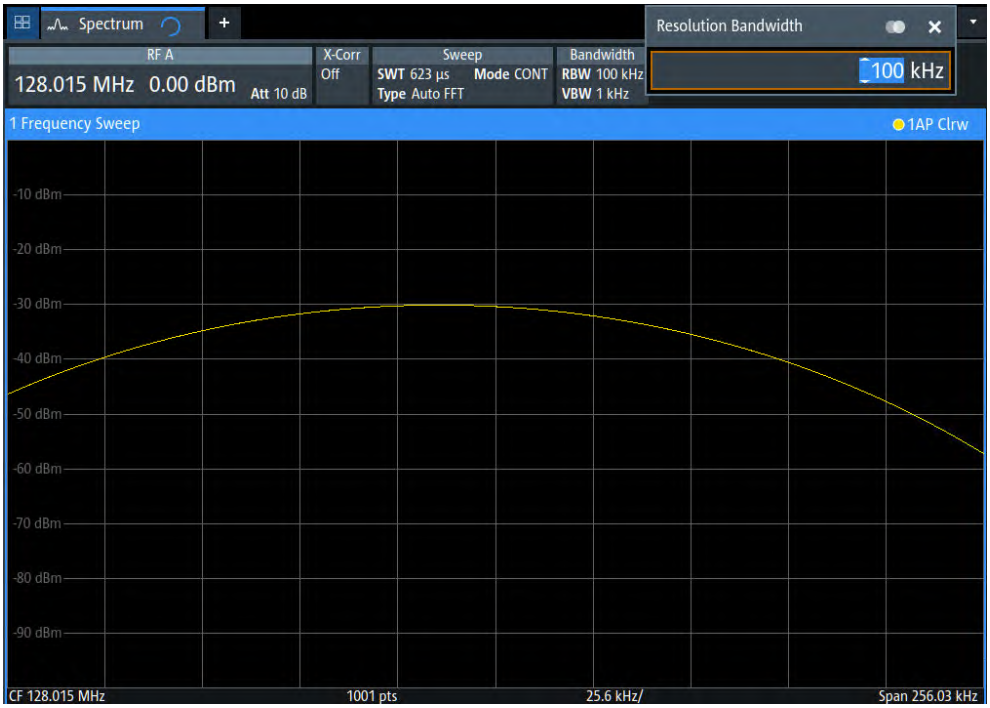


Figure 5-11: Measurement of two equally-leveled RF sinusoidal signals (2)

7. Set the "Resolution Bandwidth Manual" to *1 kHz*.

   The two generator signals are shown with high resolution. However, the sweep time becomes longer. At smaller bandwidths, the noise display decreases simultaneously (10 dB decrease in noise floor for a decrease in bandwidth by a factor of 10). Figure 5-12 shows the result of measuring two equally-leveled RF sinusoidal signals with an RBW of 1 kHz, which is significantly smaller than their frequency spacing.

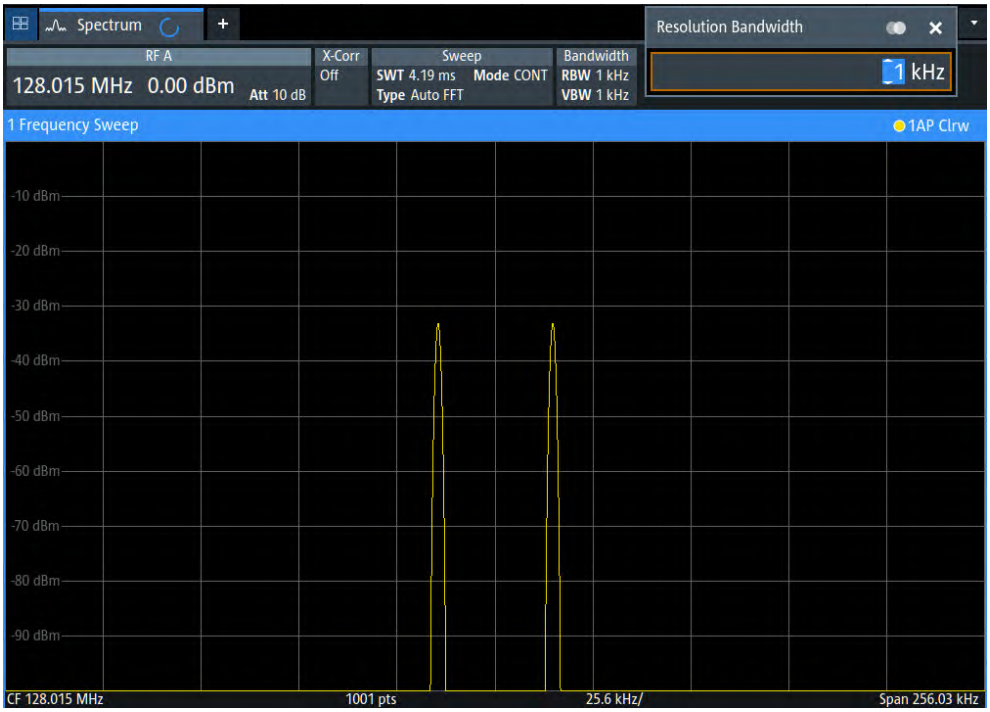


Figure 5-12: Measurement of two equally-leveled RF sinusoidal signals (3)

Measuring the modulation depth of an AM-modulated carrier in the frequency domain

In the "Spectrum" display, the AM sidebands can be resolved with a narrow bandwidth, and measured separately. The modulation depth of a carrier modulated with a sinusoidal signal can then be measured. Since the dynamic range of the FSWX is large, it can also measure extremely small modulation depths precisely. The FSWX provides measurement routines that output the modulation depth numerically, in percent.

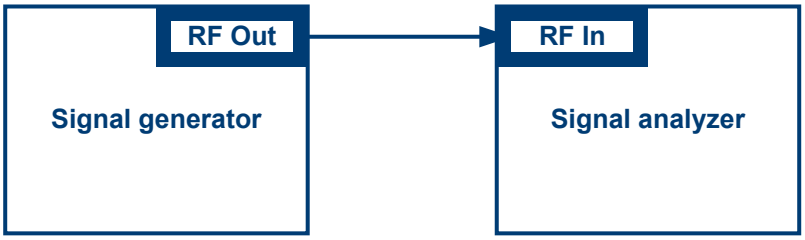


Figure 5-13: Test setup

Table 5-3: Signal generator settings (e.g. R&S SMW)

"Frequency"	128 MHz
"Level"	-30 dBm
"Modulation"	50 % AM, 10 kHz AF

1. Select [Preset] to reset the instrument.

2. Set the "Center Frequency" to *128 MHz*.
3. Set the "Frequency Span"n to *256 kHz*.
4. Select [Meas] > "AM Modulation Depth" to enable the modulation depth measurement.

   The FSWX automatically sets a marker on the carrier signal in the center of the diagram. A delta marker is set to each of the upper and lower AM sidebands. The FSWX calculates the AM modulation depth from the level differences of the delta markers to the main marker. The numeric value is displayed in the marker information.



Figure 5-14: Measurement of the AM modulation depth

The modulation depth is displayed as "MDepth"""". You can determine the frequency of the AF signal from the frequency value of the delta marker.

Measuring AM-modulated signals

The FSWX rectifies the RF input signal (that is, removes the negative parts) and displays it as a magnitude spectrum. The rectification also demodulates AM-modulated signals. The AF voltage can be displayed in zero span if the modulation sidebands fall within the resolution bandwidth.

Displaying the AF of an AM-modulated signal (zero span)

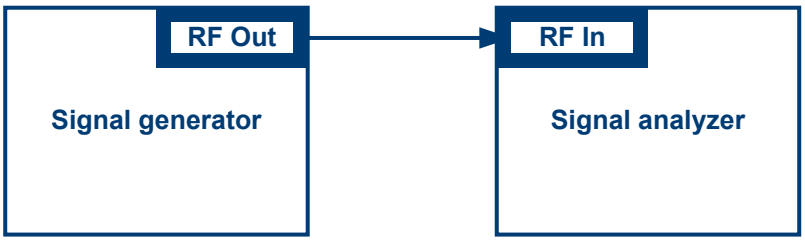


Figure 5-15: Test setup

Table 5-4: Signal generator settings (e.g. R&S SMW)

"Frequency"	128 MHz
"Level"	-30 dBm
"Modulation"	50 % AM, 1 kHz AF

1. Select [Preset] to reset the instrument.
2. Set the "Center Frequency" to *128 MHz*.
3. Set the "Frequency Span" to *0 Hz*, or select "Zero Span".
4. Set the "Sweep Time" to *2.5 ms*.
5. Set the "Resolution Bandwidth Manual" to *3 MHz*.
6. Set the "Reference level" to *-24 dBm* .
7. Set the display range to linear ([Ampt / Scale] > "Scale Configuration" > "Scaling": "Linear Percent").
8. Define triggering in response to the AF signal using the video trigger to produce a static image ([Trigger] > "Video").
9. Set the "Level" to *50%*.

   The trigger level is displayed as a horizontal line across the entire measurement diagram. The FSWX displays the 1 kHz AF signal as a static image in zero span.

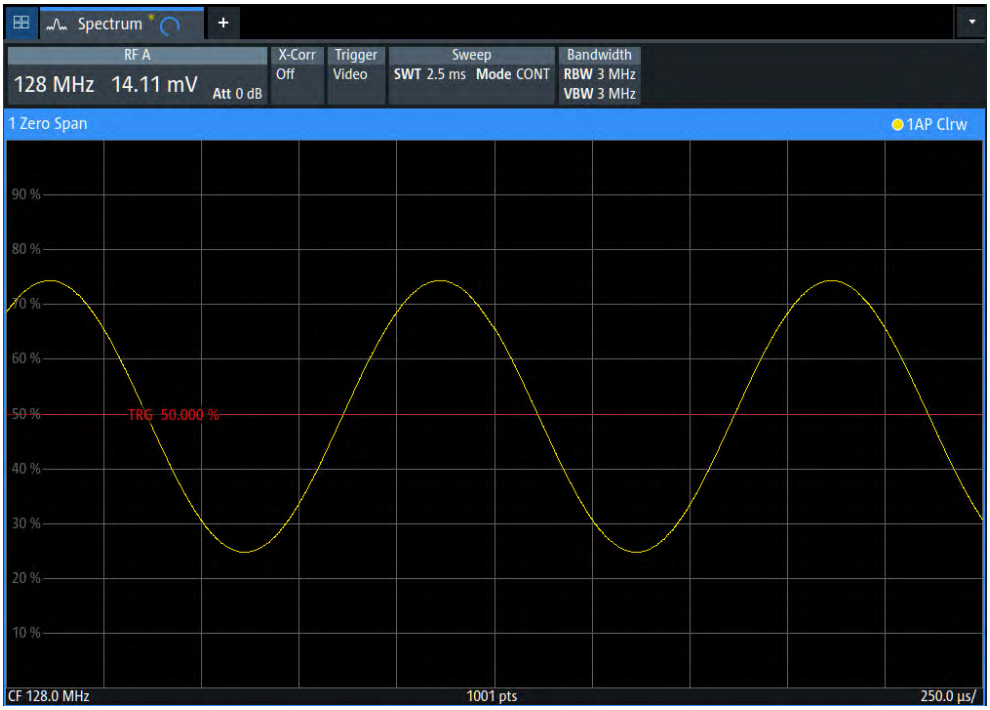


Figure 5-16: Measurement of the AF signal of a carrier that is AM-modulated with 1 kHz

10. Enable the internal AM demodulator to output the audio signal ([Marker Function] > "Marker Demodulation").

    The FSWX automatically switches on the AM audio demodulator. You can hear a 1 kHz tone using a headset (via the "Phones" connector). If necessary, use the volume control to turn up the volume.

5.3.1.6 Measurement examples in zero span

For radio transmission systems that use the TDMA method (for example, GSM), transmission quality is determined not only by spectral characteristics, but also by characteristics in zero span. Since several users share the same frequency, a timeslot is assigned to each user. Smooth operation is ensured only if all users adhere exactly to their assigned timeslots.

The power during the send phase, the timing and duration of the TDMA burst, and rise and fall times of the burst, are important.

- Measuring the power characteristic of burst signals 1003
- Measuring the signal-to-noise ratio of burst signals 1007

Measuring the power characteristic of burst signals

To measure power in zero span, the FSWX offers easy-to-use functions that measure the power over a predefined time.

Measuring the power of a GSM burst during the activation phase

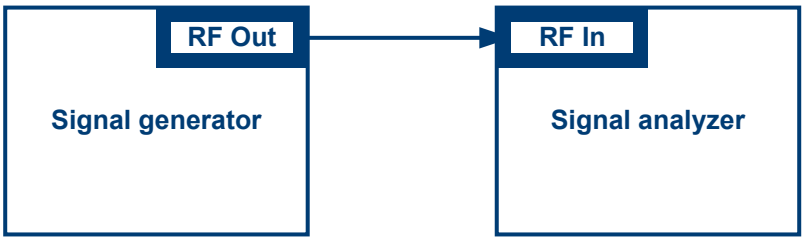


Figure 5-17: Test setup

Table 5-5: Signal generator settings (e.g. R&S SMW)

"Frequency"	890 MHz
"Level"	0 dBm
"Modulation"	GSM, one timeslot enabled

1. Select [Preset] to reset the instrument.
2. Set the "Center Frequency" to *890 MHz* ([Freq]).
3. Set the "Frequency Span" to *0 Hz* ([Span] > "Zero Span").
4. Set the "Reference level" to *10 dBm* (= level of the signal generator +10 dB) ([Ampt / Scale]).
5. Set the attenuation to *20 dB* ([Ampt / Scale] > "RF Attenuation Mode": "Manual").
6. Set the "Resolution Bandwidth Manual" to *1 MHz* ([BW] > "Resolution Bandwidth Manual").
7. Set the "Sweep Time" to *1 ms* ([Sweep] > "Sweep Time": "Manual").

   The FSWX shows the GSM burst continuously across the display.
8. Using the video trigger, set triggering on the rising edge of the burst.
   a) Select [Trigger].
   b) Set the "Trigger Source" to "Video".
   c) Set the "Level" to *70%*.

   The FSWX shows a static image with the GSM burst at the start of the trace. The trigger level is displayed as a horizontal line labeled with the absolute level for the trigger threshold in the measurement diagram.
9. Enable power measurement within the activation phase of the burst in zero span.
   a) Select [Meas].
   b) Select "Time Domain Power".
   c) Select "Time Domain Power Configuration".
   d) Set the "Limits" state to "On".
   e) Select the "Left" input field.
   f) By turning the rotary knob clockwise, move the vertical line "S1" to the start of the burst.

g) Select the "Right" input field.
h) By turning the rotary knob clockwise, move the vertical line "S2" to the end of the burst.

The FSWX displays the average (mean) power during the activation phase of the burst.

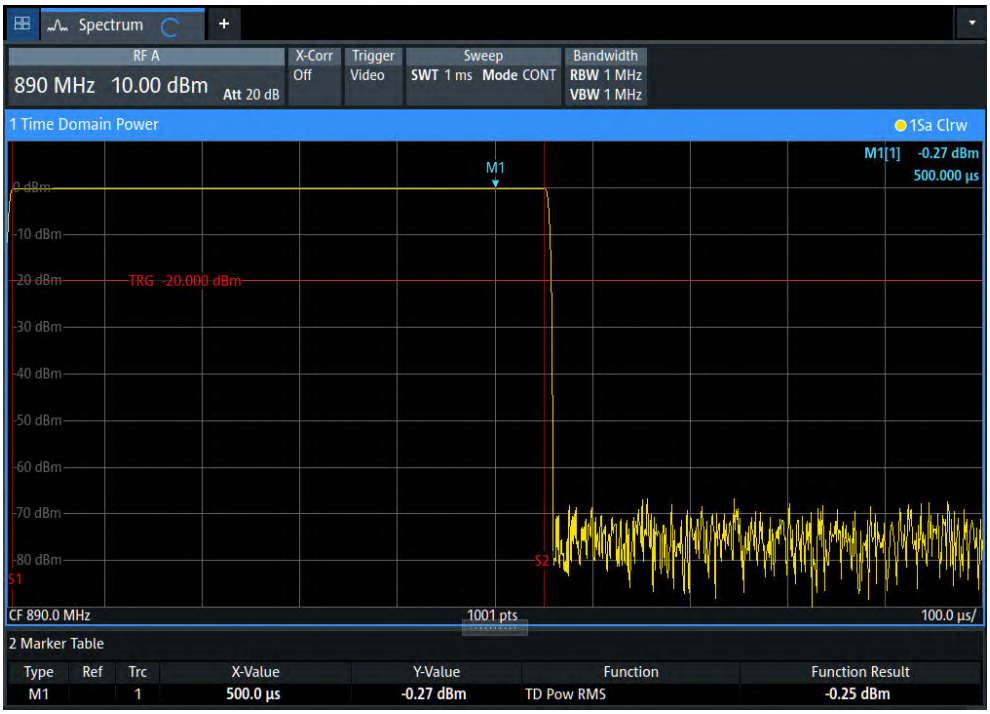


Figure 5-18: Measurement of the average power during the burst of a GSM signal

Measuring the edges of a GSM burst with high time-resolution

The FSWX has a very high time resolution in the zero span display range. Thus, it can measure the edges of TDMA bursts precisely. You can shift the edges to the display area using the trigger offset.

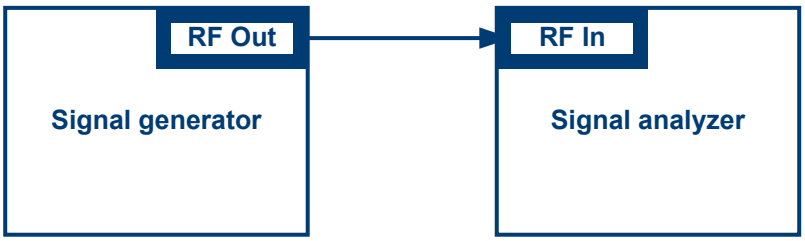


Figure 5-19: Test setup

Table 5-6: Signal generator settings (e.g. R&S SMW)

"Frequency"	890 MHz
"Level"	0 dBm
"Modulation"	GSM, one timeslot enabled

The measurement is based on the example "Measuring the power of a GSM burst during the activation phase" on page 1004.

1. Switch off the power measurement.
   a) Select [Meas].
   b) Select "Zero Span".
2. Increase the time resolution by setting the sweep time to *100 µs* ([Sweep] > "Sweep Time": "Manual").
3. Shift the rising edge of the GSM burst to the center of the display by defining a trigger offset.
   a) Select [Trigger].
   b) Select "Trigger Offset".
   c) By turning the rotary knob counterclockwise, reduce the trigger offset until the burst edge is displayed in the center of the display, or enter *-50 µs*.
   The FSWX displays the rising edge of the GSM burst.

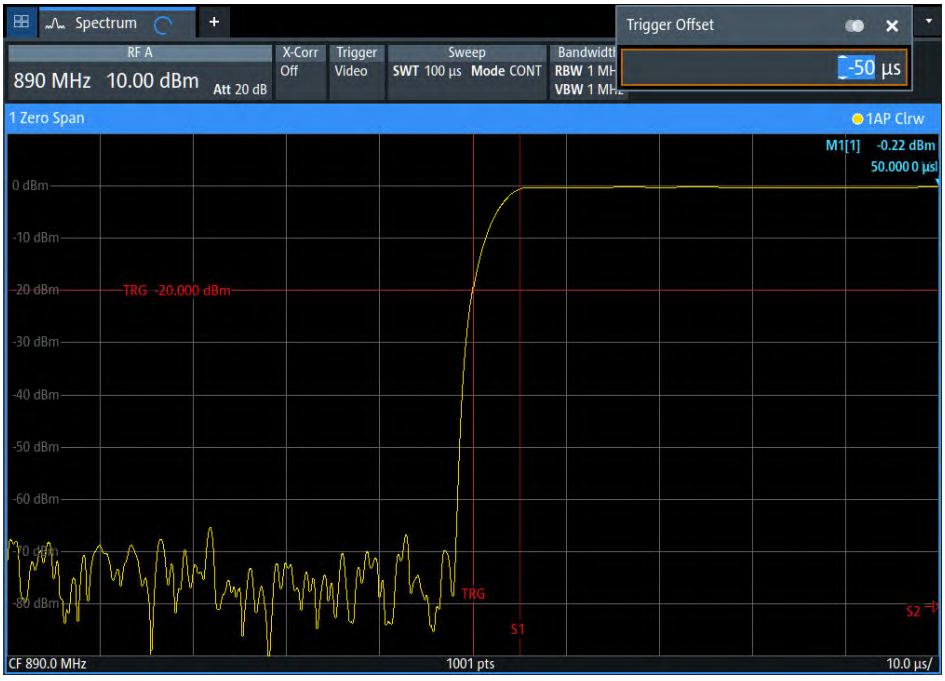


Figure 5-20: Rising edge of the GSM burst displayed with high time resolution

4. Move the falling edge of the burst to the center of the display. To do so, switch the trigger "Slope" to "Falling" ([Trigger] > "Trigger / Gate Configuration").

   The FSWX displays the falling edge of the GSM burst.

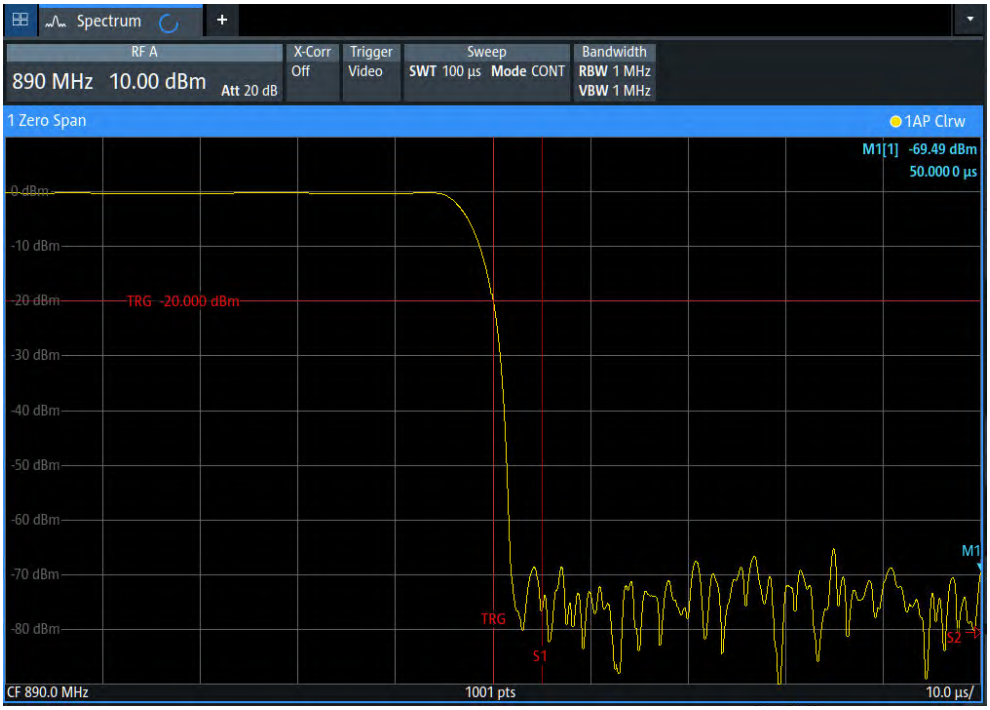


Figure 5-21: Falling edge of the GSM burst displayed with high time resolution

Measuring the signal-to-noise ratio of burst signals

Assume TDMA transmission methods are used, and you want to determine the signal-to-noise ratio of the signal or the dynamic range of the deactivation phase. You can do so by comparing the power values during the activation phase and the deactivation phase of the transmission burst. The FSWX provides a measurement for absolute and relative power in zero span. In the following example, the measurement is performed using a GSM burst.

Signal-to-noise ratio of a GSM signal

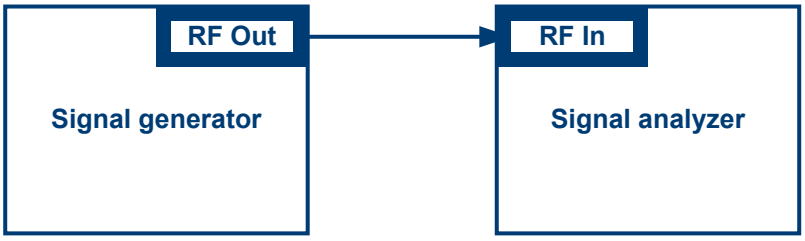


Figure 5-22: Test setup

Table 5-7: Signal generator settings (e.g. R&S SMW)

"Frequency"	890 MHz
"Level"	0 dBm
"Modulation"	GSM, one timeslot is switched on

1. Select [Preset] to reset the instrument.
2. Set the "Center Frequency" to *890 MHz*.
3. Set the "Frequency Span" to *0 Hz*.
4. Set the "Resolution Bandwidth Manual" to *1 MHz*.
5. Set the "Reference level" to *0 dBm* (= level of the signal generator).
6. Set the sweep time to *2 ms*.

   The FSWX shows the GSM burst continuously across the display.
7. Use the trigger source "Video" and the trigger slope "Rising" to trigger on the rising edge of the burst. Shift the start of the burst to the center of the display (see step 3 in "Measuring the edges of a GSM burst with high time-resolution" on page 1005).
8. Enable power measurement within the activation phase of the burst in zero span.
   a) Select [Meas].
   b) Select "Time Domain Power".
   c) Select "Time Domain Power Configuration".
   d) Set the "Limits" "State" to "On".
   e) Select the "Left" input field.
   f) By turning the rotary knob clockwise, move the vertical line "S1" to the start of the burst.
   g) Select the "Right" input field.
   h) By turning the rotary knob clockwise, move the vertical line "S2" to the end of the burst.
   i) Note down the power result for the burst, indicated by the "TD Pow RMS" result in the marker table.
9. Measure the power during the deactivation phase of the burst by switching the trigger slope to "Falling" ([Trigger] > "Trigger / Gate Configuration").

   The FSWX initiates triggering in response to the falling edge of the burst. The burst is shifted to the left-hand side of the measurement diagram. The power is measured in the deactivation phase.

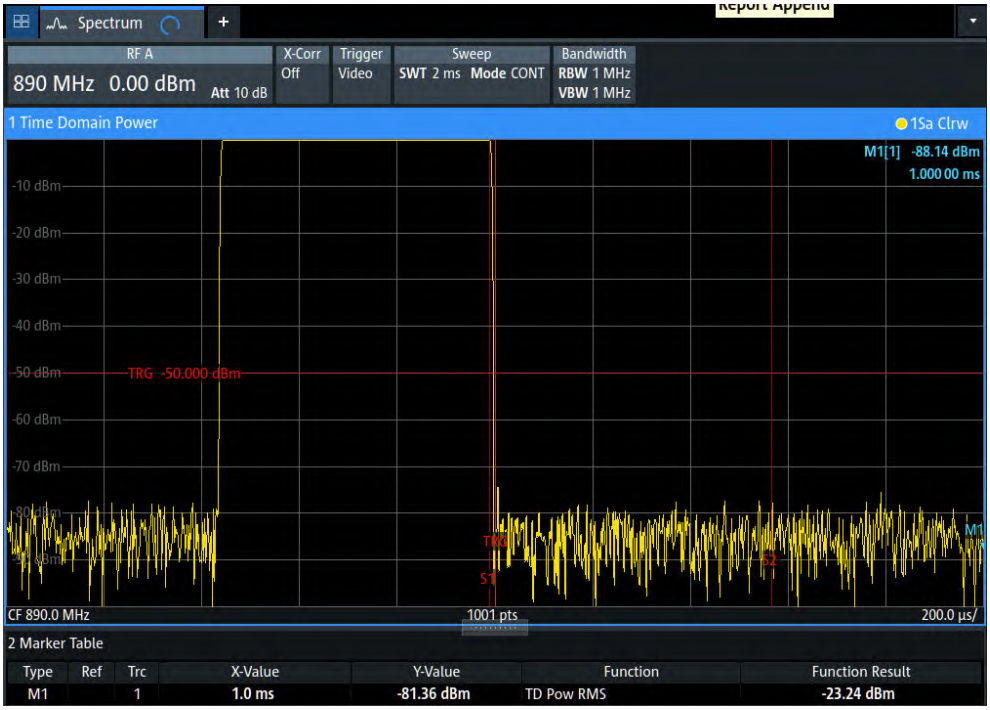


Figure 5-23: Measurement of the signal-to-noise ratio of a GSM burst signal in zero span

10. Note the power result for the measured noise, indicated by the "TD Pow RMS" result in the marker table.
11. Subtract the measured noise power from the burst power to obtain the signal-to-noise ratio of the burst signal.

5.3.2 Statistical measurements (APD, CCDF)

The FSWX provides two statistical measurement functions to determine the amplitude distribution:

- "APD": amplitude probability distribution
- "CCDF": complementary cumulative distribution function

You can only enable one of the signal statistics functions at a time.

- About the measurements 1010
- Typical applications 1010
- APD and CCDF results 1010
- APD and CCDF basics - gated triggering 1013
- APD and CCDF configuration 1014
- How to perform an APD or CCDF measurement 1021
- Examples 1022
- Optimizing and troubleshooting the measurement 1025

5.3.2.1 About the measurements

You can measure the probability of amplitude values with the amplitude probability distribution function ("APD"). During a selectable measurement time, the measurement assigns all occurring amplitude values to an amplitude range. The measurement counts the number of amplitude values in the individual ranges and displays the result as a histogram.

The complementary cumulative distribution function ("CCDF") shows the probability that the measured signal power amplitude exceeds the mean signal power amplitude in percent.

You can only enable one of the signal statistics functions at a time. The FSWX measures the statistics of the signal applied to the RF input with the defined analysis bandwidth.

You can perform statistical measurements on pulsed signals using a gated trigger. For details see Section 5.3.2.4, "APD and CCDF basics - gated triggering", on page 1013.

5.3.2.2 Typical applications

Digital modulated signals are similar to white noise within the transmit channel, but are different in their amplitude distribution. To avoid distortion, the output power amplifier has to transmit all amplitudes of the modulated signal linearly. The peak amplitude values are most critical. The transmit quality of a transmitter two-port network depends on the amplitude of the peak values and on their probability.

Modulated signals using amplitude modulation, such as QPSK, contain peak amplitudes that are greater than the average power. CDMA transmission modes, in particular, can have power peaks that are large compared to the average power. You can recognize such signals in zero span because their envelope is not constant.

When transmitting such signals, the transmitter must provide large reserves for the peak power. Otherwise, signal compression can occur and the bit error rate at the receive can increase. The peak power or the crest factor of a signal is therefore an important transmitter design criterion. The crest factor is defined as the peak (envelope) power to mean power ratio. Logarithmically, it is defined as the peak level minus the average level of the signal. To reduce power consumption and cut costs, transmitters are not designed for the largest power that could ever occur. They are designed for a power level that has a specified probability of being exceeded (e.g. 0.01 %).

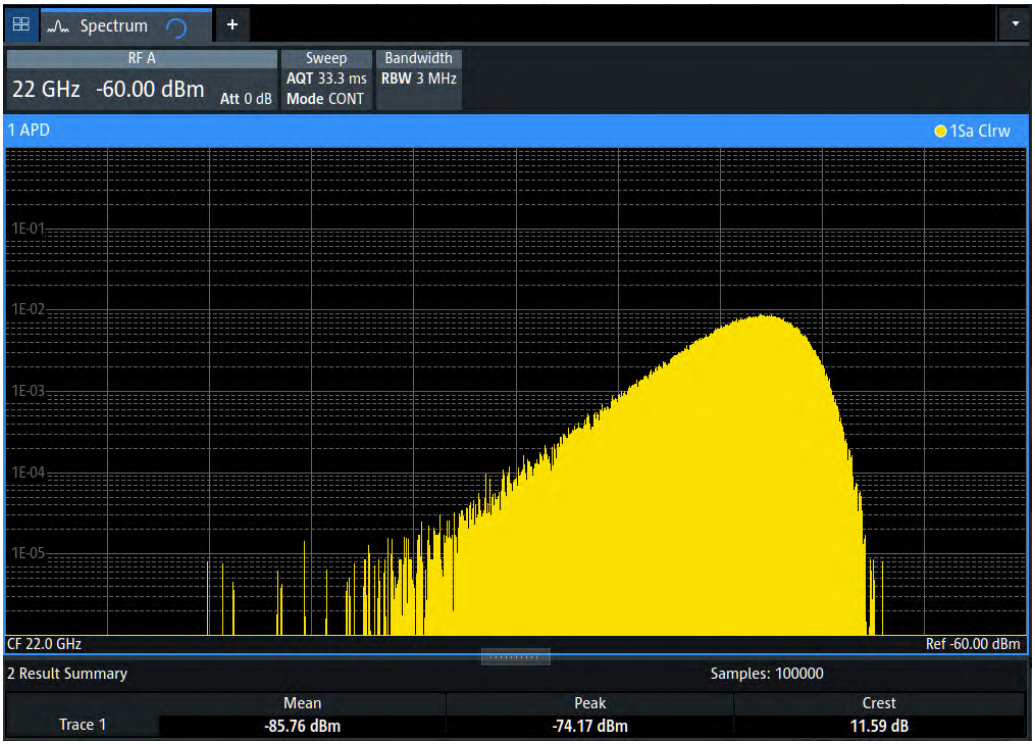
The statistical functions provide information on such signal criteria.

5.3.2.3 APD and CCDF results

Amplitude probability distribution (APD)

As a result of the amplitude probability distribution ("APD") function, the probability of measured amplitude values is displayed. During a selectable measurement time, all measured amplitude values are assigned to an amplitude range (*bin*). The number of amplitude values in the individual ranges is counted, and the result is displayed

as a histogram. Each bar of the histogram represents the percentage of measured amplitudes within the specific amplitude range. The x-axis represents the amplitude values and is scaled in absolute values (dBm).

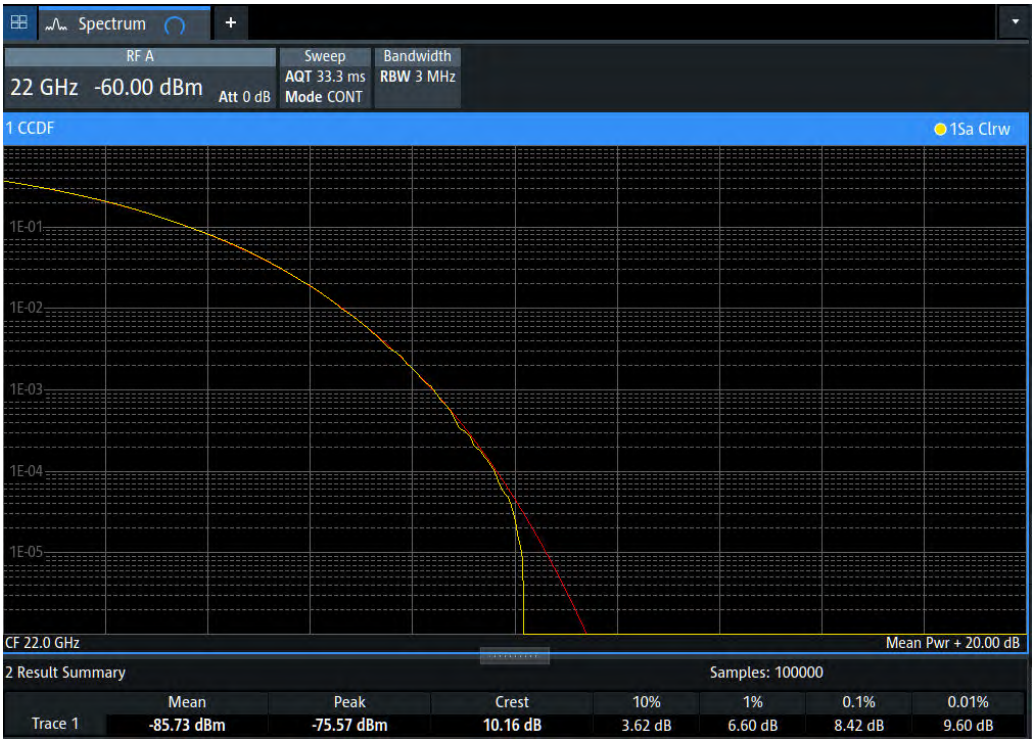


In addition to the histogram, a "Result Summary" displays the following information:

- Number of samples used for calculation
- For each displayed trace:
  - Mean amplitude
  - Peak amplitude
  - Crest factor
    The crest factor is defined as the peak (envelope) power to mean power ratio or, logarithmically, as the peak (envelope) level minus the average level of the signal.

Complementary cumulative distribution function (CCDF)

The complementary cumulative distribution function ("CCDF") shows the probability that the signal power amplitude exceeds the mean value in percent. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that a level is exceeded is plotted along the y-axis.



A red line indicates the ideal Gaussian (normal) distribution for the measured amplitude range.

The displayed amplitude range is indicated as "Mean Pwr" + "x dB".

In addition to the diagram, a "Result Summary" displays the following information:

- Number of samples used for calculation
- For each displayed trace:

"Mean"	Mean power
"Peak"	Peak power
"Crest"	Crest factor (peak envelope power – mean power)
"10 %"	10 % probability that the level exceeds mean power + [x] dB
"1 %"	1 % probability that the level exceeds mean power + [x] dB
"0.1 %"	0.1 % probability that the level exceeds mean power + [x] dB
"0.01 %"	0.01 % probability that the level exceeds mean power + [x] dB

Percent marker

In addition to the results for specific percentages in the table, you can enable a percent marker for a freely selectable percentage. This marker indicates how many level values are over <x> % above the mean power.



As with all markers, you can move the percent marker simply by selecting it with a finger or mouse cursor and dragging it to the desired position.

Diagram scaling

You can configure the scaling for both the x-axis and y-axis of the statistics diagram. In particular, you can restrict the range of amplitudes to evaluate and the probabilities to display.

Remote commands:

`CALCulate<n>:STATistics:CCDF:X<t>?` on page 1381

`CALCulate<n>:STATistics:RESult<res>?` on page 1382

5.3.2.4 APD and CCDF basics - gated triggering

You can perform statistical measurements on pulsed signals using a gated trigger. An external or power trigger is required as a time (frame) reference.

The gate ranges define the part of the measured data that is considered for the statistics calculation. You define these ranges relative to a reference point T=0. The gate interval is repeated for each period until the end of the capture buffer.

The reference point T=0 is defined by the external trigger event and the instrument's trigger offset.

For each trace, you can define up to 3 separate ranges of a single period to be traced.

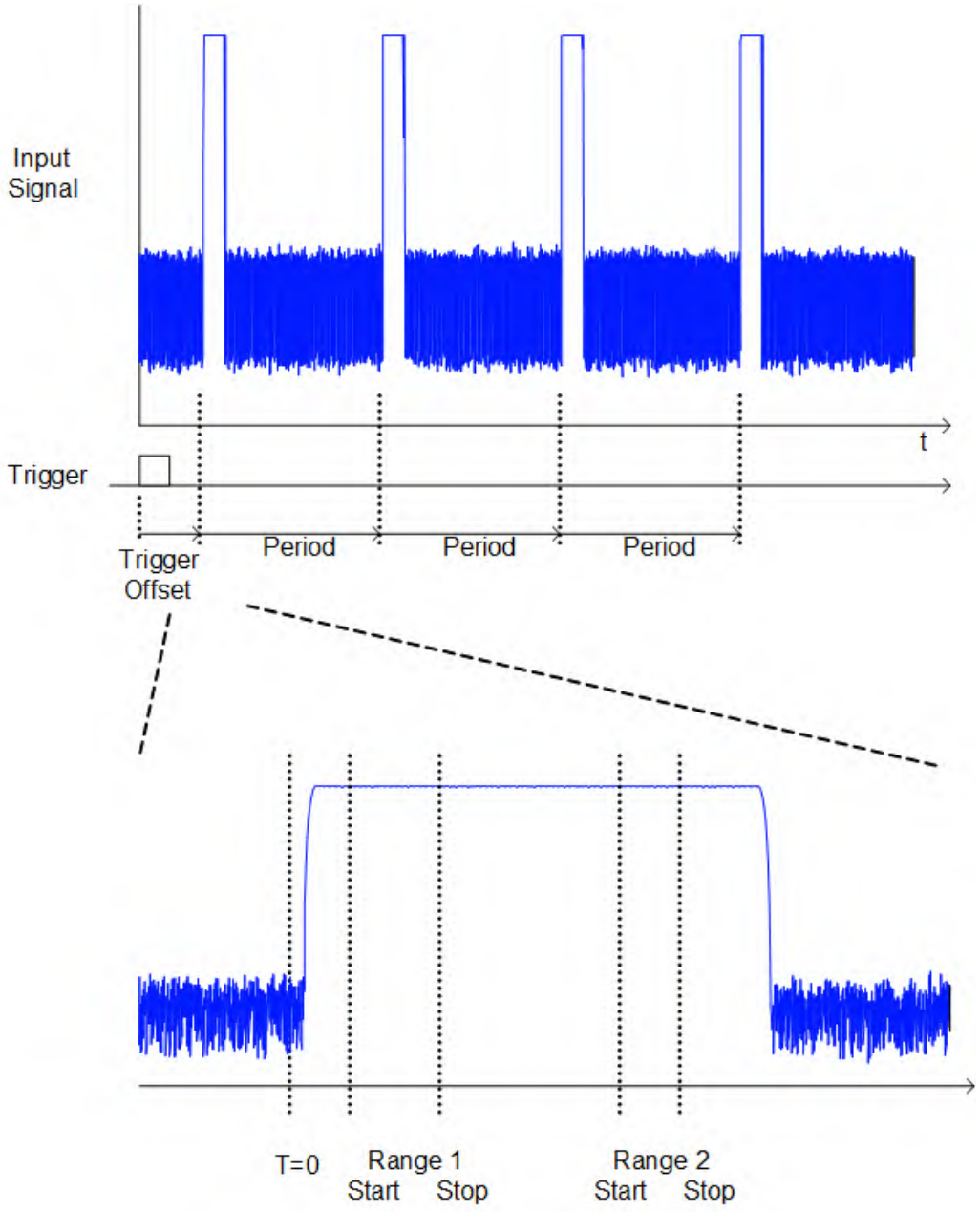


Figure 5-24: Definition of gated trigger parameters

5.3.2.5 APD and CCDF configuration

Configuration consists of the following settings:

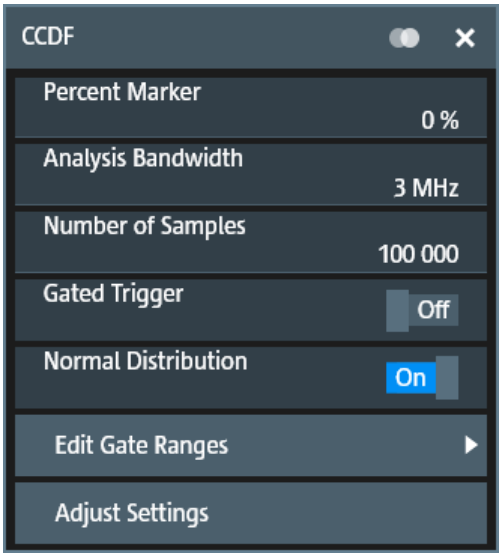
- Setting the reference level (see "Reference Level" on page 181)
  Make sure that the reference level is higher than the measured peak value.

- Basic settings 1015
- Gate range definition for APD and CCDF 1017
- Scaling for statistics diagrams 1018

Basic settings

Access: "Overview" > "Select Measurement" > "APD"/"CCDF" > "APD Configuration"/ "CCDF Configuration"

The remote commands required to perform these tasks are described in Section 5.5.1.9, "Analyzing statistics (APD, CCDF)", on page 1374.



Both dialog boxes are identical except for the "Percent Marker" setting, which is only available for "CCDF" measurements.

Percent Marker (CCDF only) 1015
Analysis Bandwidth 1015
Number of Samples 1016
Gated Trigger 1016
Normal Distribution (CCDF only) 1016
Edit Gate Ranges 1016
Adjust Settings 1016

Percent Marker (CCDF only)
Defines a probability value. Thus, you can determine the power which is exceeded with a given probability easily. If marker 1 is disabled, it is switched on automatically.

For details on the results of the "CCDF" measurement, see "Complementary cumulative distribution function (CCDF)" on page 1011.

Remote command:
`CALCulate<n>:MARKer<m>:Y:PERCent` on page 1375

Analysis Bandwidth
Defines the bandwidth of the signal to analyze.

For correct measurement of the signal statistics, define an analysis bandwidth that is wider than the signal bandwidth.

The calculated measurement time is displayed for reference only.

Remote command:
[SENSe<ip>:]BANDwidth[:RESolution] on page 1420

Number of Samples
Defines the number of power measurements to consider for the statistics.

For statistics measurements with the FSWX, you define the number of samples to be measured instead of the sweep time. Since only statistically independent samples contribute to statistics, the FSWX calculates the measurement time automatically and displays it in the application info panel. The samples are statistically independent if the time difference is at least 1/RBW. The measurement time is, therefore, expressed as follows:

Meas_time = $N_{Samples}$/RBW

The maximum number of samples is limited by the hardware capability. For gated triggered APD or CCDF measurements, the maximum number is limited further, if necessary, to accommodate for small ranges within a relatively long period. In this case, the FSWX considers the smallest gate/period ratio, and adapts the number to capture full periods of data. If the defined number of samples exceeds the limit, the FSWX automatically reduces it to the maximum value.

Remote command:
CALCulate<n>:STATistics:NSAMples on page 1375

Gated Trigger
Enables and disables gating for the ACP and the CCDF measurements. Define the gate ranges using the Edit Gate Ranges function.

Remote command:
[SENSe:]SWEep:EGATe on page 635

Normal Distribution (CCDF only)
Enables or disables the red trace in the "CCDF" diagram indicating the normal distribution.

Remote command:
DISPlay[:WINDow<n>]:STATistics:CCDF:GAUSs on page 1376

Edit Gate Ranges
Opens a dialog box to configure up to 3 gate ranges for each trace. For details see "Gate range definition for APD and CCDF" on page 1017.

Adjust Settings
Adjusts the reference level to the current input signal to obtain maximum power resolution.

- "APD": Adjusts the level settings according to the measured difference between peak and minimum power
- "CCDF": Adjusts the level settings according to the measured difference between peak and mean power

Note that this function is not available when using an external frontend.

Remote command:
CALCulate<n>:STATistics:SCALe:AUTO ONCE on page 1379

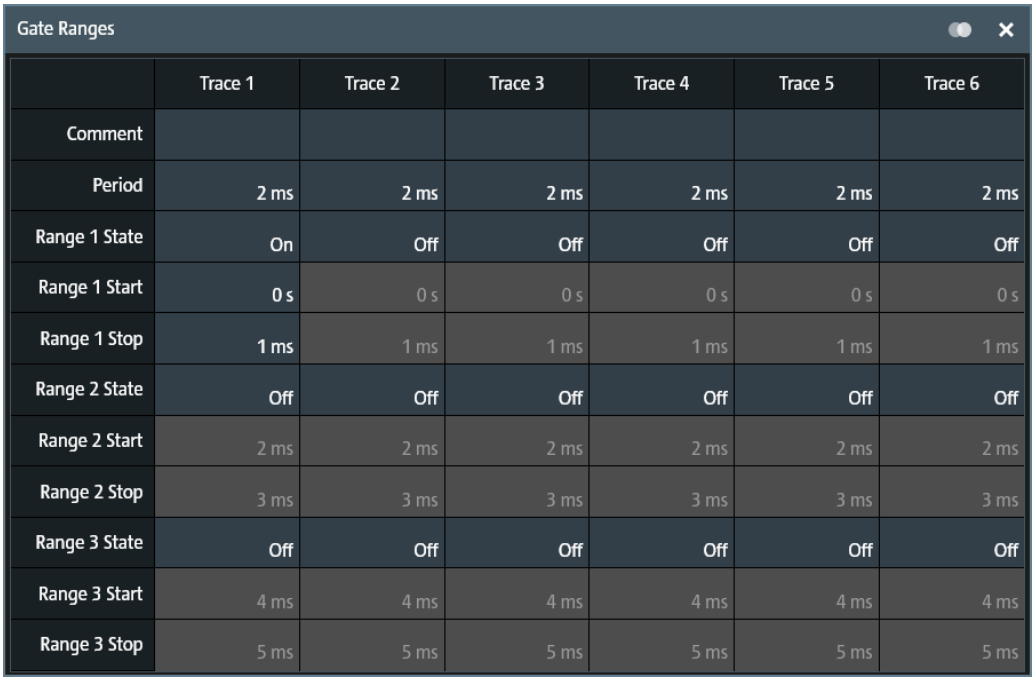
Gate range definition for APD and CCDF

Access: "Overview" > "Select Measurement" > "APD"/"CCDF" > "APD Configuration"/ "CCDF Configuration" > "Edit Gate Ranges"

You can configure gate ranges for gated triggering in statistical measurements.

For background information on defining gate ranges, see Section 5.3.2.4, "APD and CCDF basics - gated triggering", on page 1013.

The remote commands required to perform these tasks are described in "Using gate ranges for statistical measurements" on page 1376.



	Trace 1	Trace 2	Trace 3	Trace 4	Trace 5	Trace 6
Comment						
Period	2 ms	2 ms	2 ms	2 ms	2 ms	2 ms
Range 1 State	On	Off	Off	Off	Off	Off
Range 1 Start	0 s	0 s	0 s	0 s	0 s	0 s
Range 1 Stop	1 ms	1 ms	1 ms	1 ms	1 ms	1 ms
Range 2 State	Off	Off	Off	Off	Off	Off
Range 2 Start	2 ms	2 ms	2 ms	2 ms	2 ms	2 ms
Range 2 Stop	3 ms	3 ms	3 ms	3 ms	3 ms	3 ms
Range 3 State	Off	Off	Off	Off	Off	Off
Range 3 Start	4 ms	4 ms	4 ms	4 ms	4 ms	4 ms
Range 3 Stop	5 ms	5 ms	5 ms	5 ms	5 ms	5 ms

You can define up to three ranges for each of the six available traces.

Comment....1017
Period....1017
Range <n> Use....1018
Range <n> Start / Range <n> Stop....1018

Comment
Optional comment for the gate range settings of each trace.

Remote command:
`[SENSe:]SWEep:EGATe:TRACe<t>:COMMent` on page 1376

Period
Length of the period to analyze. The period is the same for all traces. If you change the period for one trace, it is automatically changed for all traces.

Make sure that the defined period is not longer than the total acquisition time of the current measurement. Keep in mind that the acquisition time depends on the Analysis Bandwidth and the Number of Samples. The current acquisition time is indicated as "AQT" in the application panel.

Remote command:
`[SENSe:]SWEep:EGATe:TRACe<t>:PERiod` on page 1377

Range <n> Use
Enables analysis of the defined range during a gated measurement.

Remote command:
`[SENSe:]SWEep:EGATe:TRACe<t>[:STATe<gr>]` on page 1377

Range <n> Start / Range <n> Stop
Defines the start and stop points of the range within the analysis period. Define a stopping time that is within the length of the period.

Note: You can define the time values with a greater numerical resolution than is displayed; the values are only rounded for display.

Remote command:
`[SENSe:]SWEep:EGATe:TRACe<t>:STARt<gr>` on page 1377
`[SENSe:]SWEep:EGATe:TRACe<t>:STOP<gr>` on page 1378

Scaling for statistics diagrams

Access: "Overview" > "Amplitude" > "Scale" tab

Or: [Ampt / Scale] > "Scale Configuration"

For statistics displays, scale settings are available for both the y-axis and the x-axis.

The remote commands required to perform these tasks are described in "Scaling the diagram" on page 1378.

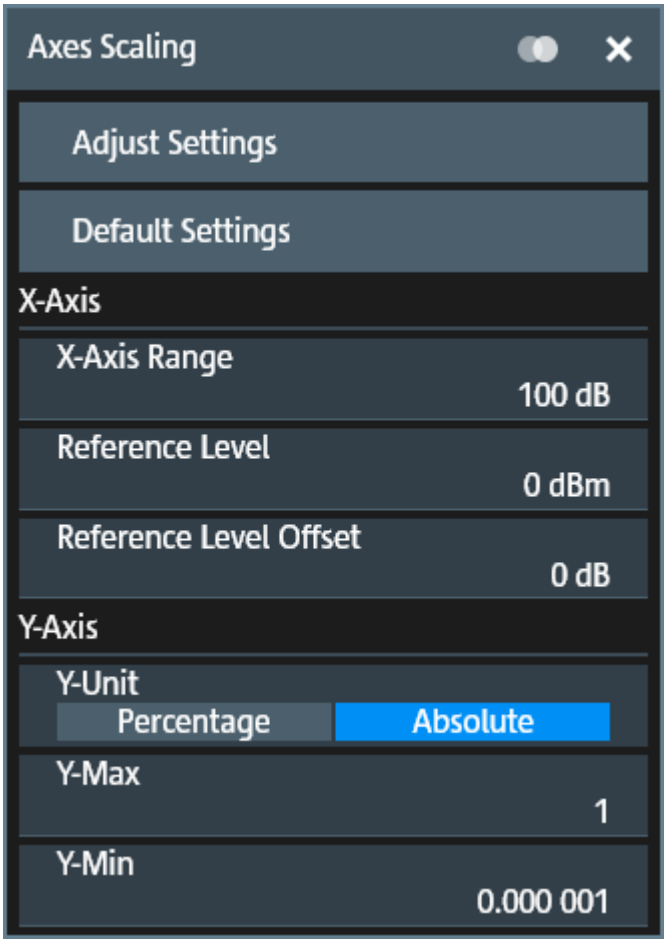


Figure 5-25: Scale settings for CCDF diagram

In statistical diagrams, the x-axis displays the signal level values (= y-axis in standard spectrum diagrams), while the y-axis displays the probability of the values. Thus, you scale the x-axis using the common amplitude settings.

See also "Adjust Settings" on page 1016.

Range....1019
Ref Level....1020
Shifting the Display (Reference Level Offset)....1020
Y-Unit....1020
Y-Max / Y-Min....1020
Default Settings....1020
Adjust Settings....1021

Range
Defines the level range in dB to evaluate statistically.

For details on the results of the measurement, see Section 5.3.2.3, "APD and CCDF results", on page 1010.

Remote command:
CALCulate<n>:STATistics:SCALe:X:RANGe on page 1379

Ref Level
Defines the reference level for the signal levels in the currently active unit (dBm, dBµV, etc.).

For the "APD" function, this value corresponds to the right diagram border.

For the "CCDF" function, there is no direct representation of this value on the diagram. The x-axis is scaled relatively to the measured mean power.

For details on the results of the measurement, see Section 5.3.2.3, "APD and CCDF results", on page 1010.

Remote command:
CALCulate<n>:STATistics:SCALe:X:RLEVel on page 1380

Shifting the Display (Reference Level Offset)
Defines an arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. The scaling of the x-axis changes accordingly. The setting range is ±200 dB in 0.1 dB steps.

Remote command:
INPut<ip>:RLEVel:OFFSet on page 615

Y-Unit
Defines the scaling type of the y-axis as either percentage or absolute. The default value is absolute scaling.

Remote command:
CALCulate<n>:STATistics:SCALe:Y:UNIT on page 1380

Y-Max / Y-Min
Defines the upper (max) and lower (min) limit of the displayed probability range. Values on the y-axis are normalized, which means that the maximum value is 1.0. The minimum value must be in the range:

1E-9 < Y-Min < 0.1

The distance between "Y-Max" and "Y-Min" must be at least one decade.

Remote command:
CALCulate<n>:STATistics:SCALe:Y:UPPer on page 1381
CALCulate<n>:STATistics:SCALe:Y:LOWer on page 1380

Default Settings
Resets the x- and y-axis scalings to their preset values.

Parameter	Value
X-axis ref level:	0 dBm
X-axis range APD:	100 dB
X-axis range CCDF:	20 dB

Parameter	Value
Y-axis upper limit:	1.0
Y-axis lower limit:	1E-6

Remote command:
`CALCulate<n>:STATistics:PRESet` on page 1379

Adjust Settings
Adjusts the level and scaling settings according to the measured difference between peak and mean power

Note that this function is not available when using an external frontend.

Remote command:
`CALCulate<n>:STATistics:SCALe:AUTO ONCE` on page 1379

5.3.2.6 How to perform an APD or CCDF measurement

The following step-by-step instructions demonstrate how to perform basic statistical measurements.



For remote operation, see "Programming example: measuring statistics" on page 1383.

To start a basic statistical measurement

1. Select [MEAS] > "APD" / "CCDF".
2. Select and configure the signal source as described in Section 4.2.2.1, "How to capture RF data", on page 189.
3. Start a sweep.

   As soon as the FSWX has acquired the defined number of samples, it displays the statistical results.

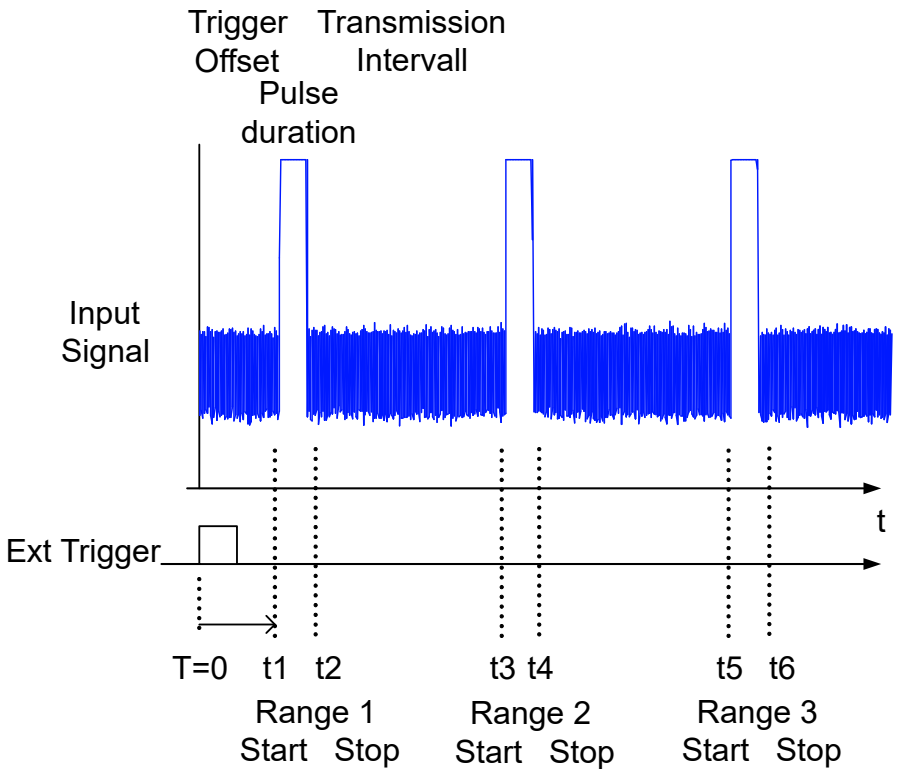
To perform a statistical measurement using gate ranges

For pulsed signals, the statistics should not evaluate the transmission intervals. Thus, you must define gate ranges to evaluate.

1. Select [Meas Config] > "APD Configuration" / "CCDF Configuration".

   The "APD" or "CCDF" dialog box is displayed.
2. Select "Edit Gate Ranges".
3. Define the time period to analyze the input signal, for example the duration of 3 signal pulses.
4. For each active trace, define up to three ranges within the time period to measure. In the example covering 3 pulses, you could define one range for each pulse.

Assume that the external trigger determines T=0 as the start of the data acquisition.



a) Define the start time of the first range as t1= T0 + trigger offset.
b) Define the stop time of range 1 as t2 = t1 + duration of the first pulse.
c) Enable range 1 by setting "Range 1 Use" to *On*.
d) Define the start time of range 2 as t3 = t1 + duration of pulse 1 + duration of interval.
e) Define the stop time of range 2 as t4 = t3 + duration of pulse 2.
f) Enable range 2 by setting "Range 1 Use" to *On*.
g) Define the third range in the same way.

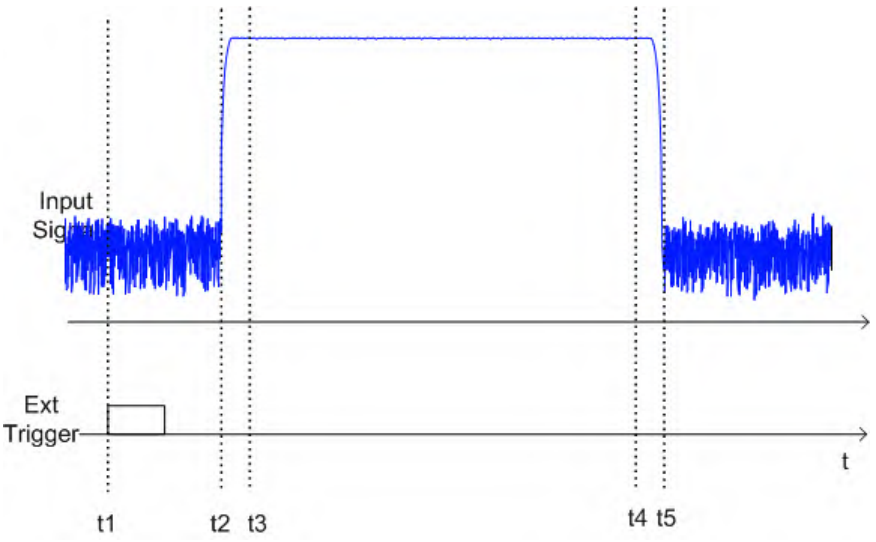
5. Start a sweep.

   As soon as the FSWX has acquired the defined number of samples, it displays the statistical results. Only the signal levels within the pulse periods are considered.

5.3.2.7 Examples

Configuration example: Gated statistics

You want to evaluate the useful part of the signal between t3 and t4 statistically. The period of the GSM signal is 4.61536 ms.



t1: External positive trigger slope

t2: Begin of burst (after 25 µs)

t3: Begin of useful part, to be used for statistics (after 40 µs)

t4: End of useful part, to be used for statistics (after 578 µs)

t5: End of burst (after 602 µs)

Configure the instrument as follows:

Setting	Value	Description
"Trigger Offset"	t2 – t1 = 25 µs	Gate ranges are relative to t2
"Range1 Start"	t3 – t2 = 15 µs	Start of range 1 relative to t2
"Range1 End"	t4 – t2 = 553 µs	End of range 1 relative to t2

Measurement example: Measuring the APD and CCDF of white noise generated by the FSWX

Setting the analysis bandwidth

When you measure the amplitude distribution, you must define the analysis bandwidth sufficiently large to contain the complete spectrum of the signal. Thus, you ensure that all the amplitudes pass through the IF filter without being distorted. If the selected bandwidth is too small for a digitally modulated signal, the amplitude distribution at the output of the IF filter corresponds to a white noise signal. (According to the central limit theorem, it becomes a Gaussian distribution.) Thus, you cannot determine the true amplitude distribution of the signal.

A programming example demonstrating a statistical measurement in a remote environment is provided in "Programming example: measuring statistics" on page 1383.

1. Preset the FSWX.
2. Set the reference level to *-60 dBm*.
3. Select [Meas], or "Overview" > "Select Measurement".
4. Select the "APD" measurement function.

   The FSWX sets the frequency span to 0 Hz and measures the amplitude probability distribution ("APD"). The number of uncorrelated level measurements used for the measurement is 100000. The mean power and the peak power are displayed in dBm. The crest factor (peak envelope power – mean power) is output as well.

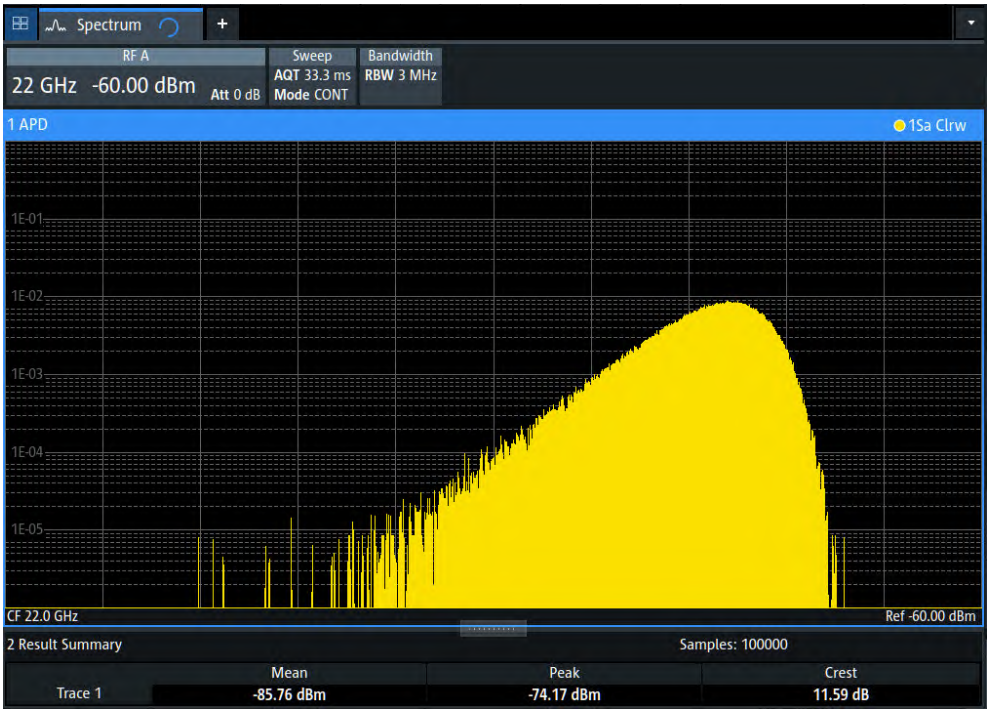


Figure 5-26: Amplitude probability distribution of white noise

5. Select [Meas], or "Overview" > "Select Measurement".
6. Select the "CCDF" measurement function.

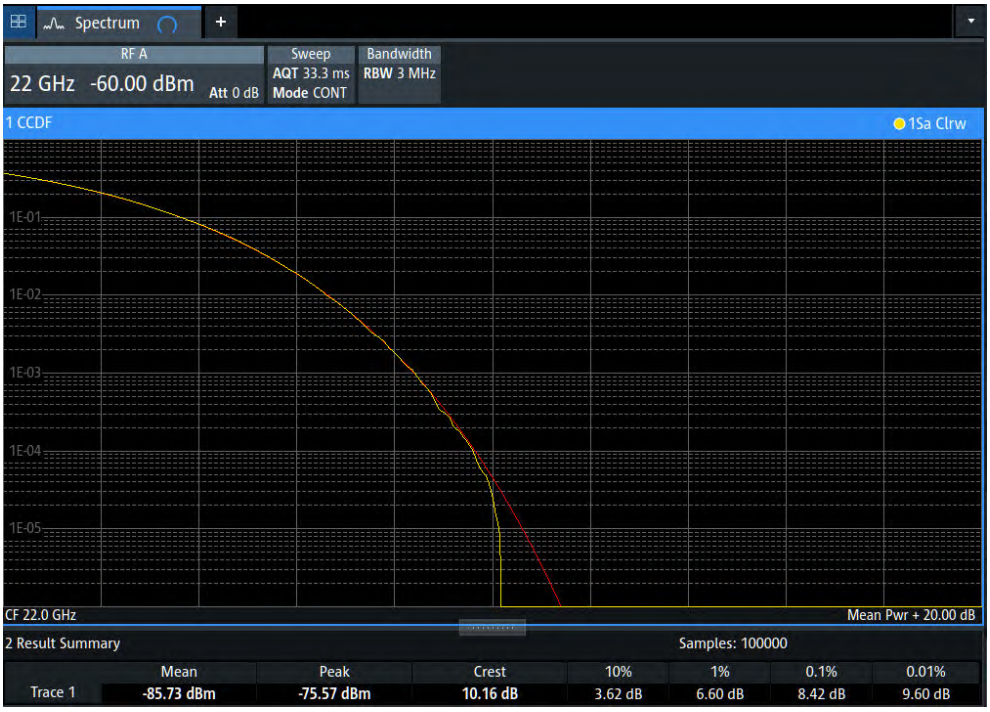


Figure 5-27: CCDF of white noise

The "CCDF" trace indicates the probability that a level exceeds the mean power. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that the power exceeds a level is plotted along the y-axis.

5.3.2.8 Optimizing and troubleshooting the measurement

If the results do not meet your expectations, try the following methods to optimize the measurement:

- Make sure that the defined analysis bandwidth is wide enough for the signal bandwidth of the device under test to be fully analyzed (see "Analysis Bandwidth" on page 1015).
- To measure the complete signal, increase the number of samples so that the resulting acquisition time is longer than one period of a burst signal.
- To examine only parts of the signal, define a trigger source and a gate.

5.3.3 Spectrum emission mask (SEM) measurement

Spectrum Emission Mask (SEM) measurements monitor compliance with a spectral mask.

- About the measurement 1026
- Typical applications 1026
- SEM results 1026

- SEM basics 1030
- SEM configuration 1040
- How to perform a Spectrum Emission Mask measurement 1058
- Measurement example: Multi-sem measurement 1062
- Reference: SEM file descriptions 1064

5.3.3.1 About the measurement

The Spectrum Emission Mask (SEM) measurement monitors compliance of the input signal power with a spectral mask. The analyzer performs measurements in predefined frequency ranges. You can specify the measurement settings individually for each of these ranges.

In the basic Spectrum application, you can measure spectrum emissions for multiple subblocks of channels. The subblocks can include gaps or overlap. You can define separate masks for each subblock. You can also analyze radio signals using multiple transmission standards.

You can save SEM measurement configurations to an XML file. You can then export them to another application or load them on the FSWX again later. The FSWX provides some predefined XML files that contain ranges and parameters according to selected standards.

The FSWX also provides a "Fast SEM" mode to improve the performance for spectrum emission mask measurements.

Using a special limit check for SEM measurements, you can monitor compliance of the spectrum.

5.3.3.2 Typical applications

Spectrum Emission Mask measurements are typically performed to ensure that modulated signals remain within the valid signal level ranges. These ranges are defined by a particular transmission standard, both in the transmission channel and neighboring channels. Any violations of the mask can interfere with other transmissions.

The 3GPP TS 34.122 standard, for example, defines a mask for emissions outside the transmission channel. This mask is defined relative to the input signal power. Three frequency ranges to each side of the transmission channel are defined.

5.3.3.3 SEM results

As a result of the "Spectrum Emission Mask" measurement, the following results are displayed in a diagram:

- The measured signal levels
- The result of the limit check (mask monitoring)
- The defined limit lines (see also "Limit lines in SEM measurements" on page 1032)
- TX channel power P
- The used power class

Example:

For example, in Figure 5-30, "31 < P < 39" indicates that the used power class is defined from 31 to 39.

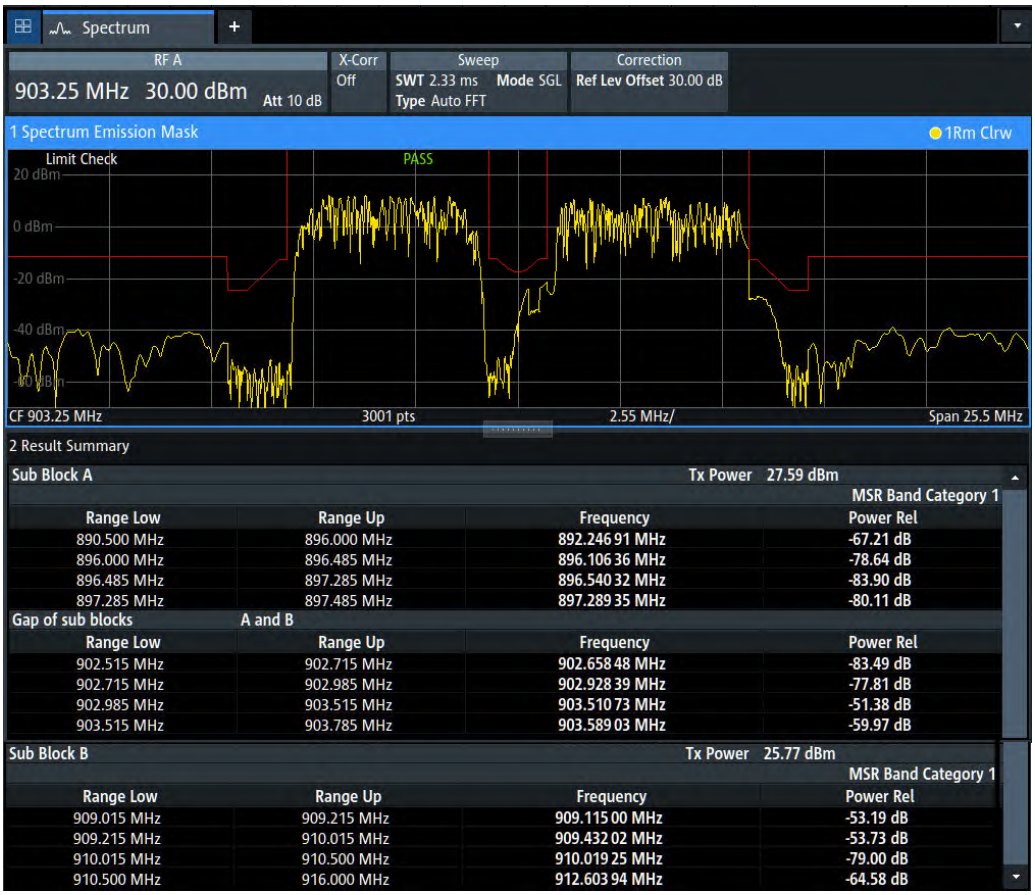


Figure 5-28: Spectrum Emission Mask result displays

Multi-SEM measurements

Multi-SEM measurements are SEM measurements with more than one subblock. In these measurements, you define power classes for each subblock. In this case, the power class is not indicated in the graphical result displays.

Result Summary

In addition to the graphical results of the SEM measurement displayed in the diagram, a "Result Summary" displays the limit check results (see also "Limit lines in SEM measurements" on page 1032).

Table 5-8: Result Summary information

Column	Description
General information	
"Center"	

Column	Description
"Peak Power"/"TX Power"	Power of the reference range
"TX Bandwidth"	TX bandwidth used by the "TX Power" reference range
"RBW"	RBW used by the reference range
"Standard"	Loaded standard settings
Range results	
"Range Low"	Start of the frequency range the peak value was found in
"Range Up"	Frequency range end the peak value was found in
"RBW"	RBW of the range
"Frequency"	Frequency of the peak power level
"Power Abs"	Absolute peak power level within the range
"Power Rel"	Peak power level within the range, relative to the reference range
"ΔLimit"	Deviation of the peak power level from the limit line

You can define in which detail the data is displayed in the "Result Summary" in the "List Evaluation" settings (see "Result summary configuration" on page 1056). By default, one peak per range is displayed. However, you can define a "Margin" to display only peaks that exceed a threshold.

Optionally, you can display detected peaks as colored squares in the "Spectrum Emission Mask" diagram (see Show Peaks in the "List Evaluation" settings).

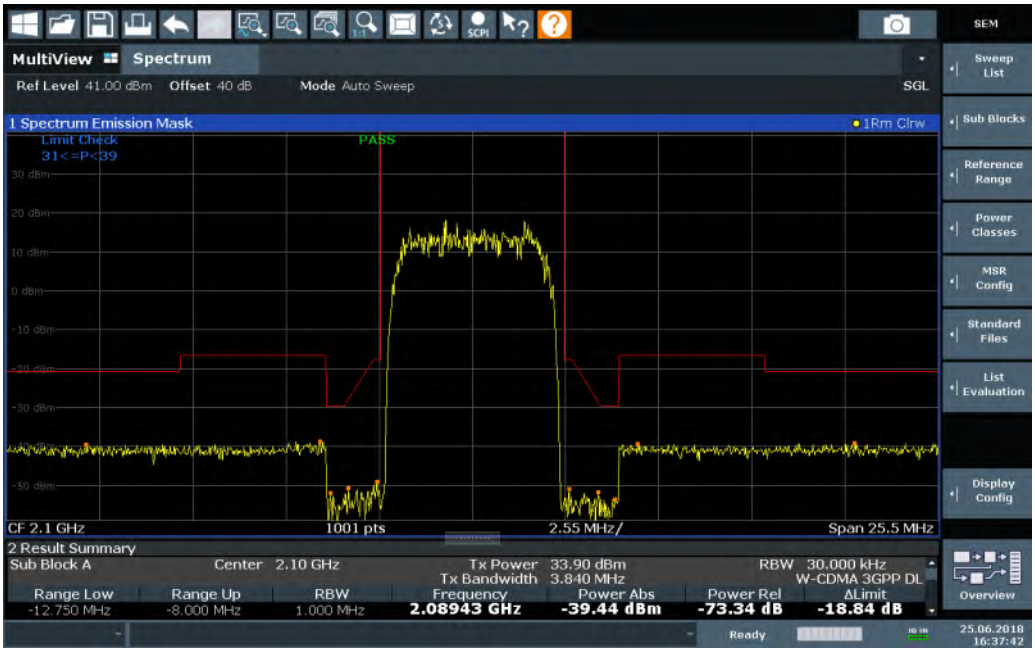


Figure 5-29: Detected peak display in SEM measurement

Furthermore, you can export the results of the "Result Summary" to a file. You can then import the file to another application for further analysis.

Results for SEM with multiple subblocks

In the "Spectrum" application only, you can measure spectrum emissions for multiple subblocks of channels (for details, see "SEM with multiple subblocks ("Multi-SEM")" on page 1036). You can define up to 8 subblocks with 7 gaps. The "Result Summary" provides the results described in Table 5-8 individually for each subblock and each gap.

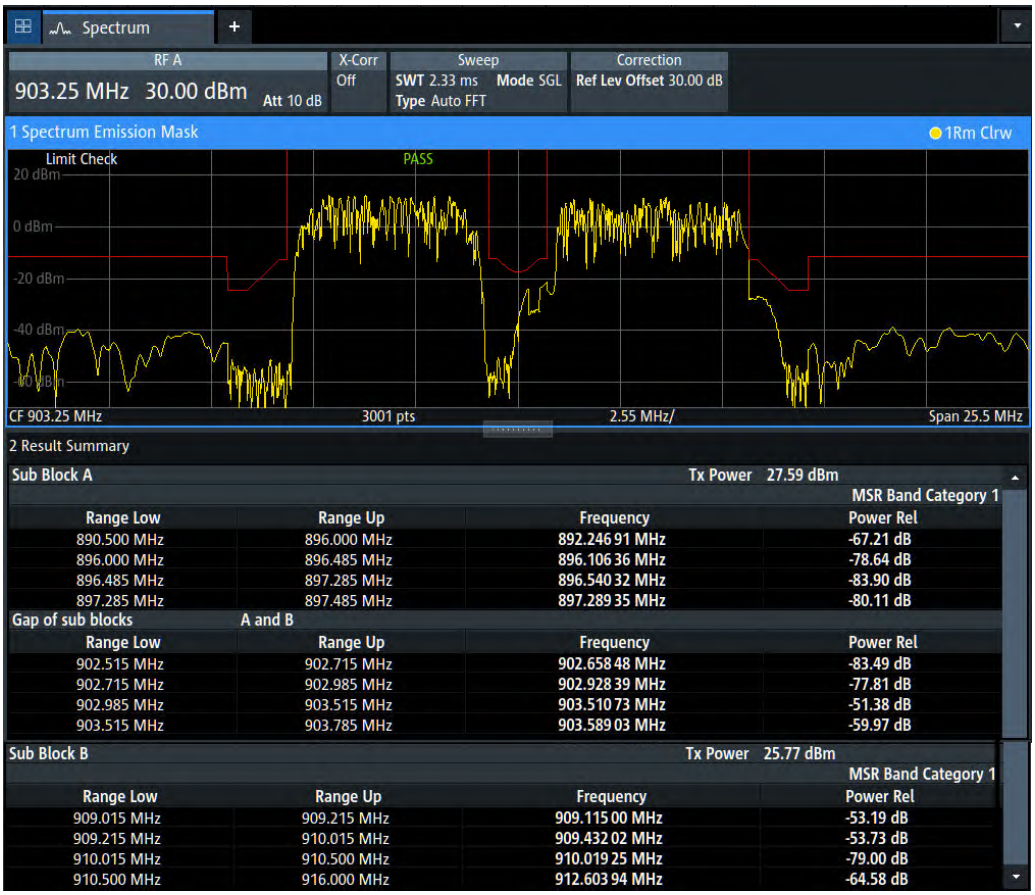


Figure 5-30: SEM results for multiple subblocks

Retrieving results via remote control

You can retrieve the results of the "Spectrum Emission Mask" measurement using the following remote commands.

Limit check:

`CALC:LIM:FAIL?`, see `CALCulate<n>:LIMit<li>:FAIL?` on page 775

Power result for the reference range:

```
CALC:MARK:FUNC:POW:RES? CPOW
```

Peak power for the reference range:

`CALC:MARK:FUNC:POW:RES? PPOW`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult` on page 1231

Power trace:

`TRAC:DATA?`, see `TRACe<n>[:DATA]` on page 688

`TRAC:DATA:X?`, see `TRACe<n>[:DATA]:X?` on page 690

Peak power list:

`TRAC:DATA? LIST`, see `TRACe<n>[:DATA]` on page 688

5.3.3.4 SEM basics

Some background knowledge on basic terms and principles used in SEM measurements is provided here for a better understanding of the required configuration settings.

- Ranges and range settings 1030
- Limit lines in SEM measurements 1032
- Fast SEM measurements 1034
- Multi-standard radio (MSR) SEM measurements 1036
- SEM with multiple subblocks ("Multi-SEM") 1036

Ranges and range settings

In the "Spectrum Emission Mask" measurements, a range defines a segment of the signal for which you can define the following parameters separately:

- Start and stop frequency
- RBW
- VBW
- Sweep time
- Sweep points
- Reference level
- Attenuator settings
- Preamplifier settings
- Transducer settings
- Limit values

You define the ranges and their settings in a "Sweep List". For details on settings, refer to "Sweep list" on page 1041.

For details on defining the limits (masks), see "Limit lines in SEM measurements" on page 1032.

Range definition

After a preset, the "Sweep List" contains a set of default ranges and parameters. For each range, you can change the parameters listed above. You can insert or delete ranges.

The FSWX keeps the changes to the sweep list until you load another parameter set (by pressing [Preset] or by loading an XML file). If you want a parameter set to be available permanently, create an XML file for this configuration (for details refer to "How to save a user-defined SEM settings file" on page 1061).

If you load one of the provided XML files, the sweep list contains ranges and parameters according to the selected standard.

Reference range

The range containing the center frequency is defined as the reference range for all other ranges in the sweep list. You define all range limits in relation to the reference range. The FSWX also uses this reference range to calculate the TX power that is used as a reference for all power level results in the "Result Summary". You can define whether the power used for reference is the peak power level or the integrated power of the reference range. In the "Sweep List", the reference range is highlighted in blue. You cannot delete the reference range.

Rules

The following rules apply to ranges:

- The minimum span of a range is 20 Hz.
- The individual ranges must not overlap (but can have gaps).
- The maximum number of ranges is 30.
- The minimum number of ranges is 3.
- The reference range cannot be deleted.
- The center of the reference range is the center frequency.
- The reference range must not be smaller than the current "Tx Bandwidth" (see "Channel Power Settings" on page 1050).
- Frequency values for each range are defined relative to the center frequency.

The measurement span (defined in the [Span] menu) can be smaller than the combined span of all ranges. In this case, the measurement includes only the ranges that lie within the defined measurement span and have a minimum span of 20 Hz. The first and last ranges are adapted to the measurement span as long as the minimum span of 20 Hz is not violated.

Sweep points

You can define a minimum number of sweep points for each range. The FSWX distributes the total number of available sweep points among the ranges and considers the minimum values. If the total number of sweep points is not sufficient to satisfy the minimum sweep point requirements in all ranges, the FSWX adjusts the global number of sweep points accordingly. By default, each range has a minimum of one sweep point.

Thus, you can increase the resolution within a specific range for detailed analysis. You do not have to increase the overall number of sweep points and thus the measurement time for the SEM measurement.

Symmetrical ranges

The FSWX provides a special option for sweep lists in which the ranges to the left and right of the reference range are symmetric. If you enable symmetrical setup, the FSWX changes the current sweep list configuration to define a symmetrical setup regarding the reference range. The number of ranges to the left of the reference range is reflected to the right. That means any missing ranges on the right are inserted, while superfluous ranges are removed. The values in the ranges to the right of the reference range are adapted symmetrically to the values in the left ranges.

Symmetrical ranges fulfill the conditions required for "Fast SEM" mode (see "Fast SEM measurements" on page 1034).

Power classes

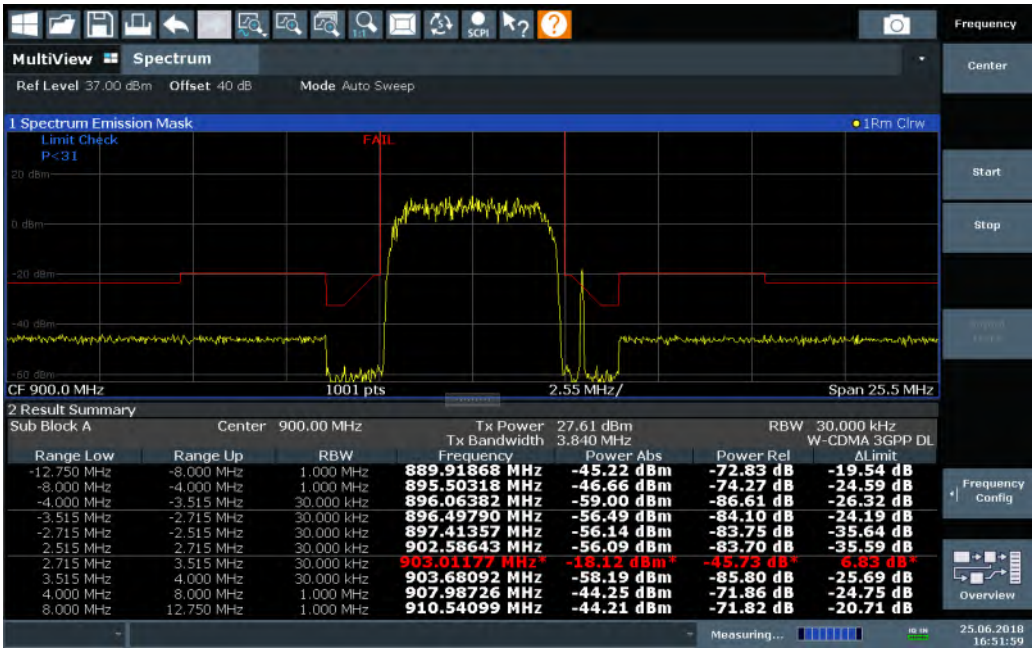
Sometimes, the signal power level that you want to monitor varies throughout the frequency range, and the limits vary accordingly. In this case, you can define power classes and assign them to the frequency ranges. Thus, you can define the limits for the signal levels differently for varying input levels. For instance, for higher input levels a transmission standard can allow for higher power levels in adjacent channels, whereas for lower input levels the allowed deviation can be stricter. You can define up to four different power classes.

Limit lines in SEM measurements

The FSWX defines the spectrum emission mask using limit lines. Using limit lines, you can check the measured data (that is, the trace results) against specified limit values. Generally, you can define limit lines for any measurement in the "Spectrum" application using the "Limit Lines" function. For "Spectrum Emission Mask" measurements, however, the FSWX provides special limit lines via the "Sweep List". We strongly recommend that you use only these specific limit line definitions.

In the "Sweep List", you can define a limit line for each power class. The limit line level can vary for the specified frequency ranges. The FSWX automatically defines special limit lines for each power class according to the current "Sweep List" settings. When you change the settings, the limit lines change, as well. These limit lines are labeled "SEM_LINE_ABS<xxx>" and "SEM_LINE_REL<xxx>", where <xxx> is an index to distinguish limit lines between different application instances.

The limit line defined for the currently used power class is indicated by a red line in the display. The result of the limit check ("Pass" or "Fail") is indicated at the top of the diagram. Note that a "Margin" function as for general limit lines is not available.



Several types of limit checks are supported:

Table 5-9: Limit check types

Limit check type	Pass/fail criteria	Limit line definition
"Absolute"	Absolute power levels must not exceed limit line.	"Abs Limit Start"/ "Abs Limit Stop" values for each range.
"Relative"	Power deviations relative to the TX channel power must not exceed the limit line.	"Rel Limit Start"/ "Rel Limit Stop" values (relative to the TX channel power), fixed for each range.
"Relative with function f(x)"	If the power exceeds **both** the absolute **and** the relative limits, the check fails (see "Relative limit line functions" on page 1034).	Maximum of the absolute or relative start and stop limit values for each range. Thus, the start or stop point of the limit range, or both, are variable (since the maximum can vary).
"Abs and Rel"	If the power exceeds **both** the absolute **and** the relative limits, the check fails.	The less strict (higher) limit line is displayed for each range. If you use a function to define the relative limit start or stop value, the signal is checked against an additional condition: the power must exceed the absolute limit, and the absolute and relative function values.
"Abs or Rel"	If the power exceeds **either** the absolute **or** the relative limits, the check fails.	The stricter (lower) limit line is displayed for each range. If you use a function to define the relative limit start or stop value, the signal is checked against an additional condition: if the power exceeds the absolute limit, or the higher of the absolute and relative function values, the check fails.

Relative limit line functions

Common relative limit lines are calculated once for the defined start and endpoints and maintain a constant slope. Using a special function on the FSWX, you can define limit lines whose start or endpoints (or both) are variable, depending on the carrier power. Thus, the resulting limit line can change its slope within the range, depending on the carrier power.

If you use the relative limit value function in combination with the "Abs and Rel" or "Abs or Rel" limit check types, the FSWX considers an additional condition for the limit check (see Table 5-9).

Limit check results in the Result Summary

For each range, the "Result Summary" indicates the peak measured value and the deviation of these values from the limit line. If the range passes the limit check, the deviation represents the closest value to the limit line. If the range fails the limit check, the deviation represents the maximum violation against the limit line. Furthermore, the absolute power levels and the relative deviation of the peaks from the TX channel power are displayed. Values that exceed the limit are indicated in red and by an asterisk (*).

A2 Spectrum Emission Mask — W-CDMA 3GPP (31,39)dBm DL
Tx Power -28.10 dBm — Tx Bandwidth 3.840 MHz — RBW 1.000 MHz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-12.750 MHz	-8.000 MHz	1.000 MHz	13.24173 GHz*	-47.08 dBm*	-18.98 dB*	35.52 dB*
-8.000 MHz	-4.000 MHz	1.000 MHz	13.24364 GHz*	-25.01 dBm*	3.09 dB*	53.59 dB*
-4.000 MHz	-3.515 MHz	30.000 kHz	13.24619 GHz	-100.18 dBm	-72.08 dB	-8.58 dB
-3.515 MHz	-2.715 MHz	30.000 kHz	13.24668 GHz	-105.92 dBm	-77.83 dB	-17.23 dB

Although the limit check does not provide a margin functionality, you can define a margin (threshold) for the peak values that are displayed in the "Result Summary". See "Result summary configuration" on page 1056.

Fast SEM measurements

To improve the performance for spectrum emission mask measurements, the FSWX provides a "Fast SEM" mode. If you enable this mode, the FSWX combines several consecutive ranges with identical sweep settings to one sweep internally. Fewer sweeps make the measurement considerably faster. The displayed results remain unchanged and still consist of several ranges. Thus, you can still define measurement settings that apply only to the results, such as limits, individually for each range.

Prerequisites

"Fast SEM" mode is available if the following criteria apply:

- The frequency ranges are consecutive, without frequency gaps
- The following sweep settings are identical (for details see "Sweep list" on page 1041):
  - "Filter Type"
  - "RBW"
  - "VBW"
  - "Sweep Time Mode"

– "Reference Level"
– "RF Attenuation Mode"
– "RF Attenuation"
– "Preamplifier"

Enabling Fast SEM mode

You enable "Fast SEM" mode in the "Sweep List" (see "Sweep list" on page 1041) or using a remote command. If you enable the mode for one range, it is automatically enabled for all ranges in the "Sweep List".

Remote command:

`[SENSe:]ESPectrum<sb>:HSPeed` on page 1324

"Fast SEM" not supported for multiple subblocks

For SEM with multiple subblocks, "Fast SEM" is not available. If you define more than one subblock and load a standard which contains an active "Fast SEM" setting, this setting is disabled.

For more information on multi-SEM measurements, see "SEM with multiple subblocks ("Multi-SEM")" on page 1036.

Consequences

When you enable the "Fast SEM" mode, the FSWX displays the ranges for which these criteria apply as one single range in the "Sweep List" (see Figure 5-31). The sweep time is defined as the sum of the individual sweep times, initially, but you can change it.

If "Symmetrical Setup" mode is active when you enable "Fast SEM", not all sweep list settings can be configured symmetrically automatically (see also "Symmetrical ranges" on page 1032).

If you change any other sweep settings of the combined range, the settings are applied to each included range. They remain changed even after you disable "Fast SEM" mode.

Example



Figure 5-31: Sweep list using Fast SEM mode

Figure 5-31 shows a "Sweep List" with "Fast SEM" enabled. The former five separately defined ranges are combined to two sweep ranges internally.

Multi-standard radio (MSR) SEM measurements

Multi-standard radio (MSR) measurements allow you to perform SEM tests on signals with multiple carriers using different digital standards. MSR measurements are described in the specification 3GPP TS 37.141. Various typical combinations of standards for base station tests are described, e.g. LTE FDD and WCDMA carriers. By performing an MSR SEM measurement, you can determine if or how the different carriers affect each other, i.e. if unwanted emissions occur. On the FSWX, the MSR SEM measurement is a standard measurement as for single carriers. The MSR settings merely provide a convenient way of configuring the "Sweep List" for all required ranges according to the specification quickly.

Using special settings, the FSWX can calculate the SEM limits according to standard 3GPP 37.141 V12.2.0. This standard distinguishes between base station configurations and power values.

SEM with multiple subblocks ("Multi-SEM")

In the "Spectrum" application only, you can measure spectrum emissions for multiple subblocks of channels. We refer to this measurement as a "Multi-SEM" measurement.

Subblocks are a set of multiple ranges around a defined center frequency (carrier). Multiple subblocks can include gaps or overlap, and each subblock defines a separate mask. For the overlapping masks, the FSWX calculates multi-limit lines. You can define up to 8 subblocks with 7 gaps. For each subblock, you can define the familiar configuration settings concerning ranges, limit lines etc. individually.

Comparison to "traditional" SEM measurement

The default SEM measurement is simply a special case of "*Multi-SEM*" - consisting of one single block. Only if the number of subblocks in the basic SEM configuration is larger than 1, multiple subblocks are inserted in the configuration settings and result tables.

Particular features of configuring multiple subblocks

The subblocks are independent of the global start, stop, center and span frequencies for the complete SEM measurement. Thus, there can be gaps that can even include other carrier ranges, but are not configured for the SEM measurement.

For each subblock, you define:

- The center frequency of the reference range of the subblock
  Define center frequencies in ascending order for subblocks A,B,C
- The reference range
  Note that although individual ranges of different subblocks can overlap, reference ranges for different subblocks can*not*. Reference ranges must define distinct frequency ranges.
- The sweep list, including the limit lines
- Optionally: a standard file *or* MSR settings to be used for measurement
  If one is selected, the other is disabled.



Fast SEM not supported for multiple subblocks

For SEM with multiple subblocks, "Fast SEM" is not available. If you define more than one subblock and load a standard which contains an active "Fast SEM" setting, this setting is disabled.

Absolute vs relative frequencies

In the default configuration with only one subblock, you define frequencies relative to the center frequency.

For setups with more than one subblock, you define frequencies relative to the center frequency of the reference ranges for the individual subblocks. However, the "Result Summary" indicates frequencies as absolute values. Relative frequencies that refer to different reference ranges would be inconvenient and difficult to analyze.

Limit check behavior for overlapping masks

You define spectrum emission masks individually for each subblock, and subblocks can overlap. Thus, the question arises: what happens during the limit check in the overlapping regions? To answer this question, we must distinguish the following cases:

- For the reference range, which contains the carrier, limits are not checked.
- For other ranges, only the limit lines defined for ranges between the carriers, that is: the reference ranges to either side, are significant. In other words: if a limit line covers the frequency area of several carriers, only the limit lines for ranges between the corresponding reference range and the next closest reference range are significant.

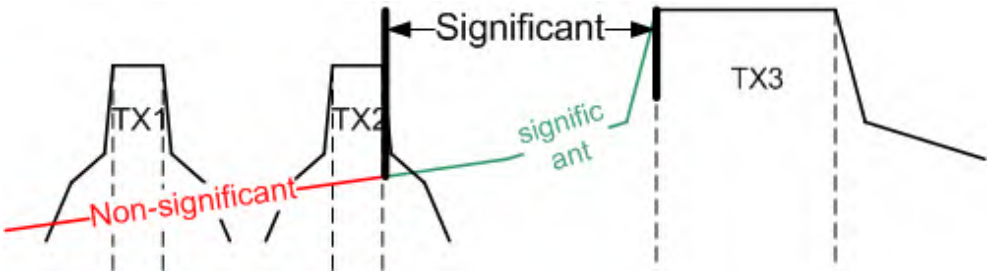


Figure 5-32: Behavior for overlapping masks

- For the ranges in which multiple limit lines are significant, a range-specific function determines the behavior of the limit check.

Limit calculation for individual ranges

For each range, you can define a function that determines the behavior of the limit check if there are multiple limit lines:

- **"NONE"**: In reference ranges, limits are not checked.
  Reference ranges always use the function "NONE".
  For other ranges, see the combinations for overlapping ranges below.
- **"SUM"**: Sum of the two limit lines (calculated for linear powers) is used.
- **"MAX"**: Maximum of the two limit lines is used.

This leads to the following **combinations for overlapping ranges**:

- **"MAX"+"MAX"**: Maximum of the two limit lines is used.
- **"MAX"+"SUM"**: Maximum of the two limit lines is used.
- **"SUM"+"SUM"**: Sum of the two limit lines (calculated for linear powers) is used.
- **"NONE"+"MAX"/"NONE"+"SUM"**: Limit line (and parameters) of the "NONE" range are ignored.
- **"NONE"+"NONE"**: Depends on the position of the overlapping ranges in relation to the mid-frequency between the two neighboring subblocks:
  - Overlap is completely *below* the mid-frequency: Limits and parameters of the left subblock are used.
  - Overlap is completely *above* the mid-frequency: Limits and parameters of the right subblock are used
  - Overlap crosses the mid-frequency: New subranges are created: one to the left of the mid-frequency, one to the right of the mid-frequency. The left subrange uses the limits and parameters of the left subblock, the right subrange uses the limits and parameters of the right subblock.

Different RBWs in overlapping ranges

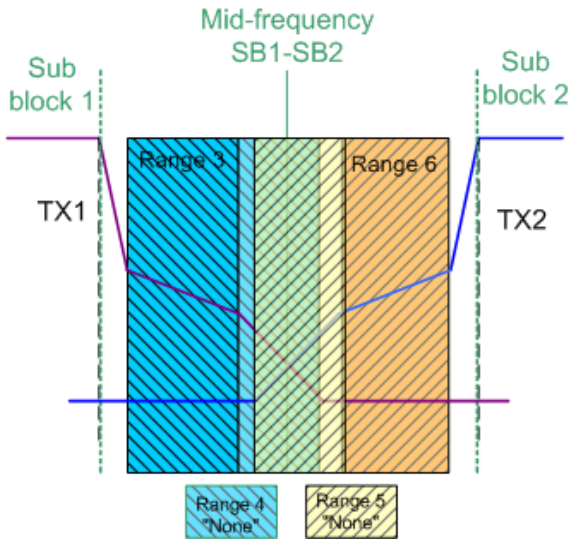
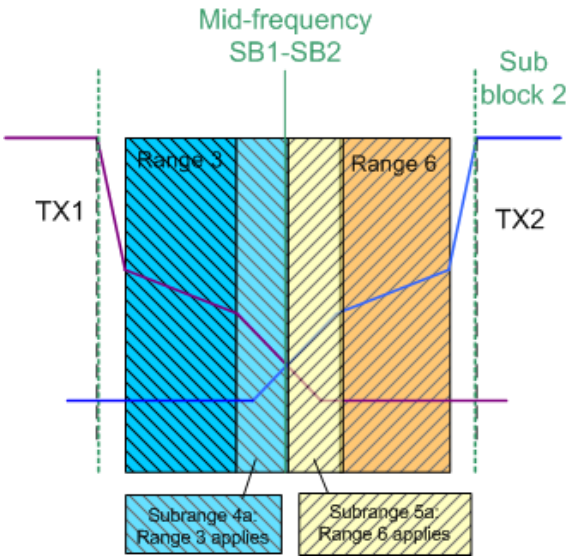
If different RBWs are defined for the overlapping ranges, the following parameters from the range with the smaller RBW are considered for both ranges:

- RBW
- VBW
- Attenuation
- Reference level
- Transducer
- Filter type
- (Proportional) sweep time

In the range with the higher RBW, the following offset is applied to the limit line:

$-10*log(RBW_{large} / RBW_{small})$

Table 5-10: Limit lines in overlapping ranges crossing the mid-frequency

	
Initial situation: overlapping ranges Range 4 ("None") + Range 5 ("None") overlap and cross the mid-frequency between subblocks 1 and 2	**Result:** Subranges 4a and 5a are created left and right of the mid-frequency; For subrange 4a: limit line and parameters of range 4 apply For subrange 5a: limit line and parameters of range 5 apply

Global SEM limit check

For the complete SEM measurement, which can consist of multiple subblocks, the FSWX performs only one single limit check. The FSWX calculates a single limit line according to the individual range limit lines and the defined functions for overlapping ranges. The FSWX then compares the measured values with this single limit line. If any measured value exceeds the limit in any range, the result of the limit check is "Failed".

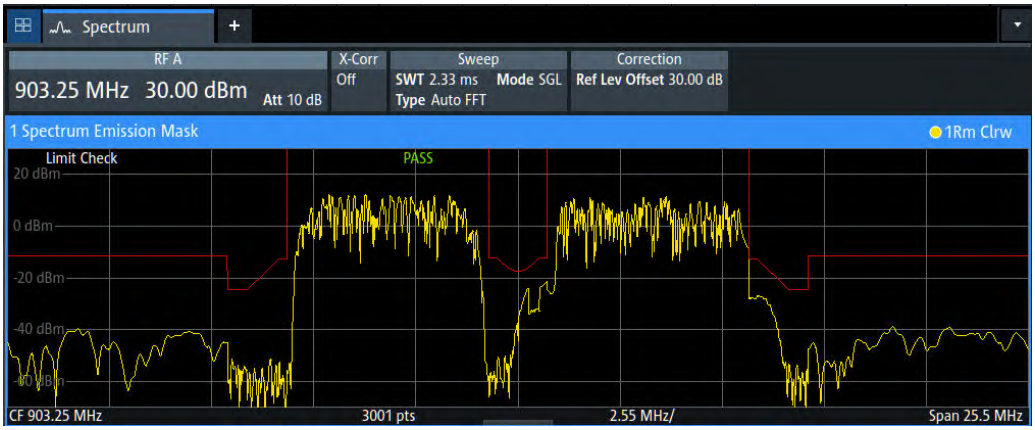


Figure 5-33: Summarized limit line for multiple subblocks

5.3.3.5 SEM configuration

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask"

The SEM measurement starts immediately with the default settings.

The remote commands required to perform these tasks are described in Section 5.5.1.7, "Measuring the spectrum emission mask", on page 1320.

Global span settings

You configure the span of the signal to monitor in the general span settings (see Section 5.2.2, "Frequency and span configuration", on page 958). The SEM measurement only considers ranges within this global span.

Multi-SEM configuration

In the "Spectrum" application only, you can measure spectrum emissions for multiple subblocks of channels (see "SEM with multiple subblocks ("Multi-SEM")" on page 1036). You can define up to 8 subblocks with 7 gaps. For each subblock, you define the familiar configuration settings concerning ranges, limit lines etc. in individual tabs. In addition, you define settings on the subblocks themselves in the "Sub Block" tab of the "Spectrum Emission Mask" configuration dialog (see "Multi-SEM (subblock) settings" on page 1047).

The following settings are available in individual tabs of the "Spectrum Emission Mask" configuration dialog.

- Sweep list....1041
- Multi-SEM (subblock) settings....1047
- Reference range....1049
- Power classes....1050
- MSR settings....1052
- Standard files....1054
- Result summary configuration....1056

Sweep list

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Sweep List"

For SEM measurements, the FSWX splits the input signal into several frequency ranges and sweeps them individually. Each range has different limitations. You configure the individual frequency ranges and mask limits in the "Sweep List".

When you edit the "Sweep List", always follow the rules and consider the limitations described in "Ranges and range settings" on page 1030.



Range Start/ Range Stop 1042
Filter Type 1042
RBW 1042
VBW 1042
Sweep Time Auto 1042
Sweep Time 1042
X-Corr Factor 1043
Ref level 1043
Optimization 1043
RF Attenuation Overall 1043
RF Attenuation Mechanical 1044
External Frontend Attenuation 1044
Preamplifier 1045
Transducer 1045
Multi Limit Calc 1045
Min. Sweep Points 1045
Limit Check <n> 1045
Abs Limit Start / Abs Limit Stop <n> 1046
Rel Limit Start / Rel Limit Stop <n> 1046

Insert before Range/ Insert after Range....1046
Delete Range....1047
Fast SEM....1047
Symmetrical Setup....1047

Range Start/ Range Stop
Sets the start frequency/stop frequency of the selected range.

Define frequency values for each range relative to the center frequency. Center the reference range on the center frequency. The current Tx Bandwidth defines the minimum span of the reference range (see "Reference range" on page 1049).

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<ri>[:FREQuency]:STARt` on page 1327
`[SENSe:]ESPectrum<sb>:RANGe<ri>[:FREQuency]:STOP` on page 1327

Filter Type
Sets the filter type for this range.

For details on filter types, see Section 4.3.3.6, "Which data can pass: filter types", on page 245.

Remote command:
`[SENSe:]LIST:RANGe<ri>:FILTer:TYPE` on page 1363

RBW
Sets the resolution bandwidth for this range.

For details on the RBW, see Section 4.3.3.1, "Separating signals by selecting an appropriate resolution bandwidth", on page 241.

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<ri>:BANDwidth:RESolution` on page 1325

VBW
Sets the video bandwidth for this range.

For details on the VBW, see Section 4.3.3.2, "Smoothing the trace using the video bandwidth", on page 242.

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<ri>:BANDwidth:VIDeo` on page 1325

Sweep Time Auto
Enables or disables the auto mode for the sweep time.

For details on the sweep time mode, see Section 4.3.3.7, "How long the data is measured: sweep time", on page 246.

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<ri>:SWEep:TIME:AUTO` on page 1338

Sweep Time
Sets the sweep time value for the range.

For details on the sweep time, see Section 4.3.3.7, "How long the data is measured: sweep time", on page 246.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:SWEep:TIME on page 1338

X-Corr Factor
Indicates the number of sweep samples that are cross-correlated to determine a single sweep point if the "RMS X-Corr" detector is used.

See also Section 4.1.5.2, "RMS X-Corr detector", on page 161.

Remote command:
[SENSe<ip>:]LIST:RANGe<ri>:SWEep:XFACtor on page 1368

Ref level
Sets the reference level for the range.

For details on the reference level, see Section 4.3.2.1, "Expected input levels: Reference level", on page 238.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:RLEVel on page 1337

Optimization
Selects the priority for signal processing when determining the required RF attenuation.

"On" (Default:) Optimized for low distortion by avoiding intermodulation. Corresponds to "Low Distortion" in the general amplitude settings. See "Optimization" on page 182.

"Off" Define the attentuation manually. Corresponds to "Manual" in the general amplitude settings. See "Optimization" on page 182.

Remote command:
INPut<ip>:ATTenuation:AUTO on page 616

RF Attenuation Overall
Defines or indicates the overall attenuation applied to the RF input of the FSWX.

By default and without the additional option, the FSWX uses the electronic attenuator for attenuation levels up to 19 dB. For higher levels, the FSWX enables the mechanical attenuator for 20 dB attenuation, and covers the remaining level by electronic attenuation. Thus, the FSWX provides an overall RF attenuation up to 39 dB.

If you set RF Attenuation Mechanical to "Manual", you can change the overall RF attenuation down to 0 dB. Using the arrow keys, the value changes in 5-dB steps. Using the rotary knob, the step size is 1 dB. If you enter other values using the keypad, they are rounded to the next integer value. The valid range is defined in the specifications document. Ensure that the signal power level does not exceed the maximum level allowed at the RF input. An overload can lead to hardware damage. If the FSWX cannot set the defined reference level for the defined RF attenuation, it adjusts the reference level accordingly and displays the warning "Limit reached".

Remote command:
INPut<ip>:ATTenuation on page 616

RF Attenuation Mechanical
If an external frontend is active, you can configure attenuation settings for the external frontend and the analyzer separately. This setting defines the attenuation for the analyzer.

For more information, see "External frontend attenuation vs. analyzer attenuation" on page 209.

When using an external frontend, only mechanical attenuation is available.

You can set the RF attenuation automatically as a function of the selected reference level ("Auto" mode). Automatic attenuation ensures that no overload occurs at the RF input connectors for the current reference level. It is the default setting.

In "Manual" mode, you can set the RF attenuation in 1-dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is defined in the specifications document. If the FSWX cannot set the defined reference level for the defined RF attenuation, it adjusts the reference level accordingly and displays the warning "Limit reached".

When you decrease the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input. An overload can lead to hardware damage.

Remote command:
`[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:SANalyzer:ATTenuation` on page 1329
`[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:SANalyzer:ATTenuation:AUTO` on page 1330

External Frontend Attenuation
If an external frontend is active, you can configure the attenuation for the external frontend and the analyzer separately.

For more information, see "External frontend attenuation vs. analyzer attenuation" on page 209.

When using an external frontend, only mechanical attenuation is available.

The FSWX can set the RF attenuation automatically as a function of the selected reference level ("Auto" mode). Automatic attenuation ensures that no overload occurs at the RF Input connector for the current reference level. It is the default setting.

In "Manual" mode, you can set the RF attenuation in 1-dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is defined in the specifications document. If the FSWX cannot set the defined reference level for the defined RF attenuation, it adjusts the reference level accordingly and displays the warning "Limit reached".

When you decrease the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input. An overload can lead to hardware damage.

Remote command:
`INPut<ip>:ATTenuation` on page 616
`INPut<ip>:ATTenuation:AUTO` on page 616

Preamplifier
Switches the preamplifier on or off.

For details on the preamplifier, see "Preamplifier" on page 183.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:GAIN:STATe on page 1329

Transducer
Sets a transducer for the specified range. You can only choose a transducer that fulfills the following conditions:

- The transducer overlaps or equals the span of the range.
- The x-axis is linear.
- The unit is dB.

For details on transducers, see Section 4.1.6.1, "Fixed transducer factors for discrete trace points", on page 163.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:TRANsducer on page 1339

Multi Limit Calc.
Defines the function used to calculate the limit line for overlapping ranges in Multi-SEM measurements. For details, see "Limit calculation for individual ranges" on page 1038.

"NONE" (Reference ranges only:) The limit of the reference range is used.

"SUM" Sum of the two limit lines (calculated for linear powers) is used.

"MAX" Maximum of the two limit lines is used.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:MLCalc on page 1337

Min. Sweep Points
Defines the minimum number of sweep points for the range.

If necessary to fulfill all minimum sweep point requirements in all ranges, the FSWX increases the global "Sweep Point" setting. By default, each range is supplied with a minimum of one sweep point.

For details, see "Sweep Points" on page 969.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:POINts:MINimum[:VALue]
on page 1336

Limit Check <n>
Sets the type of limit check for the n-th power class in the range. You can define up to four limits.

For details on limit checks, see "Limit lines in SEM measurements" on page 1032.

If the limit check is enabled, further limit settings are available.

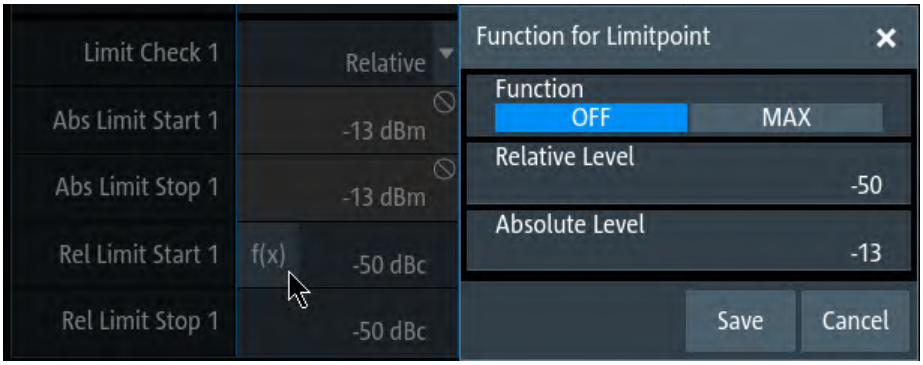
Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:STATe on page 1336
CALCulate<n>:LIMit<li>:FAIL? on page 775

Abs Limit Start / Abs Limit Stop <n>
Sets an absolute limit value in dBm for the n-th power class at the start or stop frequency of the range.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STARt
on page 1331
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STOP
on page 1332

Rel Limit Start / Rel Limit Stop <n>
Sets a relative limit value in dBc for the n-th power class at the start or stop frequency of the range.

By default, this value is a fixed relative limit, i.e. no function is defined. To define a function for the relative limit, select the input field for "Rel Limit Start" or "Rel Limit Stop", and then the "f(x)" icon that appears.



If you set the function to "Max", you can define a relative *and* an absolute limit level. In this case, the maximum of the two values is used as the limit level.

For more information, see "Relative limit line functions" on page 1034.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt
on page 1332
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP
on page 1334
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:FUNCtion on page 1333
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:FUNCtion
on page 1335
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:ABS
on page 1333
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:ABS
on page 1334

Insert before Range/ Insert after Range
Inserts a new range to the left (before) or to the right (after) of the range in which the cursor is currently displayed. The range numbers of the currently focused range and all higher ranges are increased accordingly. The maximum number of ranges is 30.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:INSert on page 1331

Delete Range
Deletes the currently focused range, if possible. The reference range cannot be deleted. A minimum of three ranges is required. The range numbers are updated accordingly.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:DELete on page 1326

Fast SEM
If enabled, enables "Fast SEM" mode for all ranges in the "Sweep List". For details, see "Fast SEM measurements" on page 1034.

Note: If you disable "Fast SEM" mode while "Symmetrical Setup" mode is on, "Symmetrical Setup" mode is automatically also disabled.
If you enable "Fast SEM" mode while "Symmetrical Setup" mode is on, not all range settings can be configured symmetrically automatically.

Remote command:
[SENSe:]ESPectrum<sb>:HSPeed on page 1324

Symmetrical Setup
If enabled, any changes to the range settings lead to symmetrical changes in the other ranges (where possible). In particular, this means:

- Inserting ranges: a symmetrical range is inserted on the other side of the reference range
- Deleting ranges: the symmetrical range on the other side of the reference range is also deleted
- Editing range settings: the settings in the symmetrical range are adapted accordingly

Note: If you disable "Fast SEM" mode "Symmetrical Setup" mode is enabled, "Symmetrical Setup" mode is automatically also disabled.
If you enable "Fast SEM" mode while "Symmetrical Setup" mode is enabled, not all range settings can be set automatically.

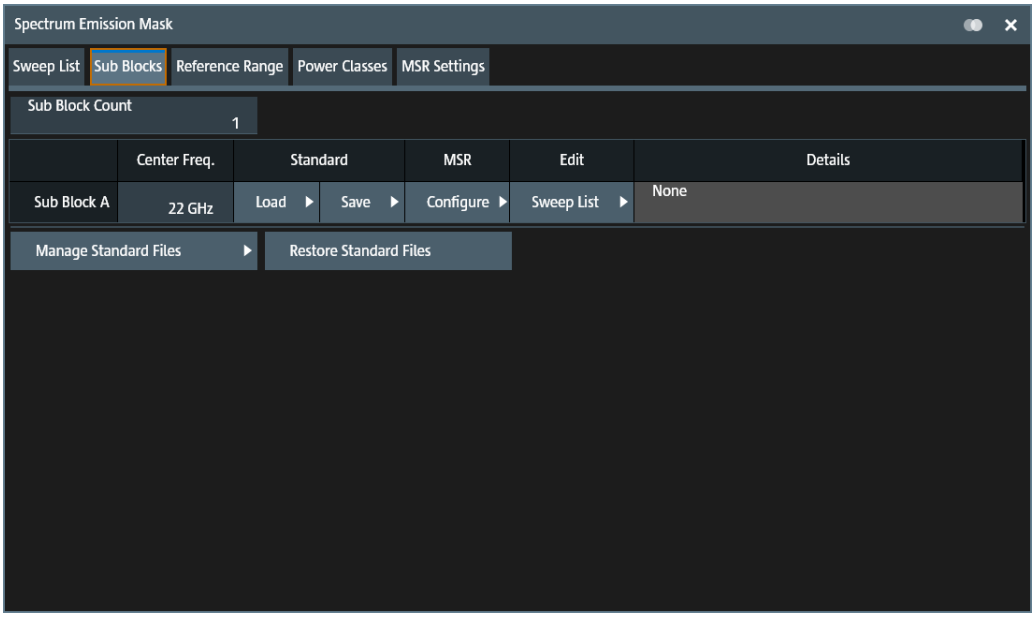
Remote command:
[SENSe:]ESPectrum<sb>:SSETup on page 1339

Multi-SEM (subblock) settings

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Sub Blocks"

In the "Spectrum" application only, you can measure spectrum emissions for multiple subblocks of channels (see "SEM with multiple subblocks ("Multi-SEM")" on page 1036). Subblocks are a set of multiple ranges around a defined center frequency (carrier).

By default, a single subblock is assumed. If you define more than one subblock, the "Spectrum Emission Mask" configuration dialog provides additional tabs for each subblock.



Sub Block Count 1048
Center Frequency 1048
Select: Standard 1048
Select: MSR 1048
Edit Sweep List 1049

Sub Block Count
Defines the number of subblocks. By default, the common SEM measurement with just one single block of ranges is configured.

Remote command:
`[SENSe:]ESPectrum<sb>:SCOunt` on page 1323

Center Frequency
Defines the center frequency for an individual subblock. The center frequency determines the reference range used for each block.

For measurements with only one subblock, this setting corresponds to the global "Center Frequency" setting in the "Frequency Configuration" (see Center Frequency).

Remote command:
`[SENSe:]ESPectrum<sb>:SCENter` on page 1323

Select: Standard
Defines the use of a standard settings file for a particular subblock. For details, see "Standard files" on page 1054.

Remote command:
`[SENSe:]ESPectrum<sb>:PRESet[:STANdard]` on page 1320

Select: MSR
Defines the use of a multi-standard radio (MSR) configuration for a particular subblock. For details, see "MSR settings" on page 1052.

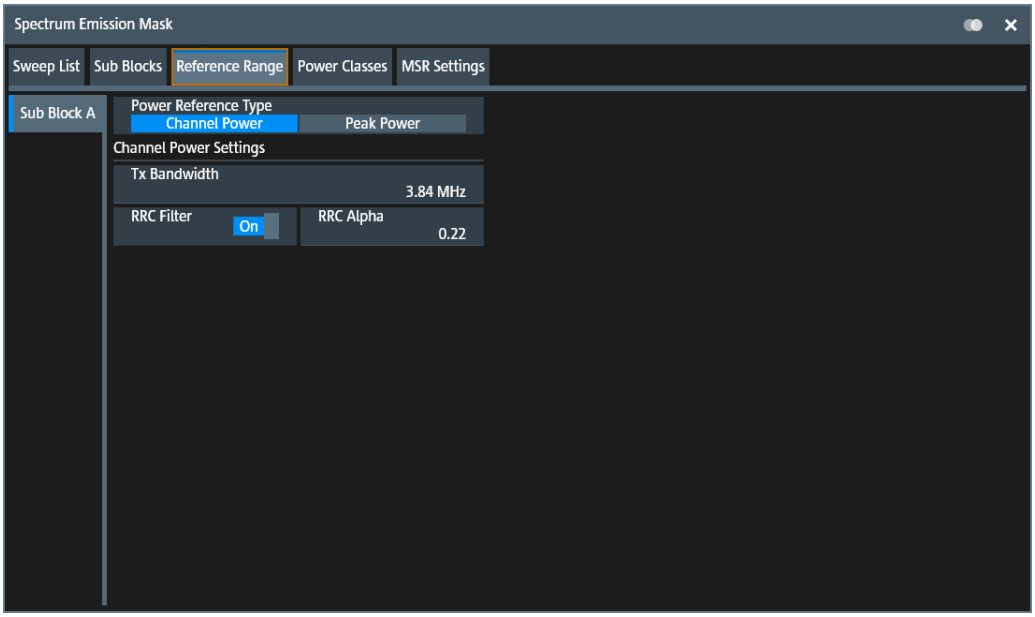
Remote command:
"Configuring a multi-sem measurement" on page 1322

Edit Sweep List
Switches to the "Sweep List" tab of the "Spectrum Emission Mask" dialog to configure the individual frequency ranges and mask limits for the corresponding subblock. See "Sweep list" on page 1041.

Reference range

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Reference Range"

The range around the center frequency is used as the reference range for all other ranges in the "Sweep List".



Power Reference Type....1049
Channel Power Settings....1050
└ Tx Bandwidth....1050
└ RRC Filter State....1050
└ Alpha....1050

Power Reference Type
Defines how the reference power is determined.

"Channel Power"
The FSWX measures the channel power within the reference range using the integration bandwidth method. You can configure additional settings for this method.
See also "IBW method" on page 1088.

"Peak Power"
The FSWX determines the peak power within the reference range.

Remote command:
[SENSe:]ESPectrum<sb>:RTYPe on page 1341

Channel Power Settings
For the "Power Reference Type": "Channel Power" you can configure additional parameters.

For details on the IBW method used to determine the channel power, see "IBW method" on page 1088.

Tx Bandwidth ← Channel Power Settings
Defines the bandwidth used to measure the channel power. The TX bandwidth also defines the minimum span for the reference range.

Remote command:
[SENSe:]ESPectrum<sb>:BWID on page 1340

RRC Filter State ← Channel Power Settings
Enables or disables the use of an RRC filter.

Remote command:
[SENSe:]ESPectrum<sb>:FILTer[:RRC][:STATe] on page 1341

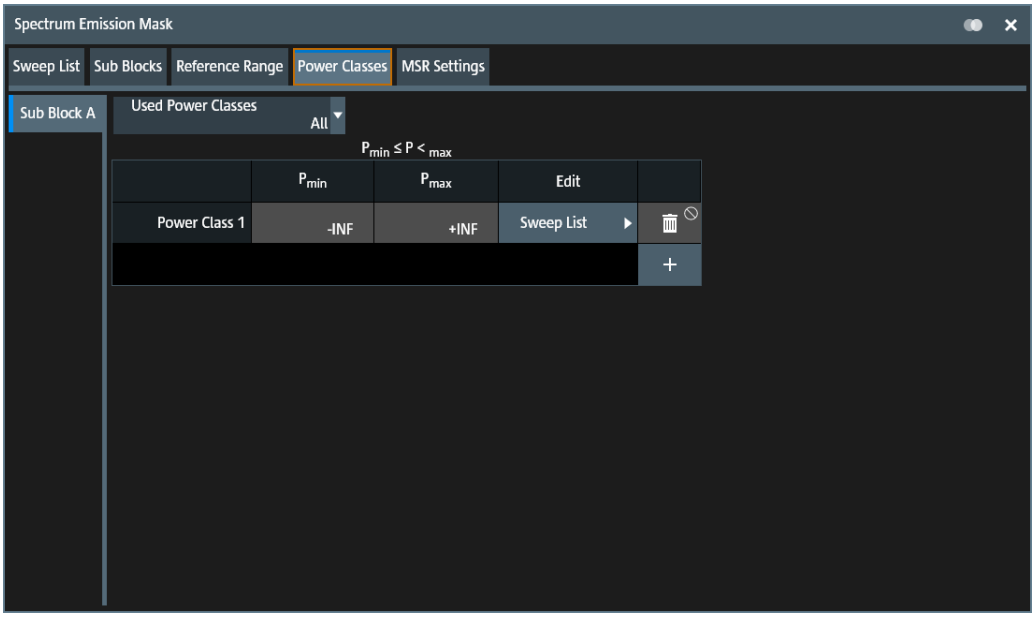
Alpha ← Channel Power Settings
Sets the alpha value of the RRC filter, if enabled.

Remote command:
[SENSe:]ESPectrum<sb>:FILTer[:RRC]:ALPHa on page 1340

Power classes

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Power Classes"

You can configure power classes and assign them to sweep list ranges. For details, see "Power classes" on page 1032.



Used Power Classes....1051
P_{Min}/ P_{Max}....1051
Sweep List....1052
Adding or removing a power class....1052

Used Power Classes
Defines which power classes the SEM measurement considers. You can only define limits for used power classes. You can only select one specific power class or all defined power classes.

If you select "All", the FSWX uses the power class that corresponds to the currently measured power in the reference range for the limit check. The check uses the limits assigned to that power class (see "Abs Limit Start / Abs Limit Stop <n>" on page 1046 and "Rel Limit Start / Rel Limit Stop <n>" on page 1046).

Remote command:
`CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>[:EXCLusive]`
on page 1345
To define all limits in one step:
`CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:LIMit[:STATe]`
on page 1345

P_{Min}/ P_{Max}
Defines the power limits for each power class. The first range always starts at -200 dBm ("-INF") and the last range always stops at 200 dBm ("+INF"). You cannot edit those values. If you define more than one power class, "P_{Max}" must be equal to "P_{Min}" of the subsequent power class.

Note that the power level can be equal to any lower limits, but must be lower than any upper limits:

$P_{min} \leqq P < P_{max}$

Otherwise the ranges are corrected automatically.

Remote command:
CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:MINimum
on page 1346
CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:MAXimum
on page 1346

Sweep List
Switches to the "Sweep List" tab of the "Spectrum Emission Mask" dialog. The "Limit Check" setting for the selected power class and range is focused.

Adding or removing a power class
Adds a new power class at the end of the list or removes the last power class. After you add or remove a class, the last power class is adapted to end at "+INF". You can define a maximum of four power classes.

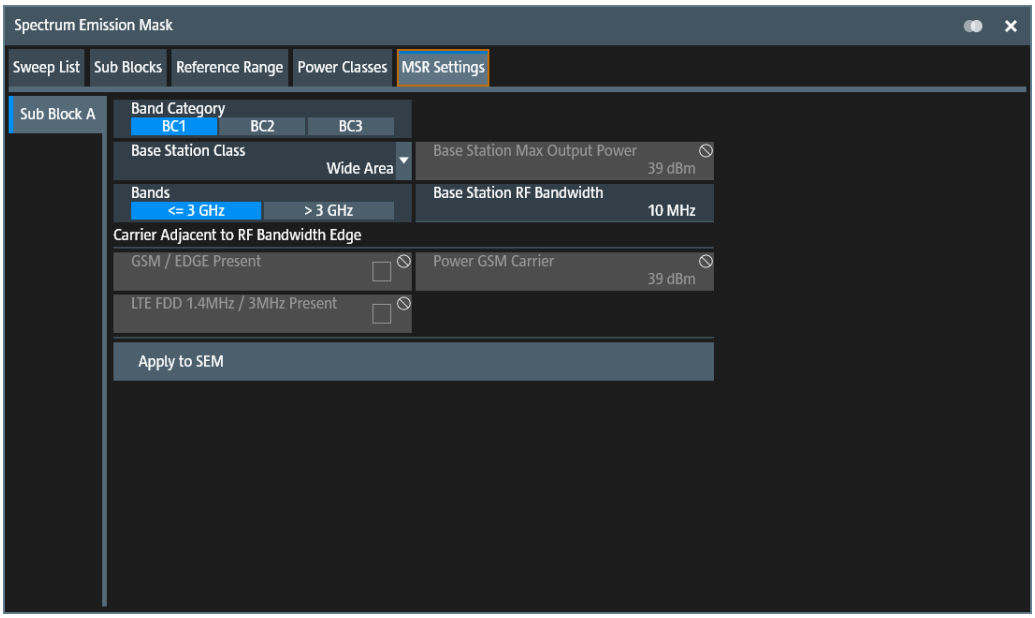
Remote command:
CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:COUNt on page 1344

MSR settings

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "MSR Settings"

Using multi-standard radio (MSR) measurements, you can perform SEM tests on multiple carriers using different digital standards.

For details, see "Multi-standard radio (MSR) SEM measurements" on page 1036.



Band Category 1053
Base Station Class 1053
Base Station Maximum Output Power 1053
Bands 1053
Base Station RF Bandwidth 1053

Carrier Adjacent to RF Bandwidth Edge..... 1053
Power GSM Carrier.....1054
Apply to SEM..... 1054

Band Category
Defines the combination of available carriers to measure for MSR measurements.

"BC1" LTE FDD and WCDMA

"BC2" LTE FDD, WCDMA and GSM/EDGE

"BC3" LTE TDD and TD-SCDMA

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:BCATegory` on page 1348

Base Station Class
Defines the class of the base station according to its sending range.

This setting is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:CLASs` on page 1349

Base Station Maximum Output Power
Defines the maximum output power of the base station. Possible values are from 0 dBm to 100 dBm in 1 dB steps.

This setting is only available for base stations with a medium range Base Station Class.

This value is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:MPOWer` on page 1352

Bands
Defines the frequency range of the bands used by the base station.

This setting is only available for Band Category 1 or 3.

This setting is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:BAND` on page 1348

Base Station RF Bandwidth
Defines the relevant RF bandwidth (span) required to measure all available carriers in MSR SEM measurements.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:RFBWidth` on page 1352

Carrier Adjacent to RF Bandwidth Edge
For particular measurement setups, the specification demands specific limits for the SEM ranges.

These settings are only available for Band Category 2.

"GSM/Edge Present"
A GSM/EDGE carrier is located at the edge of the RF band.
In this case, you must specify the power of the GSM carrier (see "Power GSM Carrier" on page 1054).

"LTE FDD 1.4MHz/3MHz Present"
An LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the RF band.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent` on page 1351
`[SENSe:]ESPectrum<sb>:MSR:LTE:CPResent` on page 1351

Power GSM Carrier
Defines the power of the GSM carrier (if available, see "Carrier Adjacent to RF Bandwidth Edge" on page 1053). Possible values are from 0 dBm to 100 dBm in 1 dB steps.

This setting is only available for Band Category2.

This setting is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:GSM:CARRier` on page 1350

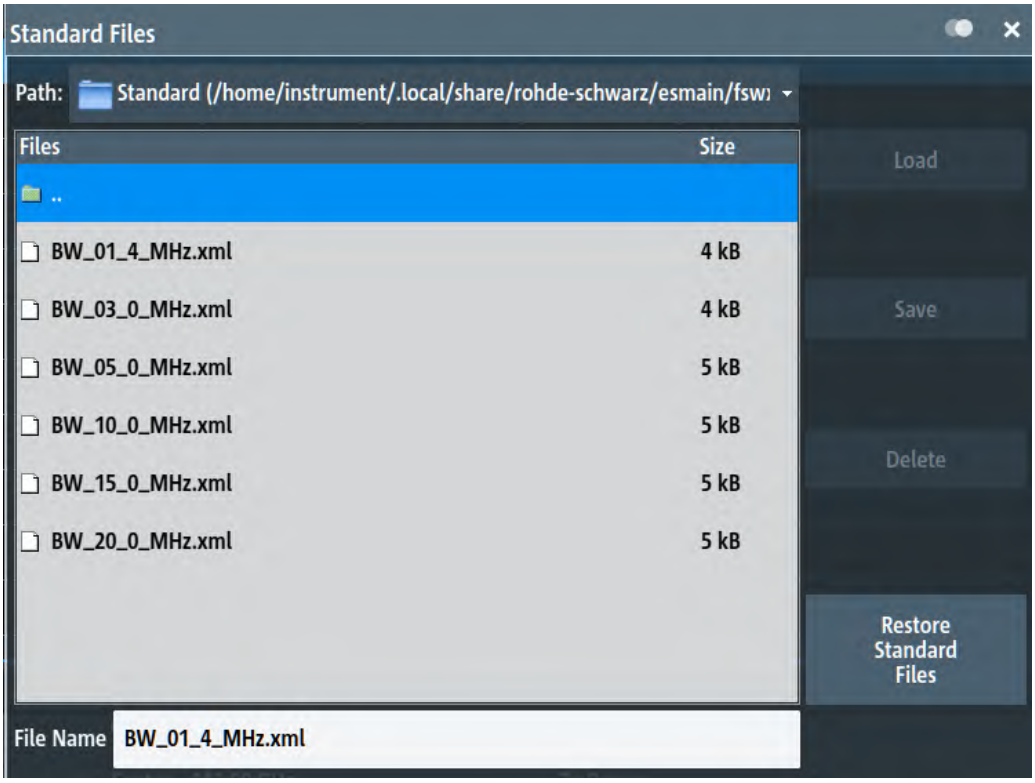
Apply to SEM
Configures the SEM sweep list according to the specified MSR settings.

Remote command:
`[SENSe:]ESPectrum<sb>:MSR:APPLy` on page 1347

Standard files

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Sub Blocks" > "Select": "Standard"

You can save the current measurement settings as a user-defined standard (XML file), or load stored measurement settings. Furthermore, you can delete an existing settings file.



For details, see "How to manage SEM settings files" on page 1061.

Standard files for subblocks (Multi-SEM measurements)

The "Standard Files" function is not available if you define more than one subblock. To load a standard file for an individual subblock, use the Select: Standard setting in the "Sub Blocks" tab.

Selecting the storage location 1055
File Name 1055
Load 1056
Save 1056
Delete 1056
Restore Standard Files 1056

Selecting the storage location

Select the storage location of the file on the FSWX or an external drive.

The default storage location for the SEM settings files is:
`home/instrument/.local/share/rohde-schwarz/esmain/fswx/sem_std`.

Remote command:
`MMEMory:CATalog` on page 780

File Name

Contains the name of the data file without the path or extension.

For details on the filename and location, see "Storage location and filename" on page 360.

Load
Loads the selected measurement settings file.

Remote command:
`[SENSe:]ESPectrum<sb>:PRESet[:STANdard]` on page 1320

Save
Saves the current measurement settings for a specific standard as a file with the defined name.

Remote command:
`[SENSe:]ESPectrum<sb>:PRESet:STORe` on page 1321

Delete
Deletes the selected standard. You can also delete standards that are predefined by Rohde & Schwarz. A confirmation query is displayed to avoid unintentional deletion of the standard.

Note: Restoring predefined standard files. You can restore the standards that were predefined by Rohde & Schwarz at the time of delivery using the "Restore Standard Files" function (see "Restore Standard Files" on page 1056).

Restore Standard Files
Restores the standards predefined by Rohde & Schwarz at the time of delivery.

The XML files from the `opt/rohde-schwarz/esmain/fswx/etc/sem_backup` folder are copied to the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/sem_std` folder.

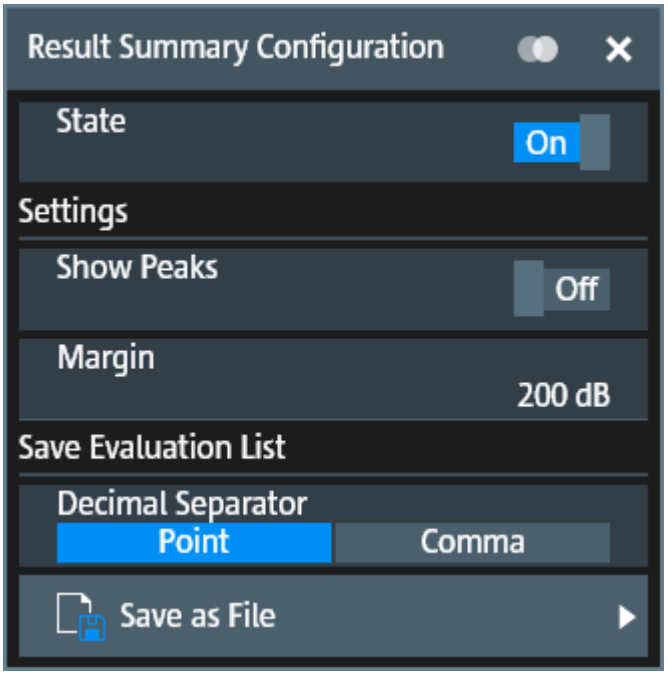
Note that this function overwrites customized standards that have the same name as predefined standards.

Remote command:
`[SENSe:]ESPectrum<sb>:PRESet:RESTore` on page 1321

Result summary configuration

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Result Summary Configuration"

In the "Result Summary Configuration" dialog, you configure the contents and display of the "Spectrum Emission Mask" results.



Result Summary State 1057
Show Peaks 1057
Margin 1057
Save Evaluation List 1058

Result Summary State
Enables or disables the "Result Summary".

Remote command:
`CALCulate<n>:ESPectrum:PEAKsearch:AUTO` on page 1353
`TRACe<n>[:DATA]` on page 688

Show Peaks
If enabled, all peaks that are detected during an active SEM measurement are marked with colored squares in the "Spectrum Emission Mask" diagram.

Remote command:
`CALCulate<n>:ESPectrum:PEAKsearch:PSHow` on page 1354

Margin
The limit check does not support a margin functionality. However, you can define a margin (or: *threshold*) for the peak values that are displayed in the "Result Summary" and the "Spectrum Emission Mask" diagram. Only peaks that exceed the margin value are displayed.

Remote command:
`CALCulate<n>:ESPectrum:PEAKsearch:MARGin` on page 1354

Save Evaluation List
Exports the "Result Summary" of the "Spectrum Emission Mask" measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

Define the filename and storage location in the file selection dialog that is displayed when you select the "Save" function.

For details, see "ASCII file export format (spectrum emission mask)" on page 1070.

Remote command:
`MMEMory:STORe<n>:LIST` on page 803
`FORMat:DEXPort:DSEParator` on page 779

5.3.3.6 How to perform a Spectrum Emission Mask measurement

You can perform "Spectrum Emission Mask" measurements according to a specific standard or freely configured. You can configure measurements for signals with a regular channel definition quickly and easily.

For signals with multiple carriers, also in non-contiguous ranges, you can configure an SEM measurement with multiple subblocks.

For multi-standard radio SEM measurements, the FSWX can configure the measurement for specified scenarios automatically.

The following tasks are described:

- "To select an SEM measurement" on page 1058
- "To perform an SEM measurement according to a standard" on page 1058
- "To configure a user-defined SEM measurement" on page 1059
- "To perform an MSR SEM measurement" on page 1060
- "To perform a Multi-SEM measurement" on page 1060



For remote operation, see "Example: SEM measurement" on page 1355.

To select an SEM measurement

► Select [MEAS] > "Spectrum Emission Mask".

To perform an SEM measurement according to a standard

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

► Load the settings file as described in "How to load an SEM settings file" on page 1061 and start a measurement.

To configure a user-defined SEM measurement

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. In the general span settings ([Freq]), define the span of the signal to monitor.
2. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.
   Starting from the center frequency, determine which sections of the signal to the left and right can be swept and monitored using the same parameters. Criteria for such a range definition can be, for example:
   - The signal power level
   - The required resolution bandwidth or sweep time
   - Transducer factors
   - Permitted deviation from the defined signal level, i.e. the required limit values for monitoring

   If the signal consists of a transmission channel and adjacent channels, you can usually use the channel ranges for the range definition.
3. If the signal power levels and the limits vary, define power classes. For each range of levels that can be monitored in the same way, define a power class.
   a) Select "Overview".
   b) Select "SEM Setup".
   c) Switch to the "Power Classes" tab.
   d) Select "Add" to add a power class.
   e) Enter the start and stop power levels to define the class.
   f) Select the power classes to use for the current measurement:
      - A specific class
      - All classes
        The required class is selected automatically according to the input level measured in the reference range.
4. Select the "Sweep List" tab.
5. Insert the required ranges using the "Insert before Range" and "Insert after Range" functions, which refer to the currently selected range (the reference range by default).
   If the signal trace is symmetric to the center frequency, enable the "Symmetrical Setup" option to make setup easier and quicker.
6. Define the measurement parameters for each range as required. If symmetrical setup is enabled, you only have to configure the ranges to one side of the center range.
   In particular, define the limits for each range of the signal, i.e. the area in which the signal level can deviate without failing the limit check. If you defined several power classes (see step 3), define limits for each power class.
   a) Define the type of limit check, i.e. whether to check absolute values or relative values, or both. The type of limit check is identical for all power classes.

b) Define the limit line start and stop values.

7. If the sweep list settings - other than the limit and transducer values - are identical for several adjacent ranges, enable "Fast SEM" mode to speed up the measurement. You only have to enable the mode for one range, the others are adapted automatically.
8. If necessary, change the settings for the reference power to which all SEM results refer in the "Reference range" tab.
9. To indicate the determined peaks in the display during an SEM measurement, select "Overview" > "Analysis" > "Show Peaks".
10. To save the current SEM measurement settings to a file to re-use them later, save a settings file as described in "How to save a user-defined SEM settings file" on page 1061.
11. Start a sweep.

    The determined powers and limit deviations for each range are indicated in the "Result Summary". If enabled, the peak power levels for each range are also indicated in the "Spectrum Emission Mask" diagram.
12. To save the "Result Summary", export the results to a file as described in "How to save SEM result files" on page 1062.

To perform an MSR SEM measurement

1. Select "MSR Configuration".
2. Select the band category that determines the digital standards used in the measurement setup (see "Band Category" on page 1053).
3. Define the bandwidth that contains all relevant carrier signals to measure.
4. For measurements with GSM/EDGE, LTE FDD and WCDMA carriers (BC2), define whether a GSM/EDGE or an LTE FDD carrier, or both, are located at the edge of the bandwidth.
5. Select "Apply to SEM".

   The sweep list is configured according to the MSR specification, with the required number of ranges and defined limits.
6. Start a sweep.

   The determined powers and limit deviations for each range are indicated in the "Result Summary". If enabled, the peak power levels for each range are also indicated in the "Spectrum Emission Mask" diagram.
7. To save the "Result Summary", export the results to a file as described in "How to save SEM result files" on page 1062.

To perform a Multi-SEM measurement

1. Define the span of the signal to monitor in the general span settings.

2. Select "Sub Blocks".
3. Define the number of subblocks (up to 8) that contain the relevant carriers.
4. For each subblock, define the center frequency, that is, the frequency of the TX carrier or a frequency in the dedicated reference range.
5. For each subblock, do one of the following:
   - Select a standard settings file to use.
   - Select "MSR Settings" and define the MSR configuration as described in "To perform an MSR SEM measurement" on page 1060.
   - Select "Edit" and configure the sweep list manually as defined in "To configure a user-defined SEM measurement" on page 1059. Be sure to select the correct vertical tab for the corresponding subblock within each subtab of the "Spectrum Emission Mask" configuration dialog.
     Define a function to use for overlapping ranges in the "Multi Limit Calc" field of the "Sweep List".
6. Start a sweep.

   The determined powers and limit deviations for each subblock, each gap, and each range are indicated in the "Result Summary". If enabled, the peak power levels for each range are also indicated in the "Spectrum Emission Mask" diagram.
7. To save the "Result Summary", export the results to a file as described in "How to save SEM result files" on page 1062.

How to manage SEM settings files

You can save SEM measurement settings to an XML file. Then you can export the file to another application or load it on the FSWX again later.
The FSWX provides some predefined XML files that contain ranges and parameters according to the selected standard. All XML files are stored under `home/instrument/.local/share/rohde-schwarz/esmain/fswx/sem_std`.

For details on the file format of the SEM settings file, see "Format description of SEM XML files" on page 1064.

You manage SEM settings or standard files in the "Standard Files" dialog. To display this dialog, select Meas Config > "Standard Files".

How to load an SEM settings file

1. In the file selection dialog, select the settings file (with an `.xml` extension).
2. Select "Load".

   The FSWX restores the settings from the selected file. You can repeat the SEM measurement with the stored settings.

How to save a user-defined SEM settings file

1. Configure the SEM measurement as required (see Section 5.3.3.6, "How to perform a Spectrum Emission Mask measurement", on page 1058).

2. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog, define a filename and storage location for the settings file.
3. Select "Save".

   The settings are stored to a file with the extension `.xml` as specified.

How to delete an SEM settings file

1. In the "Standard Files" dialog, select the file you want to delete.
2. Select "Delete".
3. Confirm the message.

   The FSWX deletes the settings file.

How to restore default SEM settings files

The FSWX is delivered with predefined settings files that you can edit and overwrite. You can restore the original files.

► Select "Standard Files" > "Restore Standard Files".

The FSWX provides the original predefined settings files.

How to save SEM result files

You can save the "Result Summary" from an SEM measurement to a file. You can then export the file to another application for further analysis, for example.

For details on the file format of the SEM export file, see "Format description of SEM XML files" on page 1064.

1. Configure and perform an SEM measurement as described in Section 5.3.3.6, "How to perform a Spectrum Emission Mask measurement", on page 1058.
2. Select "Overview" > "Analysis".
3. If necessary, change the "Decimal Separator" to "Comma" for evaluation in other languages.
4. Select "Save".
5. In the file selection dialog, select a storage location and filename for the result file.
6. Select "Save".

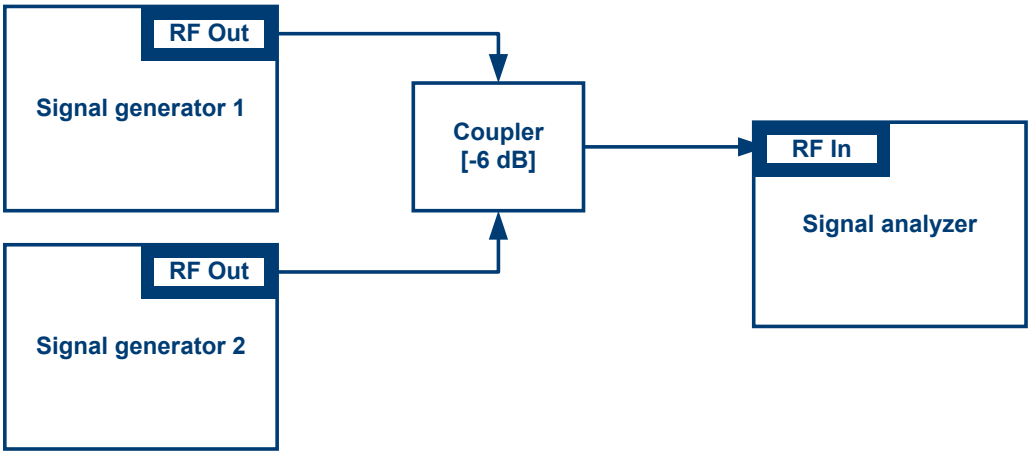
   The FSWX stores the file with the specified name and the extension `.dat` in the defined storage location.

5.3.3.7 Measurement example: Multi-sem measurement

The following measurement example demonstrates an SEM measurement for a signal with multiple subblocks.

A programming example demonstrating a SEM measurement in a remote environment is provided in "Example: SEM measurement" on page 1355.

Test setup:



Signal generator settings (e.g. FSWX SMW):

Device	Standard	Center frequency	Level	Test model
SigGen 1	3GPP/FDD	900 MHz	0 dBm	1-16
SigGen 2	EUTRA/LTE	906.5 MHz	0 dBm	1_1_5MHz

Setting up the measurement

1. Preset the FSWX.
2. Set the center frequency to *903.25 MHz*.
3. Set the reference level to *10 dBm* with an offset of to *30 dB*.
4. Select "Overview" > "Select Measurement".
5. Select the "Spectrum Emission Mask" measurement function.
6. Select "Sub Blocks".
7. Enter "Sub Block Count": *2*.
8. For "Sub Block A", define the settings for the 3GPP/FDD signal:
   - Set the "Center Frequency" to *900 MHz*
   - Select "MSR Settings".
   - Set the "Base Station RF Bandwidth" to *5 MHz*.
   - Select "Apply to SEM".
9. For "Sub Block B", define the settings for the EUTRA/LTE signal:
   - Set the "Center Frequency" to *906.5 MHz*
   - Select "MSR Settings".

- Set the "Base Station RF Bandwidth" to *5 MHz*.
- Select "Apply to SEM".

10. Select Run Single to perform a measurement with the new settings.

    The "Result Summary" displays the results of the measurement for each subblock. The "Spectrum Emission Mask" diagram shows the summarized limit line.

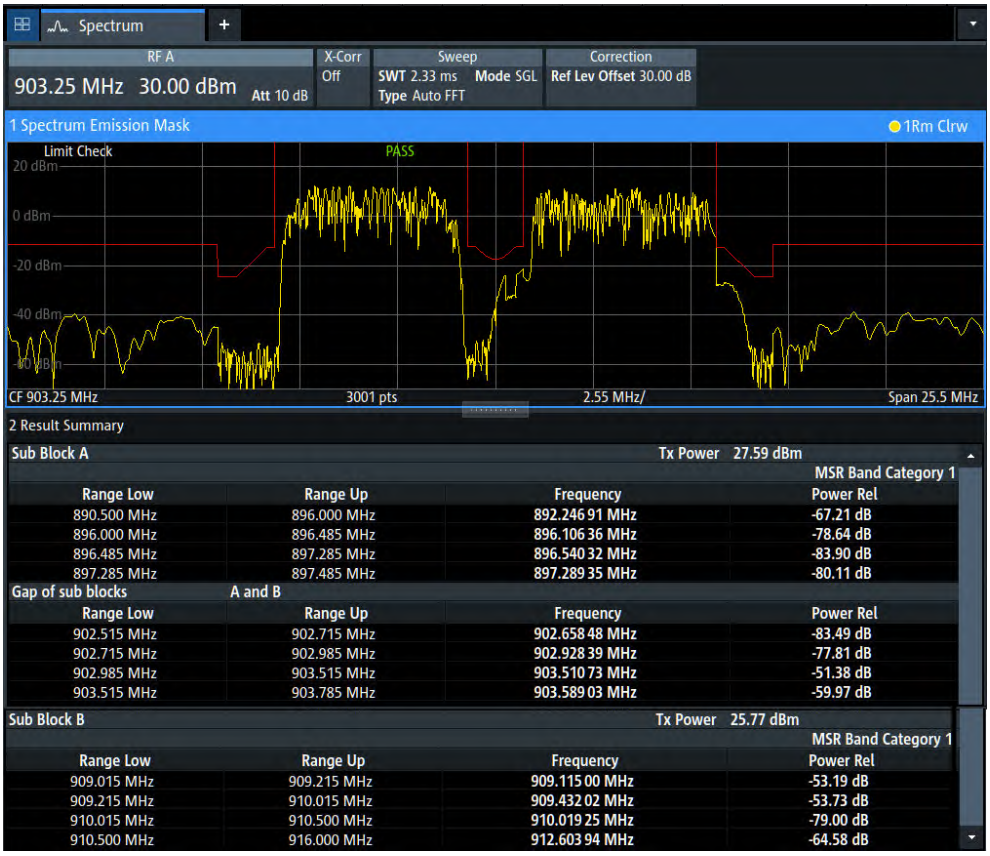


Figure 5-34: Multi-SEM measurement: results of the measurement for each subblock

5.3.3.8 Reference: SEM file descriptions

This reference provides details on the format of the SEM settings and result files.

- Format description of SEM XML files.....1064
- ASCII file export format (spectrum emission mask).....1070

Format description of SEM XML files

The SEM XML files offer a quick way to change the measurement settings. The FSWX already provides a set of predefined XML files for different standards. You can also define the settings directly in the "Spectrum Emission Mask" dialog and save the XML file afterwards.

In addition to saving the current settings to a file, you can also create settings files independently of the FSWX, in an external application. When creating your

own XML files, be sure to comply with the following conventions because the FSWX can only interpret XML files of a known structure. For sample files, see the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/sem_std` directory of the FSWX.

To load a settings file, use the "Load" function in the "Standard Files" tab of the "Spectrum Emission Mask" dialog (see "How to load an SEM settings file" on page 1061). All XML files are stored under `home/instrument/.local/share/rohde-schwarz/esmain/fswx/sem_std`.

The files used to import settings must comply with the rules of the XML standard. The child nodes, attributes, and structure defined for the data import are described here.

Be sure to follow the structure exactly as shown below. Otherwise, the FSWX cannot interpret the XML file and shows an error message on the screen. We recommend that you copy an existing file and edit the copy.

Basically, the file consists of three elements:

- BaseFormat element....1065
- PowerClass element....1066
- Range element....1067

BaseFormat element

It contains information about basic settings. In this element, only the `ReferencePower` child node has any effect on the measurement itself. The other attributes and child nodes are used to display information about the Spectrum Emission Mask standard on the measurement screen.

Table 5-11: Attributes and child nodes of the BaseFormat element

Child node	Attribute	Value	Parameter description	Mand.
	FileFormatVersion	1.0.0.0		Yes
	Date	YYYY-MM-DD HH:MM:SS	Date in ISO 8601 format	No
Name		<string>	Name of the standard	Yes
Instrument	Type	FSL	Name of the instrument	No
	Application	SA | K72 | K82	Name of the application	No
LinkDirection	Name	Downlink | Uplink | None		Yes
	ShortName	DL | UL		No
Reference-Power				Yes
Method	TX Channel Power | TX Channel Peak Power			Yes
Reference-Channel	<string>			No

Example

```
<RS_SEM_ACP_FileFormat Version="1.0.0.0">
<Name>"Standard"</Name>
<Instrument>
<Type>"Instrument Type"</Type>
<Application>"Application"</Application>
</Instrument>
<LinkDirection Name="Name">
<ReferencePower>
<Method>"Method"</Method>
</ReferencePower>
<PowerClass Index="n">
<!-- Define up to four PowerClass nodes -->
</PowerClass>
</LinkDirection>
</RS_SEM_ACP_File>
```

Example:

The sample file `PowerClass_39_43.xml` under `home/instrument/.local/share/rohde-schwarz/esmain/fswx/sem_std` defines these attributes as follows:

- Standard="WCDMA 3GPP"
- LinkDirection="DL"
- PowerClass="(39,43)dBm"

PowerClass element

It is embedded in the `BaseFormat` element and contains settings for the power classes. You can define up to four different power classes. For details, refer to "Power classes" on page 1050.

Table 5-12: Attributes and child nodes of the PowerClass element

Child node	Attribute	Value	Parameter description	Mand.
StartPower	Value	<power in dBm>	The start power must be equal to the stop power of the previous power class. The StartPower value of the first range is -200	Yes
	Unit	dBm		Yes
	InclusiveFlag	true		Yes
StopPower	Value	<power in dBm>	The stop power must be equal to the start power of the next power class. The StopPower value of the last range is 200	Yes
	Unit	dBm		

Child node	Attribute	Value	Parameter description	Mand.
	InclusiveFlag	false		Yes
DefaultLimitFailMode		Absolute | Relative | Absolute and Relative | Absolute or Relative		Yes

Example

```
<PowerClass Index="n">
<StartPower Unit="dBm" InclusiveFlag="true" Value="StartPowerValue"/>
<StopPower Unit="dBm" InclusiveFlag="false" Value="StopPowerValue"/>
<DefaultLimitFailMode>"Limit Fail Mode"</DefaultLimitFailMode>
<Range Index="n">
<!-- For contents of the Range node, see Table 6-15 -->
<!-- Define up to twenty Range nodes -->
</Range>
…
</PowerClass>
```

Range element

This element is embedded in the `PowerClass` element. It contains the settings of the range. Define at least three ranges: one reference range and at least one range to either side of the reference range. The maximum number of ranges is 30. Note that the FSWX uses the same ranges in each power class. Therefore, the contents of the ranges of each defined power class have to be identical to the first power class. The `Start` and `Stop` values of the two `Limit` nodes that are used to determine the power class are an exception. Note also that you must define two limit nodes: one that defines the limit in absolute values and one in relative values. Make sure the units for the `Start` and `Stop` nodes are identical for each `Limit` node.

For details, refer to "Sweep list" on page 1041.

Table 5-13: Attributes and child nodes of the Range element (normal ranges)

Child node	Attribute	Value	Parameter description	Mand.
	Index	0…19	Indices are continuous and have to start with 0	Yes
	Name	<string>	Name of the range	Only if ReferenceChannel contains a name and the range is the reference range
	ShortName	<string>	Short name of the range	No
ChannelType		TX | Adjacent		Yes

Child node	Attribute	Value	Parameter description	Mand.
WeightingFilter				Only if ReferencePower method is TX Channel Power and the range is the reference range
Type		RRC | CFilter	Type of the weighting filter	Yes
Roll Off Factor		0…1	Excess bandwidth of the filter	Only if the filter type is RRC
Bandwidth		<bandwidth in Hz>	Filter bandwidth	Only if the filter type is RRC
FrequencyRange				Yes
Start		<frequency in Hz>	Start value of the range	Yes
Stop		<frequency in Hz>	Stop value of the range	Yes
Limit		dBm/Hz | dBm | dBc | dBr | dB	A range must contain exactly two limit nodes; one of the limit nodes has to have a relative unit (e.g. dBc), the other one must have an absolute unit (e.g. dBm)	Yes
Start	Value	<numeric_value>	Power limit at start frequency	Yes
	Unit	dBm/Hz | dBm | dBc | dBr | dB	Sets the unit of the start value	
Stop	Value	<numeric_value>	Power limit at stop frequency	
	Unit	dBm/Hz | dBm | dBc | dBr | dB	Sets the unit of the stop value	
LimitFailMode		Absolute | Relative | Absolute and Relative | Absolute or Relative	If used, it has to be identical to DefaultLimitFailMode	No
RBW	Bandwidth	<bandwidth in Hz>	"RBW" on page 1042	Yes
	Type	NORM | PULS | CFIL | RRC		No
VBW	Bandwidth	<bandwidth in Hz>		Yes
Detector		NEG | POS | SAMP | RMS | AVER | QUAS	If used, it has to be identical in all ranges.	No
Sweep	Mode	Manual | Auto	"Sweep Time Auto" on page 1042	Yes
	Time	<time in sec>	"Sweep Time" on page 1042	No
Amplitude				No

Child node	Attribute	Value	Parameter description	Mand.
ReferenceLevel	Value	<power in dBm>	"Ref level" on page 1043	Yes, if the ReferenceLevel child node is used
	Unit	dBm	Defines dBm as a unit	Yes, if the ReferenceLevel node is used
RFAttenuation	Mode	Manual | Auto	"RF Attenuation Overall" on page 1043	Yes, if the ReferenceLevel child node is used
Preamplifier		ON | OFF | 1 | 0	"Preamplifier" on page 1045	Yes

Example

```
<Range Index="n">
<Name="Name">
<ChannelType>"Channel Type"</Channel Type>
<WeightingFilter>
<Type>"FilterType"</Type>
<RollOffFactor>"Factor"</RollOffFactor>
<Bandwith>"Bandwidth"</Bandwidth>
</WeightingFilter>
<FrequencyRange>
<Start>"RangeStart"</Start>
<Stop>"RangeStop"</Stop>
</FrequencyRange>
<Limit>
<Start Unit="Unit" Value="Value"/>
<Stop Unit="Unit" Value="Value"/>
</Limit>
<Limit>
<Start Unit="Unit" Value="Value"/>
<Stop Unit="Unit" Value="Value"/>
</Limit>
<RBW Bandwidth="Bandwidth" Type="FilterType"/>
<VBW Bandwidth="Bandwidth"/>
<Detector>"Detector"</Detector>
<Sweep Mode="SweepMode" Time="SweepTime"/>
<Amplitude>
<ReferenceLevel Unit="dBm" Value="Value"/>
<RFAttenuation Mode="Auto" Unit="dB" Value="Value"/>
<Preamplifier State="State"/>
</Amplitude>
<MeasPointsMin>1</MeasPointsMin>
<CalcRuleMulti>Sum</CalcRuleMulti>
</Range>
```

ASCII file export format (spectrum emission mask)

When you export trace data from an SEM measurement, the data is stored in ASCII format as described below. The first part of the file lists information about the signal analyzer and the general setup.

File contents	Explanation
File header	
Type;FSW-26;	Model
Version;1.00;	Firmware version
Date;31.Mar 17;	Storage date of data set
Mode;ANALYZER;SEM;	Application and measurement function
Center Freq;13250000000.000000;Hz	X-axis settings
Freq Offset;0.000000;Hz	
Span;25500000.000000;Hz	
x-Axis;LIN;	
Start;13237250000.000000;Hz	
Stop;13262750000.000000;Hz	
Level Offset;0.000000;dB	Y-axis settings
Ref Position;100.000000;%	
y-Axis;LOG;	
Level Range;100.000000;dB	
Trace settings	
Trace Mode;CLR/WRITE;	
Detector;RMS;	
Sweep Count;0;	
Trace 1:;	
x-Unit;Hz;	
y-Unit;dBm;	
Result summary settings	
Margin;200;	Peak List margin
Reference range settings	
RefType; CPOWER;	Reference power type
TxBandwidth;3840000;;Hz	Channel power settings
Filter State; ON;	
Alpha;0.22;	
PeaksPerRange;1;	Max. number of peaks per range to be detected

File contents	Explanation
Values;2;	Number of detected peaks
File data section	
0;-12750000;-2515000;30000;13242367500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL;	Measured peak values: <range number>; <start frequency>; <stop frequency>; <resolution bandwidth of range>; <frequency of peak>; <absolute power in dBm of peak>; <relative power in dBc of peak>; (related to the channel power) <distance to the limit line in dB>; (positive value means above the limit) <limit fail (pass = 0, fail =1)>;
2;2515000;12750000;30000;13257632500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL;	

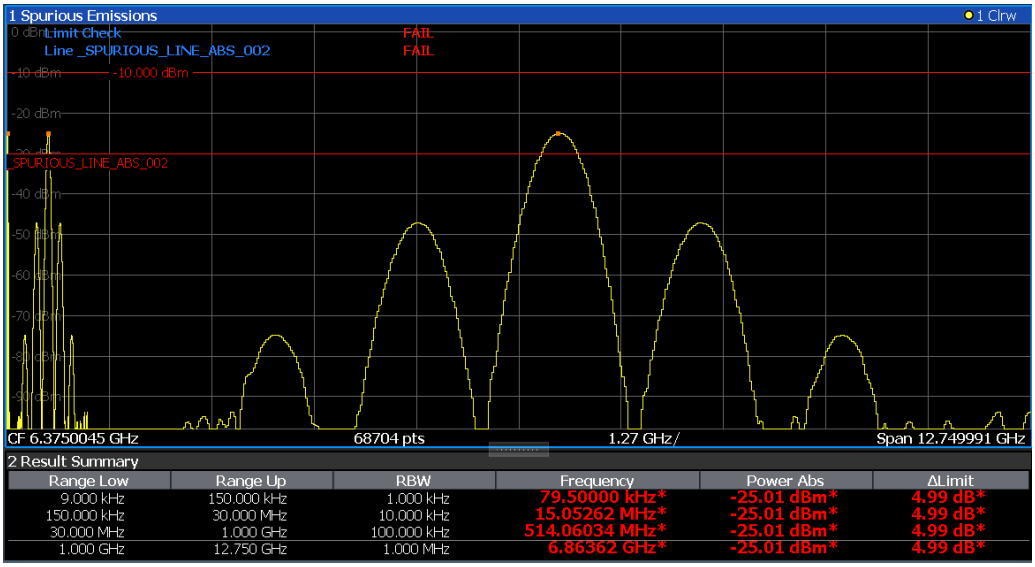
5.3.4 Spurious emissions measurement

"Spurious Emissions" measurements monitor unwanted RF products outside the assigned frequency band generated by an amplifier.

- About the measurement 1071
- Spurious Emissions measurement results 1072
- Spurious emissions basics 1073
- Spurious emissions measurement configuration 1075
- How to measure spurious emissions 1082
- Reference: ASCII export file format (spurious) 1084

5.3.4.1 About the measurement

The "Spurious Emissions" measurement monitors unwanted RF products outside the assigned frequency band that are generated by an amplifier. The "Spurious Emissions" measurement usually analyzes a wide frequency range. You can define all parameters for the "Spurious Emissions" measurement flexibly. A result table indicates the largest deviations of the absolute power from the limit line for each range. The FSWX can also check the results against defined limits automatically.



5.3.4.2 Spurious Emissions measurement results

As a result of the "Spurious Emissions" measurement, the following results are displayed in a diagram:

- The measured signal levels including any spurious emissions
- Optionally, the detected peaks
- Any defined limit lines and the limit check results

In addition to the graphical results, a "Result Summary" can be displayed to evaluate the measured powers and limit check results (see also "Limit lines in spurious measurements" on page 1074). You can configure the details of the "Result Summary".

2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	79.50000 kHz*	-25.01 dBm*	4.99 dB*
150.000 kHz	30.000 MHz	10.000 kHz	15.05262 MHz*	-25.01 dBm*	4.99 dB*
30.000 MHz	1.000 GHz	100.000 kHz	514.06034 MHz*	-25.01 dBm*	4.99 dB*
1.000 GHz	12.750 GHz	1.000 MHz	6.86362 GHz*	-25.01 dBm*	4.99 dB*

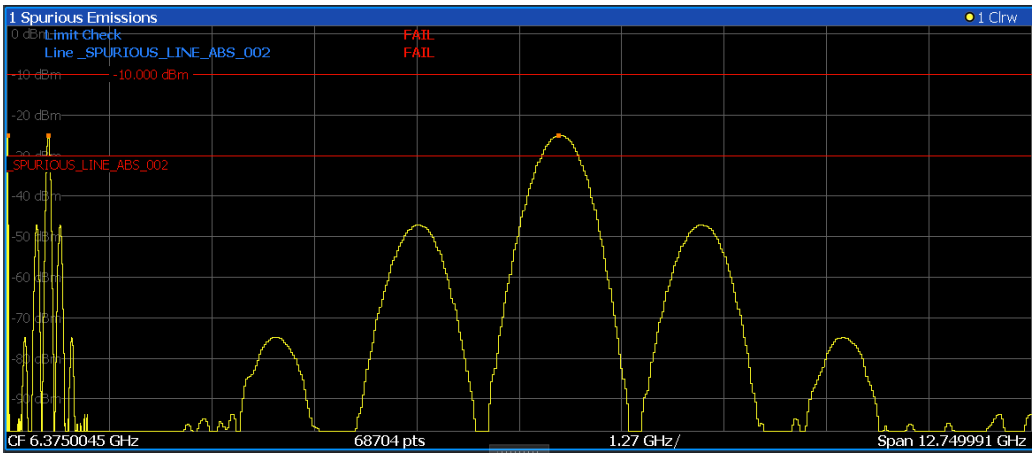
The following information is provided in the "Result Summary" for each range:

Table 5-14: Result Summary information

Column	Description
"Range Low"	Frequency range start for the range that the peak value belongs to
"Range Up"	Frequency range end for the range that the peak value belongs to
"RBW"	RBW of the range
"Frequency"	Frequency at the peak value
"Power Abs"	Absolute power level at the peak value
"ΔLimit"	Deviation of the absolute power level from the defined limit for the peak value

By default, the "Result Summary" indicates one peak per range. However, you can change the settings to:

- Display all peaks
- Display a certain number of peaks per range
- Display only peaks that exceed a threshold ("Margin")
- Display detected peaks as blue squares in the diagram, and in the peak list



Furthermore, you can save the "Result Summary" to a file.

Retrieving results via remote control

You can retrieve the measured spurious values of the displayed trace using the `TRAC:DATA? SPUR` command (see `TRACe<n>[:DATA]` on page 688).

5.3.4.3 Spurious emissions basics

Some background knowledge on basic terms and principles used in "Spurious Emissions" measurements is provided here for a better understanding of the required configuration settings.

- Ranges and range settings 1073
- Limit lines in spurious measurements 1074

Ranges and range settings

Conditions for ranges

The following rules apply to ranges:

- The minimum span of a range is 20 Hz.
- The individual ranges must not overlap (but can have gaps).
- The maximum number of ranges is 30.
- The maximum number of sweep points in all ranges is limited to 100001.

The measurement span (defined in the Span menu) can be smaller than the combined span of all ranges. In this case, the measurement includes only the ranges that lie within the defined measurement span and have a minimum span of 20 Hz.

Defining ranges by remote control

In "Spurious Emissions" measurements, there are no remote commands to insert new ranges between existing ranges directly. However, you can delete or redefine the existing ranges to create the required order.

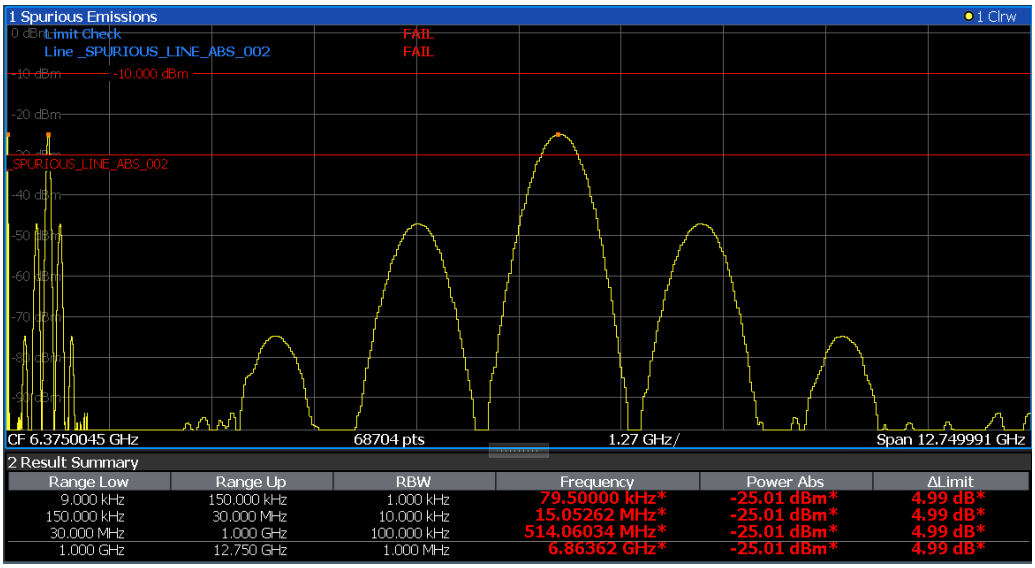
A remote command example for defining parameters and ranges in "Spurious Emissions" measurements is described in "Programming example: spurious emissions measurement" on page 1371.

Limit lines in spurious measurements

Using limit lines, you can check the measured data (that is, the trace results) against specified limit values. Generally, you can define limit lines for any measurement in the "Spectrum" application using the "Limit Lines" function. For "Spurious Emissions" measurements, however, the FSWX provides a special limit line via the "Sweep List". We strongly recommend that you use only this limit line definition.

In the "Sweep List", you can define a limit line that varies its level for the specified frequency ranges. The FSWX automatically defines a special limit line according to the current "Sweep List" settings. When you change the settings, the limit line changes, as well. This limit line is labeled "_SPURIOUS_LINE_ABS<xxx>", where <xxx> is an index to distinguish limit lines between different application instances.

If you enable the limit check, the "_SPURIOUS_LINE_ABS<xxx>" limit line is indicated by a red line in the display. The result of the limit check is indicated at the top of the diagram. The result of the limit check ("Pass" or "Fail") is indicated at the top of the diagram. Note that a "Margin" function as for general limit lines is not available. The "Spurious Emissions" measurement only checks absolute limits, not relative values.



The "Spurious Emissions" diagram shows both the results of each limit line check ("_SPURIOUS_LINE_ABS<xxx>"), and the combined result for all defined limit lines ("Limit Check").

The limit check is indicated as "Failed" if the measurement detects any signal level outside the absolute limits.

If the limit check is enabled, the "Result Summary" indicates the limit line values for each range. Furthermore, for each range, it displays the largest deviations of the absolute power from the limit line. Values that exceed the limit are indicated in red and by an asterisk (*).

Although the limit check does not provide a margin functionality, you can define a margin (threshold) for the peak values that are displayed in the "Result Summary". Furthermore, you can define how many peaks per range the summary includes. For details, see "Result summary configuration" on page 1080.

5.3.4.4 Spurious emissions measurement configuration

Access: "Overview" > "Select Measurement" > "Spurious Emissions"

The spurious emissions measurement is started immediately with the default settings.

The remote commands required to perform these tasks are described in Section 5.5.1.8, "Measuring spurious emissions", on page 1359.

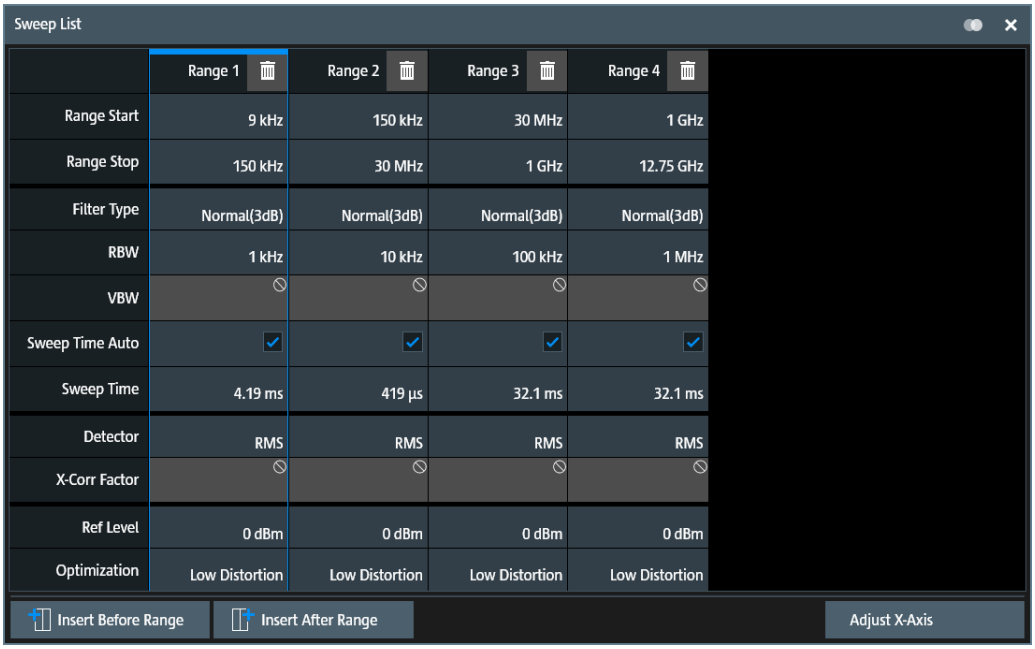
- Sweep list....1075
- Adjusting the x-axis to the range definitions....1080
- Result summary configuration....1080

Sweep list

Access: "Overview" > "Select Measurement" > "Spurious Emissions" > "Sweep List"

For "Spurious Emissions" measurements, the FSWX splits the input signal into several frequency ranges and sweeps them individually. Each range has different limitations. You configure the individual frequency ranges and limits in the sweep list.

When you edit the "Sweep List", always follow the rules and consider the limitations described in "Conditions for ranges" on page 1073.



Range Start/ Range Stop 1076
Filter Type 1077
RBW 1077
VBW 1077
Sweep Time Mode 1077
Sweep Time 1077
Detector 1077
X-Corr Factor 1078
Ref level 1078
RF Att Mode 1078
RF Attenuation 1078
SPA: RF Attenuation Mode / SPA: RF Attenuation 1078
Preamp 1079
Sweep Points 1079
Stop After Sweep 1079
Transducer 1079
Limit Check 1080
Abs Limit Start / Abs Limit Stop 1080
Insert before Range/ Insert after Range 1080
Delete Range 1080

Range Start/ Range Stop
Sets the start frequency/stop frequency of the selected range.

You can define a span that is smaller than the overall span of the ranges. You can set a span that is smaller than the overall span of the sweep list ranges. In this case, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz.

Remote command:
[SENSe:]LIST:RANGe<ri>[:FREQuency]:STARt on page 1362
[SENSe:]LIST:RANGe<ri>[:FREQuency]:STOP on page 1363

Filter Type
Sets the filter type for this range.

For details on filter types, see Section 4.3.3.6, "Which data can pass: filter types", on page 245.

Remote command:
[SENSe:]LIST:RANGe<ri>:FILTer:TYPE on page 1363

RBW
Sets the resolution bandwidth for this range.

For details on the RBW, see Section 4.3.3.1, "Separating signals by selecting an appropriate resolution bandwidth", on page 241.

Remote command:
[SENSe:]LIST:RANGe<ri>:BANDwidth:RESolution on page 1360

VBW
Sets the video bandwidth for this range.

For details on the VBW, see Section 4.3.3.2, "Smoothing the trace using the video bandwidth", on page 242.

Remote command:
[SENSe:]LIST:RANGe<ri>:BANDwidth:VIDeo on page 1360

Sweep Time Mode
Enables or disables the auto mode for the sweep time.

For details on the sweep time mode, see Section 4.3.3.7, "How long the data is measured: sweep time", on page 246.

Remote command:
[SENSe:]LIST:RANGe<ri>:SWEep:TIME:AUTO on page 1368

Sweep Time
Sets the sweep time value for the range.

For details on the sweep time, see Section 4.3.3.7, "How long the data is measured: sweep time", on page 246.

Remote command:
[SENSe:]LIST:RANGe<ri>:SWEep:TIME on page 1367

Detector
Sets the detector for the range.

For details, refer to "Mapping samples to sweep points with the trace detector" on page 278.

Note: If you select the "RMS X-Corr" detector for a range, it is automatically used for all ranges in the sweep list.

Remote command:
[SENSe:]LIST:RANGe<ri>:DETector on page 1361

X-Corr Factor
Indicates the number of sweep samples that are cross-correlated to determine a single sweep point if the "RMS X-Corr" detector is used.

See also Section 4.1.5.2, "RMS X-Corr detector", on page 161.

Remote command:
[SENSe<ip>:]ESPectrum<sb>:RANGe<ri>:SWEep:XFACtor on page 1339

Ref level
Sets the reference level for the range.

For details on the reference level, see Section 4.3.2.1, "Expected input levels: Reference level", on page 238.

Remote command:
[SENSe:]LIST:RANGe<ri>:SWEep:TIME on page 1367

RF Att Mode
Enables or disables the auto mode for RF attenuation.

For details on attenuation, see Section 4.3.2.2, "Sensitivity of the hardware: RF attenuation", on page 239.

Note: If an external frontend is active, the required attenuation is applied to the input of the external frontend, not the FSWX. However, you can configure additional attenuation for the analyzer (see SPA: RF Attenuation Mode / SPA: RF Attenuation). When using an external frontend, only mechanical attenuation is available.
For more information, see "External frontend attenuation vs. analyzer attenuation" on page 209.

Remote command:
[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation:AUTO on page 1364

RF Attenuation
Sets the attenuation value for the range.

For details on attenuation, see Section 4.3.2.2, "Sensitivity of the hardware: RF attenuation", on page 239.

Remote command:
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:ATTenuation on page 1328

SPA: RF Attenuation Mode / SPA: RF Attenuation
If an external frontend is active, you can configure attenuation settings for the external frontend and the analyzer separately. This setting defines the attenuation for the analyzer.

For more information, see "External frontend attenuation vs. analyzer attenuation" on page 209.

When using an external frontend, only mechanical attenuation is available.

You can set the RF attenuation automatically as a function of the selected reference level ("Auto" mode). Automatic attenuation ensures that no overload occurs at the RF Input connector for the current reference level. It is the default setting.

In "Manual" mode, you can set the RF attenuation in 1-dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is defined in the specifications document. If the FSWX cannot set the defined reference level for the defined RF attenuation, it adjusts the reference level accordingly and displays the warning "Limit reached".

When you decrease the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input. An overload can lead to hardware damage.

Remote command:
`[SENSe:]LIST:RANGe<ri>:INPut:SANalyzer:ATTenuation` on page 1365
`[SENSe:]LIST:RANGe<ri>:INPut:SANalyzer:ATTenuation:AUTO` on page 1365

Preamp
Switches the preamplifier on or off.

For details on the preamplifier, see "Preamplifier" on page 183.

Remote command:
`[SENSe:]LIST:RANGe<ri>:INPut:GAIN:STATe` on page 1364

Sweep Points
Sets the number of sweep points for the specified range.

For details on sweep points, see Section 4.3.3.8, "How much data is measured: sweep points and sweep count", on page 246.

Remote command:
`[SENSe:]LIST:RANGe<ri>:POINts[:VALue]` on page 1367

Stop After Sweep
Configures the sweep behavior.

"On" The FSWX stops after one range is swept and continues only if you confirm in a message box.

"Off" The FSWX sweeps all ranges in one go.

Remote command:
`[SENSe:]LIST:RANGe<ri>:BREak` on page 1360

Transducer
Sets a transducer for the specified range. You can only choose a transducer that fulfills the following conditions:

- The transducer overlaps or equals the span of the range.
- The x-axis is linear.
- The unit is dB.

For details on transducers, see Section 4.1.6.1, "Fixed transducer factors for discrete trace points", on page 163.

Remote command:
[SENSe:]LIST:RANGe<ri>:TRANsducer on page 1368

Limit Check
Enables or disables the limit check for all ranges.

For details on limit checks, see "Limit lines in spurious measurements" on page 1074.

"Absolute" Signal is checked against absolute limit values.

"None" No limit check is performed.

Remote command:
[SENSe:]LIST:RANGe<ri>:LIMit:STATe on page 1366
CALCulate<n>:LIMit<li>:FAIL? on page 775

Abs Limit Start / Abs Limit Stop
Sets an absolute limit value in dBm at the start or stop frequency of the range.

Remote command:
[SENSe:]LIST:RANGe<ri>:LIMit:STARt on page 1366
[SENSe:]LIST:RANGe<ri>:LIMit:STOP on page 1366

Insert before Range/ Insert after Range
Inserts a new range to the left (before) or to the right (after) of the range in which the cursor is currently displayed. The range numbers of the currently focused range and all higher ranges are increased accordingly. The maximum number of ranges is 30.

Delete Range
Deletes the currently focused range. The range numbers are updated accordingly.

Remote command:
[SENSe:]LIST:RANGe<ri>:DELete on page 1361

Adjusting the x-axis to the range definitions

Access: "Overview" > "Select Measurement" > "Spurious Emissions" > "Adjust X-Axis"

The FSWX can adjust the frequency axis of the measurement diagram automatically so that the displayed span corresponds to the total span of all sweep list ranges. Thus, the x-axis range starts with the start frequency of the first sweep range and ends with the stop frequency of the last sweep range.

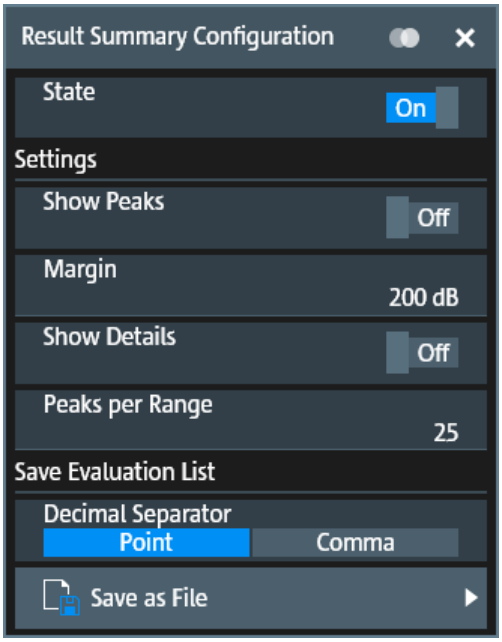
Remote command:

[SENSe:]LIST:XADJust on page 1371

Result summary configuration

Access: "Overview" > "Select Measurement" > "Spurious Emissions" > "Result Summary Configuration"

In the "Result Summary Configuration" dialog box, you configure the contents and display of the "Spurious Emissions" results.



Result Summary State 1081
Show Peaks 1081
Margin 1081
Show Details 1081
Peaks per Range 1082
Save Evaluation List 1082

Result Summary State
Enables or disables the "Result Summary".

Remote command:
`CALCulate<n>:PEAKsearch:AUTO` on page 1369

Show Peaks
If enabled, all peaks that are detected during an active "Spurious Emissions" measurement are marked with colored squares in the "Spurious Emissions" diagram.

Remote command:
`CALCulate<n>:PEAKsearch:PSHow` on page 1370

Margin
The limit check does not support a margin functionality. However, you can define a margin (or: *threshold*) for the peak values that are displayed in the "Result Summary" and the "Spurious Emissions" diagram. Only peaks that exceed the margin value are displayed.

Remote command:
`CALCulate<n>:PEAKsearch:MARGin` on page 1370

Show Details
Configures how detailed the "Result Summary" is.

"On" Includes all detected peaks (up to a maximum defined by "Peaks per Range" on page 1082)

"Off" Includes only one peak per range

Remote command:
CALCulate<n>:ESPectrum:PEAKsearch:DETails on page 1369

Peaks per Range
Defines the maximum number of peaks per range that are stored in the list. Once the FSWX has detected the selected number of peaks, it stops the peak search in the current range and continues in the next range. The maximum value is 50.

Remote command:
CALCulate<n>:PEAKsearch:SUBRanges on page 1370

Save Evaluation List
Exports the "Result Summary" of the "Spurious Emissions" measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

Define the filename and storage location in the file selection dialog box that is displayed when you select the "Save as File" function.

For details, see "How to save the Result Summary" on page 1083.

Remote command:
MMEMory:STORe<n>:LIST on page 803
FORMat:DEXPort:DSEParator on page 779

5.3.4.5 How to measure spurious emissions

The following step-by-step instructions demonstrate how to measure spurious emissions.



For remote operation, see "Programming example: spurious emissions measurement" on page 1371.

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. Select [MEAS] > "Spurious Emissions".
2. In the general span settings ([Freq]), define the span of the signal to monitor.
3. Select "Overview" > "Spurious Setup".

   The "Spurious Emissions" dialog box is displayed.
4. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.
   In the "Sweep List", define the required ranges using the "Insert before Range" and "Insert after Range" functions. The functions refer to the currently selected range.
5. Define the measurement parameters for each range as required.

6. Optionally, define a limit check.
   a) Set "Limit Check" to "Absolute" to enable the limit check.
   You always enable or disable the limit check for all ranges simultaneously.
   b) Define the limit line start and stop values for each range of the signal. If the FSWX measures a signal level that is higher than the defined limit, the limit check fails.
   An exceeded limit can indicate a spurious emission.
7. Configure the peak detection during a "Spurious Emissions" measurement.
   a) Select "Result Summary Configuration".
   b)
   - To indicate the determined peaks in the display, enable the "Show Peaks" option.
   - To restrict peak detection, define a "Margin". The measurement only detects peaks that exceed this value.
   - To detect more peaks per range than the default 1, increase the "Peaks per Range" value and set "Details" to "On".
8. Start a sweep.

   The "Result Summary" indicates the measured powers and detected limit deviations for each range. If enabled, it also indicates the peak power levels for each range.
9. To save the "Result Summary", export the results to a file as described in "How to save the Result Summary" on page 1083.

How to save the Result Summary

You can save the "Result Summary" from an "Spurious Emissions" measurement to a file. You can then export the file to another application for further analysis, for example.

For details on the file format of the "Spurious Emissions" export file, see Section 5.3.4.6, "Reference: ASCII export file format (spurious)", on page 1084.

1. Configure and perform a "Spurious Emissions" measurement as described in Section 5.3.4.5, "How to measure spurious emissions", on page 1082.
2. Select "Result Summary Configuration".
3. If necessary, change the "Decimal Separator" to "Comma" for evaluation in other languages.
4. Select "Save".
5. In the file selection dialog box, select a storage location and filename for the result file.
6. Select "Save".

   The FSWX stores the file with the specified name and the extension `.dat` in the defined storage location.

5.3.4.6 Reference: ASCII export file format (spurious)

You can save the "Result Summary" from a "Spurious Emissions" measurement to an ASCII file. You can then export the file to another application for further analysis, for example.

The file consists of:

- A header containing important parameters for scaling
- Several data sections containing the sweep settings per range
- A data section containing the peak list

The header data is made up of three columns, separated by ';', with the syntax:

Parameter name; numeric value; basic unit

Table 5-15: Description of the Spurious Emissions measurement result file

File contents	Explanation
File header	
Type;FSWX	Model
Version;1.00;	Firmware version
Date;31.Mar 11;	Storage date of data set
Mode;ANALYZER; SPURIOUS;	Application and measurement function
Center Freq;13250000000.000000;Hz	X-axis settings
Freq Offset;0.000000;Hz	
Span;26499982000.000000;Hz	
x-Axis;LIN;	
Start;9000.000000;Hz Stop;8000000000.000000;Hz	
Level Offset;0.000000;dB	Y-axis settings
Ref Position;100.000000;%	
y-Axis;LOG;	
Level Range;100.000000;dB	
Trace settings	
Trace Mode;CLR/WRITE;	
Sweep Count;1;	
TRACE 1:	
Trace Mode;CLR/WRITE;	
x-Unit;Hz;	
y-Unit;dBm;	
Result summary settings	

File contents	Explanation
Margin;6.000000;s	Peak List margin
PeaksPerRange;25;	Max. number of peaks per range to be detected
Values;3;	Number of detected peaks
File data section	
0;9000;150000;1000;79500;-25.006643295288086;-12.006643295288086;PASS; 0;9000;150000;1000;101022.11126961483;-47.075111389160156;-34.075111389160156;PASS; 0;9000;150000;1000;58380.171184022824;-47.079341888427734;-34.079341888427734;PASS;	Measured peak values: <range number>; <start frequency>; <stop frequency>; <resolution bandwidth of range>; <frequency of peak>; <absolute power in dBm of peak>; <distance to the limit line in dB>; (positive value means above the limit) <limit fail (pass = 0, fail =1)>;

5.3.5 Channel power and adjacent-channel power (ACLR) measurement

Measuring the power in channels adjacent to the carrier or transmission channel is useful to detect interference. The results of this standard measurement on the FSWX are displayed as a bar chart for the individual channels.

- About channel power measurements....1085
- Channel power results....1086
- Channel power basics....1088
- Channel power configuration....1098
- MSR ACLR configuration....1110
- How to perform channel power measurements....1122
- Measurement examples....1126
- Optimizing and troubleshooting the measurement....1128
- Reference: predefined CP/ACLR standards....1129
- Reference: predefined ACLR user standard XML files....1130

5.3.5.1 About channel power measurements

In the field of digital transmission, specified test routines require measuring channel power and adjacent channel power. In theory, you can use a power meter to measure channel power at highest accuracy. However, a power meter has low selectivity. Thus, it is not suitable for measuring adjacent channel power as an absolute value or relative to the transmit (TX) channel power. Only a selective power meter can measure the power in the adjacent channels.

A signal analyzer cannot be classified as a true power meter, because it displays the IF envelope voltage. However, it is calibrated such as to display the power of a pure sine-wave signal correctly, irrespective of the selected detector. This calibration cannot be applied for non-sinusoidal signals. Assuming that the digitally modulated signal has

a Gaussian amplitude distribution, you can obtain the signal power within the selected resolution bandwidth using correction factors. The internal power measurement routines in a signal analyzer normally use these correction factors to determine the signal power from IF envelope measurements. These factors only apply if the assumption of a Gaussian amplitude distribution is correct.

Apart from this common method, the FSWX also has a true power detector, i.e. an RMS detector. The RMS detector displays the power of the test signal within the selected resolution bandwidth correctly. The values are correct irrespective of the amplitude distribution, without additional correction factors being required.

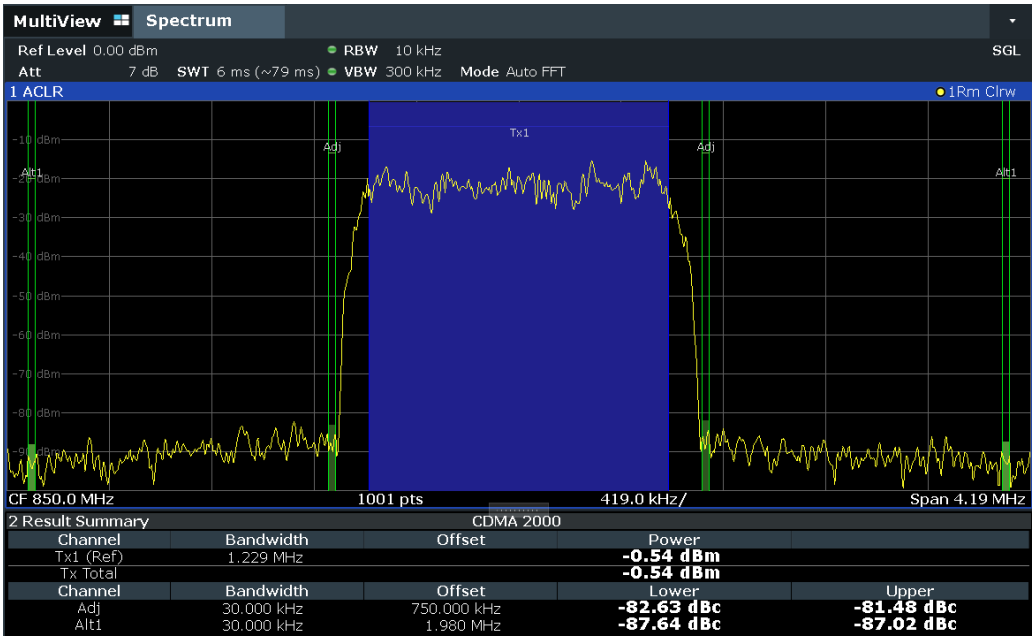
The FSWX allows you to perform ACLR measurements on input containing multiple signals for different communication standards. You can define multiple discontiguous transmit channels at specified frequencies, independent from the selected center frequency. The ACLR measurement determines the power levels of the individual transmit, adjacent, and gap channels, and the total power for each subblock of transmit channels.

5.3.5.2 Channel power results

For channel or adjacent-channel power measurements, the individual channels are indicated by different colored bars in the diagram. The height of each bar corresponds to the measured power of that channel. In addition, the name of the channel ("Adj", "Alt1", "Alt2", etc., or a user-defined name) is indicated above the bar (separated by a line which has no further meaning).

Multi-standard radio (MSR) channel power results

The channel power results for MSR signals are described in "Multi-standard radio (MSR) signals" on page 1093.



Results are provided for the transmit (TX) channel and the number of defined adjacent channels *above and below* the TX channel. If you define more than one TX channel, you must specify the channel to which the relative adjacent-channel power values refer. By default, it is the TX channel with the maximum power.

Table 5-16: Measurement results depending on the number of adjacent channels

Number of adj. chan.	Measurement results
0	TX channel power
1	• TX channel power • Power of the upper and lower adjacent (ADJ) channel
2	• TX channel power • Power of the upper and lower adjacent (ADJ) channel • Power of the next higher and lower channel (alternate channel 1)
3	• TX channel power • Power of the upper and lower adjacent (ADJ) channel • Power of the next higher and lower channel (alternate channel (ALT) 1) • Power of the second next higher and lower adjacent channel (alternate channel (ALT) 2)
…	…
12	• TX channel power • Power of the upper and lower adjacent (ADJ) channel • Power of all the higher and lower channels (alternate channels (ALT) 1 to 11)

In the FSWX display, only the first neighboring channel of the transmit (TX) channel is labeled "Adj" (adjacent) channel; all others are labeled "Alt" (alternate) channels. In this manual, "adjacent" refers to both adjacent and alternate channels.

The measured power values for the TX and adjacent channels are also output as a table in the "Result Summary" window. Which powers are measured depends on the number of configured channels.

For each channel, the following values are displayed:

Label	Description
"Channel"	Channel name as specified in the "Channel Settings" (see "Names" on page 1109).
"Bandwidth"	Configured channel bandwidth (see "Bandwidths" on page 1104)
"Offset"	Offset of the channel to the TX channel (configured channel spacing, see "Spacing" on page 1105)
"Power" ("Lower"/"Upper")	The measured power values for the TX and lower and upper adjacent channels. The powers of the transmission channels are output in dBm or dBm/Hz, or in dBc, relative to the specified reference TX channel.

Retrieving results via remote control

To retrieve all or specific channel power measurement results:

`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult` on page 1231).

Optionally, the results can be output as channel power density, i.e. in reference to the measurement bandwidth.

To retrieve the measured power value for each sweep point (by default 1001) of the displayed trace:

`TRACe<n>[:DATA]` on page 688

See also "Retrieving and analyzing measurement results" on page 1289.

5.3.5.3 Channel power basics

Some background knowledge on basic terms and principles used in channel power measurements is provided here for a better understanding of the required configuration settings.

- Measurement method 1088
- Measurement repeatability 1089
- Recommended common measurement parameters 1089
- Multi-standard radio (MSR) signals 1093

Measurement method

The channel power is defined as the integration of the power across the channel bandwidth.

The adjacent channel leakage power ratio (ACLR) is also known as the adjacent channel power ratio (ACPR). It is defined as the ratio between the total power of the adjacent channel to the power of the carrier channel. The carrier channel is also referred to as transmission or TX channel. An ACLR measurement with several carrier channels is also possible and is referred to as a *multicarrier ACLR measurement*.

IBW method

When measuring the channel power, the linear power is integrated. The linear power corresponds to the levels of the measurement points within the selected channel. The signal analyzer uses a resolution bandwidth which is far smaller than the channel bandwidth. When sweeping over the channel, the channel filter is formed by the pass-band characteristics of the resolution bandwidth.

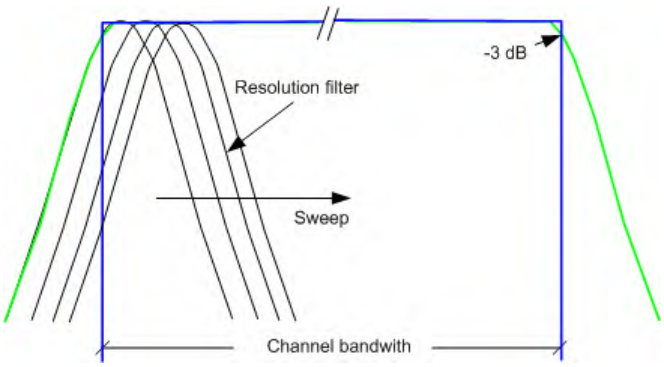


Figure 5-35: Approximating the channel filter by sweeping with a small resolution bandwidth

The following steps are performed:

1. The linear power of all the trace points within the channel is calculated.
   $P_i = 10^{(Li/10)}$
   Where P_i = power of the trace pixel i
   L_i = displayed level of trace point i
2. The powers of all trace points within the channel are summed up. The sum is divided by the number of trace points in the channel.
3. The result is multiplied by the quotient of the selected channel bandwidth and the noise bandwidth of the resolution filter (RBW).

Since the power is calculated by integrating the trace within the channel bandwidth, this method is called the integration bandwidth method (IBW) method.

Measurement repeatability

The repeatability of the results, especially in the narrow adjacent channels, strongly depends on the measurement time for a given resolution bandwidth. A longer sweep time can increase the probability that the measured value converges to the true value of the adjacent channel power. However, a longer sweep time also increases measurement time.

Assume a measurement with five channels (1 channel plus 2 lower and 2 upper adjacent channels) and a sweep time of 100 ms. This measurement requires a measurement time per channel of 20 ms. To calculate the power in one channel, the analyzer considers the following number of effective samples:

<sweep time in channel> * <selected resolution bandwidth>

For example, for a sweep time of 100 ms, the analyzer considers the following number of samples:

(30 kHz / 4.19 MHz) * 100 ms * 10 kHz ≈ 7

Recommended common measurement parameters

The following sections provide recommendations on the most important measurement parameters for channel power measurements.

All instrument settings for the selected channel setup (channel bandwidth, channel spacing) can be optimized automatically using the "Adjust Settings" function (see "Optimize Instrument Settings" on page 1103).

The easiest way to configure a measurement is using the configuration "Overview", see "Sweep Time" on page 1104.

- Sweep Time 1090
- Frequency span 1090
- Resolution bandwidth (RBW) 1091
- Video bandwidth (VBW) 1092

- Detector....1092
- Trace averaging....1092
- Reference level....1093

Sweep Time

Select the sweep time according to the desired repeatability of results. Repeatability increases with sweep time, since the power is then measured over a longer time period. As a general approach, approximately 500 non-correlated measured values are required for a repeatability of 0.5 dB. That means: 95 % of the measurements are within 0.5 dB of the true measured value. Approximately 5000 measured values are required for a repeatability of 0.1 dB (99 %). These values are valid for white noise. The measured values are considered to be non-correlated if their time interval corresponds to the reciprocal of the measured bandwidth.

The number N of A/D converter values used to calculate the power is defined by the sweep time. The time per trace pixel for power measurements is directly proportional to the selected sweep time.

If you use the sample detector, it is best to select the smallest possible sweep time for a given span and resolution bandwidth. The minimum time is obtained if the setting is coupled, that is: the time per measurement is minimal. Extending the measurement time does not have any advantages. The number of samples to calculate the power is defined by the number of trace points in the channel.

If you use the RMS detector, the selected sweep time can affect the repeatability of the measurement results. Repeatability is increased at longer sweep times.

If you use the RMS detector, the number of samples can be estimated as follows:

Since only uncorrelated samples contribute to the RMS value, the number of samples can be calculated from the sweep time and the resolution bandwidth.

Samples can be assumed to be uncorrelated if sampling is performed at intervals of 1/RBW. The number of uncorrelated samples (N_{uncorr}) is calculated as follows:

= SWT * RBW

The number of uncorrelated samples per trace pixel is obtained by dividing N_{uncorr} by 1001 (= pixels per trace).

Define the "Sweep Time" in the "Channel Power" menu or in the Sweep configuration dialog box (see Section 4.1.3, "Configuration overview", on page 114).

Frequency span

The frequency span must cover at least the channels to be measured, plus a measurement margin of approximately 10 %.

If the frequency span is large in comparison to the analyzed channel bandwidth (or the adjacent channel bandwidths), only a few points on the trace are within each channel. The calculated waveform for the used channel filter is less accurate, which has a negative effect on the measurement accuracy. We therefore recommend that you consider the equations described below for Automatic adjustment when you select the frequency span.

The frequency span for the defined channel settings can be optimized. Use the "Adjust Settings" function in the "Channel Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimize Instrument Settings" on page 1103). You can set the frequency span manually in the "Frequency" configuration dialog box.

(See Section 5.2.2.3, "How to define the frequency range", on page 963.)

Automatic adjustment

For channel power measurements, the "Adjust Settings" function sets the frequency span as follows:

"(No. of transmission channels – 1) * transmission channel spacing + 2* transmission channel bandwidth + measurement margin"

For adjacent-channel power measurements, the "Adjust Settings" function sets the frequency span as a function of the following parameters:

- Number of transmission channels
- Transmission channel spacing
- Adjacent-channel spacing
- Bandwidth of one of adjacent-channels "ADJ", "ALT1" or "ALT2", whichever is furthest away from the transmission channels

"(No. of transmission channels – 1) * (transmission channel spacing + 2) * (adjacent-channel spacing + adjacent-channel bandwidth) + measurement margin"

The measurement margin is approximately 10 % of the value obtained by adding the channel spacing and the channel bandwidth.

Resolution bandwidth (RBW)

It is important to suppress spectral components outside the channel to be measured, especially of the adjacent channels. At the same time, you expect an acceptable measurement speed. To fulfill both these requirements, the appropriate resolution bandwidth is essential. As a general approach, set the resolution bandwidth to values between 1 % and 4 % of the channel bandwidth.

If the spectrum within the channel to be measured and the spectrum around the channel have a flat characteristic, you can select a larger resolution bandwidth. In the standard setting, e.g. for IS95A REV standard at an adjacent channel bandwidth of 30 kHz, a resolution bandwidth of 30 kHz is used. This RBW yields correct results, since the spectrum near the adjacent channels usually has a constant level.

You can optimize the resolution bandwidth for the defined channel settings. Use the "Adjust Settings" function in the "Channel Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimize Instrument Settings" on page 1103). You can set the RBW manually in the "Bandwidth Configuration" dialog box, see "RBW Mode/RBW Manual" on page 971.

Except for the IS95 CDMA standards, the "Adjust Settings" function sets the resolution bandwidth (RBW) as a function of the channel bandwidth:

RBW ≤ 1/40 * <Channel bandwidth>

The maximum resolution bandwidth (concerning the requirement RBW ≤ 1/40) resulting from the available RBW steps (1, 3) is selected.

Video bandwidth (VBW)

For a correct power measurement, the video signal must not be limited in bandwidth. If the logarithmic video signal is limited in bandwidth, the signal is averaged. As a result, the power indication is too low (-2.51 dB at small video bandwidths). Thus, select the video bandwidth at least three times the resolution bandwidth:

VBW ≥3 * RBW

For FFT sweeps, instead of increasing the VBW, you can also select the trace average mode "Power" to ensure correct power measurements (see "Analyzing several traces - trace mode" on page 285). Note that in power measurements, this setting affects the VBW, regardless of whether a trace is actually averaged.

The video bandwidth for the defined channel settings can be optimized. Use the "Adjust Settings" function in the "Channel Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimize Instrument Settings" on page 1103). You can set the VBW manually in the "Bandwidth Configuration" dialog box, see "VBW Mode / VBW Manual" on page 971.

The video bandwidth (VBW) is set as a function of the channel bandwidth (see equation above). The smallest possible VBW with regard to the available step size is selected.

Detector

The RMS detector correctly indicates the power irrespective of the characteristics of the signal to be measured. For details, see "RMS detector" on page 281.

In principle, the "Sample" detector is also possible. However, due to the limited number of measurement points used to calculate the power in the channel, the "Sample" detector yields less stable results.

You can set the RMS detector for the defined channel settings automatically. Use the "Adjust Settings" function in the "Channel Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "Optimize Instrument Settings" on page 1103).

You can set the detector manually in the "Trace Configuration" dialog box, see "Detector" on page 1217.

Trace averaging

Avoid averaging. Averaging is often performed to stabilize the measurement results, but leads to a level indication that is too low. The reduction in the displayed power depends on the number of averages and the signal characteristics in the channel to be measured.

The "Adjust Settings" function switches off trace averaging. You can disable the trace averaging manually in the "Trace Configuration" dialog box, see "Average Mode" on page 1220.

Reference level

To achieve an optimum dynamic range, set the reference level so that the signal is as close to the reference level as possible without forcing an overload message. However, if the signal-to-noise ratio becomes too small, the dynamic range is also limited. The measurement bandwidth for channel power measurements is significantly smaller than the signal bandwidth. Thus, the signal path can be overloaded although the trace is still significantly below the reference level.

Selecting a predefined standard or automatically adjusting settings does not affect the reference level. You can set the reference level automatically using the "Perform Auto Level" function in the Auto Set menu, or manually in the Ampt / Scale menu.

Multi-standard radio (MSR) signals

Modern base stations can transmit multiple signals for different communication standards. Using a special measurement standard, you can measure such MSR signals, including non-contiguous setups. You can specify multiple (also non-) contiguous transmit channels at absolute frequencies, independent from the common center frequency selected for display.

Signal structure

You can group up to 18 transmit channels in a maximum of 8*subblocks*. Between two subblocks, two gaps are defined: a *lower gap* and an *upper gap*. Each gap in turn contains two channels (*gap channels*). The channels in the upper gap are identical to the channels in the lower gap, but inverted. To either side of the outermost transmit channels, you can define lower and upper adjacent channels, as in common ACLR measurement setups.

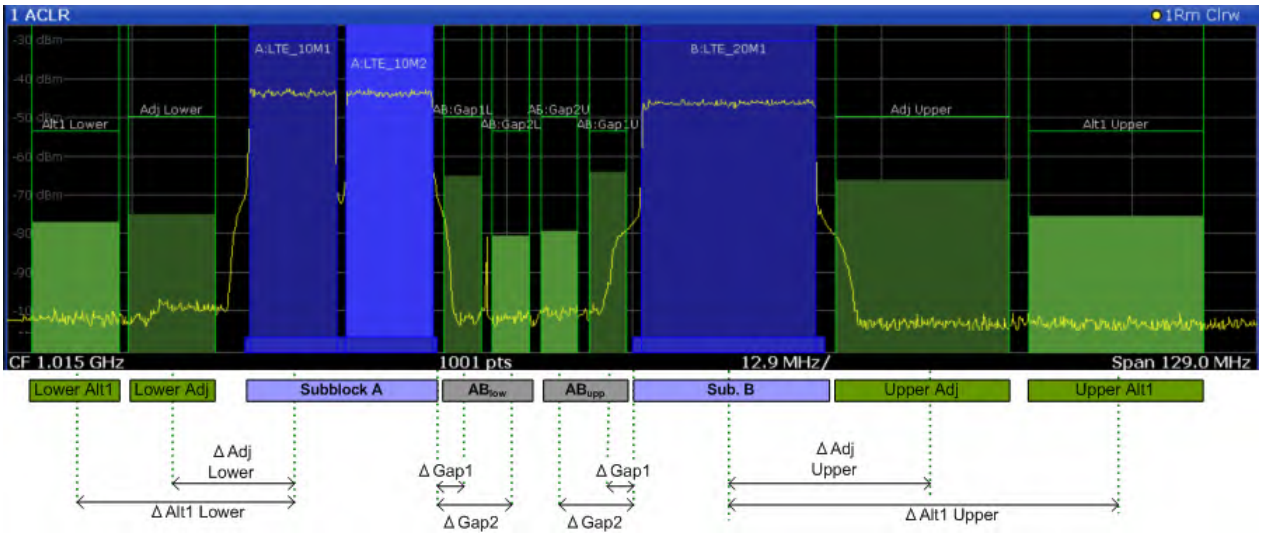


Figure 5-36: MSR signal structure

Asymmetrical gap channels

Gap channels between subblocks can also be asymmetrical, that is: channels in the lower and upper gaps are not identical. For example, in Figure 5-37, the gap between subblocks A and B contains one lower channel (AB:Gap1L), but two upper channels (AB:Gap1U, AB:Gap2U). Furthermore, the gaps between different subblocks need not be identical. For example, the gap between subblocks A and B contains 3 gap channels, while the gap between subblocks B and C contains only two gap channels (BC:Gap1L, BC:Gap2L, which are not identical to the lower gap channels in gap AB.

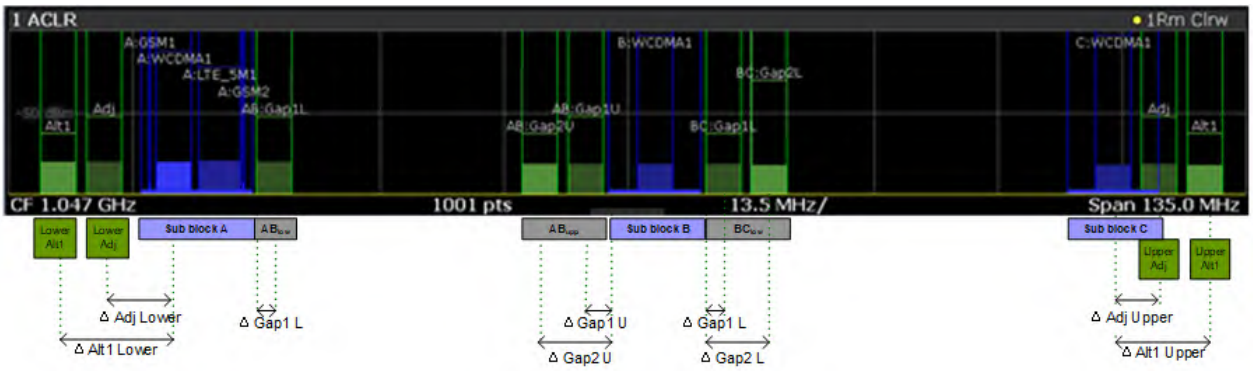


Figure 5-37: Asymmetrical MSR signal structure

Subblock and channel definition

The subblocks are defined by a specified center frequency, RF bandwidth, and number of transmit channels.

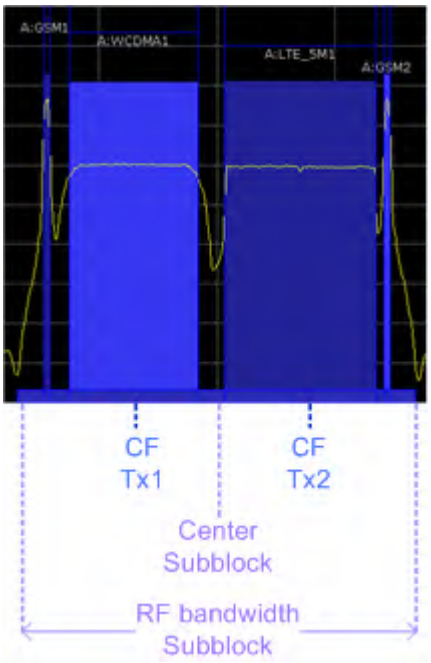


Figure 5-38: Subblock definition

In common ACLR channel definitions, the TX channels are defined by a spacing relative to the (common) center frequency. In MSR signals, the TX channels are defined at absolute frequencies. You can assign a different technology to each transmit channel, to predefine the required bandwidth.

Gap channels and CACLR

If two or more subblocks are defined, the power in the gaps between the subblocks must also be measured. Gap channels are defined using bandwidths and spacings, relative to the outer edges of the surrounding subblocks.

If the upper and lower gap channels are symmetrical, you only have to configure two gap channels. The required spacing can be determined according to the following equation (indicated for lower channels):

Spacing = [CF of gap channel] - [left subblock CF] + ([RF bandwidth of left subblock] /2)

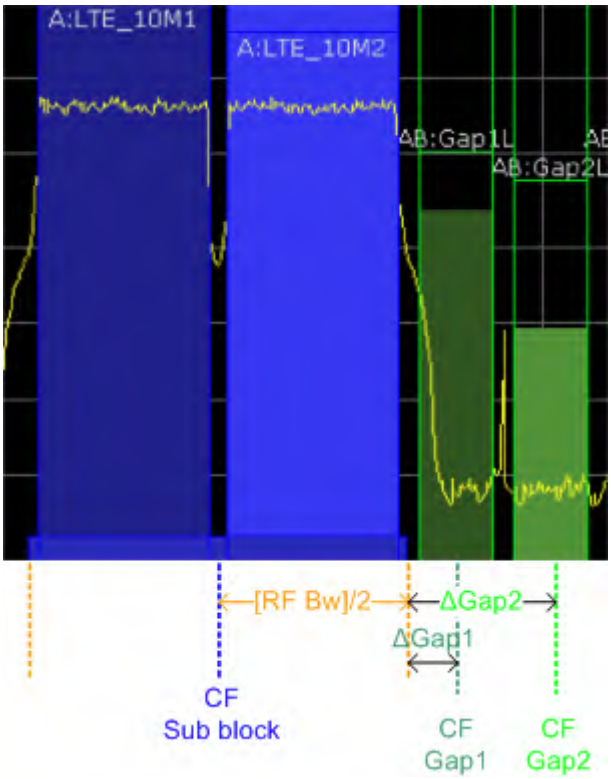


Figure 5-39: Gap channel definition for lower gap

If the gap channels are not symmetrical, you must configure up to four channels individually. The equation indicated above applies for the lower channels. For the upper channels, the spacing is defined as:

Spacing = [right subblock CF]- [CF of gap channel] - ([RF bandwidth of right subblock] /2)

According to the MSR standard, the *cumulative adjacent channel leakage ratio (CACLR) power* must be determined for the gap channels. The CACLR power is

measured in the two gap channels for the upper and lower gap. The power in the gap channels is then set in relation to the power of the two closest transmission channels to either side of the gap. The CACLR power for the gap channels is indicated in the "Result Summary".

In addition, the "Result Summary" indicates the ACLR power for the individual gap channels. The ACLR power of the lower gap channels refers to the TX channel to the left of the gap. The ACLR power of the upper gap channels refers to the TX channel to the right of the gap. You can define a separate relative limit value for the ACLR power.

Adjacent channels

Adjacent channels are defined as in common ACLR measurements, using bandwidths and spacings. The spacings are defined relative to the uppermost or lowermost transmit channels in the subblocks (see also Figure 5-36):

- The spacing of the lower adjacent channels refers to the center frequency of the first TX channel in the first subblock.
- The spacing of the upper adjacent channels refers to the center frequency of the last TX channel in the last subblock.



You can also define the upper and lower adjacent channels asymmetrically (see "Asymmetrical gap channels" on page 1094). Asymmetric definition is particularly useful if the lowest TX channel and highest TX channel use different standards. In this case, they require different bandwidths for adjacent channel power measurement.

Channel display for MSR signals

As in common ACLR measurements, the individual channels are indicated by different colored bars in the diagram. The height of each bar corresponds to the measured power of that channel. In addition, the name of the channel is indicated above the bar. Subblocks are named A,B,C,D,E,F,G,H and are also indicated by a slim blue bar along the frequency axis (see Figure 5-36).

TX channel names correspond to the specified technology (for LTE including the bandwidth), followed by a consecutive number. If the channel is too narrow to display the channel name, "..." is displayed instead. The assigned subblock is indicated with the channel name, e.g. "B: LTE_5M1" for the first TX channel in subblock B that uses the LTE 5 MHz bandwidth technology.

Adjacent and alternate channels are displayed as in common ACLR measurements.

Gap channels are indicated using the following syntax:

- The names of the surrounding subblocks (e.g. "AB" for the gap between subblocks A and B)
- The channel name ("Gap 1" or "Gap 2")
- "L" (for lower) or "U" (for upper)

For example: "ABGap1L" indicates the first lower gap channel between subblocks A and B.

Both the lower and upper gap channels are displayed.

For symmetrical configuration, gap channels can be hidden if they do not reach a minimum size.

For asymmetrical configuration, you can define the number of upper or lower gap channels to be displayed.

In both cases, you can disable all gap channels to improve the result display, as fewer lines and bars are displayed. If gap channels are disabled, the power results are not calculated and thus are not shown in the "Result Summary" table.

Channel names are user-definable for all TX, adjacent, and alternate channels (not gap channels).

Channel power results

The "Result Summary" for MSR signal measurements is similar to the table for common signals (see Section 5.3.5.2, "Channel power results", on page 1086). However, the TX channel results are grouped by subblocks, and subblock totals are provided instead of a total TX channel power. For the transmit channels, the absolute center frequencies are indicated instead of the individual channel frequency offsets.

The CACLR and ACLR power results for each gap channel are appended at the end of the table. The CACLR results are calculated as the power in the gap channel divided by the power sum of the two closest transmission channels to either side of it.

2 Result Summary		USER(MSR_ACLR_Example)		
Channel	Bandwidth	Frequency	Power	
A:GSM1	200.000 kHz	994.900 MHz	-92.97 dBm	
A:WCDMA1	3.840 MHz	997.500 MHz	-80.45 dBm	
A:LTE_5M1 (Ref)	4.515 MHz	1.002 GHz	-79.65 dBm	
A:GSM2	200.000 kHz	1.005 GHz	-93.46 dBm	
Sub Block A Total			-76.82 dBm	
Channel	Bandwidth	Frequency	Power	
B:WCDMA1	3.840 MHz	1.050 GHz	-81.98 dBm	
Sub Block B Total			-81.98 dBm	
Channel	Bandwidth	Frequency	Power	
C:WCDMA1	3.840 MHz	1.100 GHz	-82.10 dBm	
Sub Block C Total			-82.10 dBm	
Adj Channels	Bandwidth	Offset	ACLR Lower	ACLR Upper
Adj	3.840 MHz	5.000 MHz	-0.74 dBc	-2.33 dBc
Alt1	3.840 MHz	10.000 MHz	-0.83 dBc	-2.44 dBc
Gap Channels ACLR	Bandwidth	Offset	ACLR Lower	ACLR Upper
AB:Gap1	3.840 MHz	2.500 MHz	13.19 dBc	0.04 dBc
AB:Gap2	3.840 MHz	7.500 MHz	13.29 dBc	0.05 dBc
BC:Gap1	3.840 MHz	2.500 MHz	-0.02 dBc	-0.02 dBc
BC:Gap2	3.840 MHz	7.500 MHz	-0.11 dBc	0.08 dBc
Gap Channels CACLR	Bandwidth	Offset	CACLR Lower	CACLR Upper
AB:Gap1	3.840 MHz	2.500 MHz	1.41 dBc	-0.26 dBc
AB:Gap2	3.840 MHz	7.500 MHz	1.52 dBc	-0.25 dBc
BC:Gap1	3.840 MHz	2.500 MHz	-2.97 dBc	-3.10 dBc
BC:Gap2	3.840 MHz	7.500 MHz	-3.06 dBc	-2.99 dBc

Figure 5-40: Result summary for symmetrical channel definition

2 Result Summary		USER(MSR_ACLR_Example)		
Channel	Bandwidth	Frequency	Power	
A:GSM1	200.000 kHz	994.900 MHz	-92.92 dBm	
A:WCDMA1	3.840 MHz	997.500 MHz	-80.41 dBm	
A:LTE_5M1 (Ref)	4.515 MHz	1.002 GHz	-79.61 dBm	
A:GSM2	200.000 kHz	1.005 GHz	-93.37 dBm	
Sub Block A Total			-76.78 dBm	
Channel	Bandwidth	Frequency	Power	
B:WCDMA1	3.840 MHz	1.050 GHz	-82.01 dBm	
Sub Block B Total			-82.01 dBm	
Channel	Bandwidth	Frequency	Power	
C:WCDMA1	3.840 MHz	1.100 GHz	-82.10 dBm	
Sub Block C Total			-82.10 dBm	
Adj Channels	Bandwidth	Offset	ACLR Lower	ACLR Upper
Adj	3.840 MHz	5.000 MHz	-0.77 dBc	-2.35 dBc
Alt1	3.840 MHz	10.000 MHz	-0.89 dBc	-2.42 dBc
Gap Channels	Bandwidth	Offset	ACLR Power	CACLR Power
AB:Gap1L	3.840 MHz	2.500 MHz	13.08 dBc	1.41 dBc
AB:Gap1U	3.840 MHz	2.500 MHz	0.09 dBc	-0.22 dBc
AB:Gap2U	3.840 MHz	7.500 MHz	0.09 dBc	-0.22 dBc
BC:Gap1L	3.840 MHz	2.500 MHz	0.01 dBc	-2.95 dBc
BC:Gap2L	3.840 MHz	7.500 MHz	-0.03 dBc	-3.00 dBc

Figure 5-41: Result summary for asymmetrical channel definition

Remote command:

`CALCulate:MARKer:FUNCtion:POWer<sb>:RESult? GACLr`
or `CALCulate:MARKer:FUNCtion:POWer<sb>:RESult? MACM`,
see`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult` on page 1231

Restrictions and dependencies

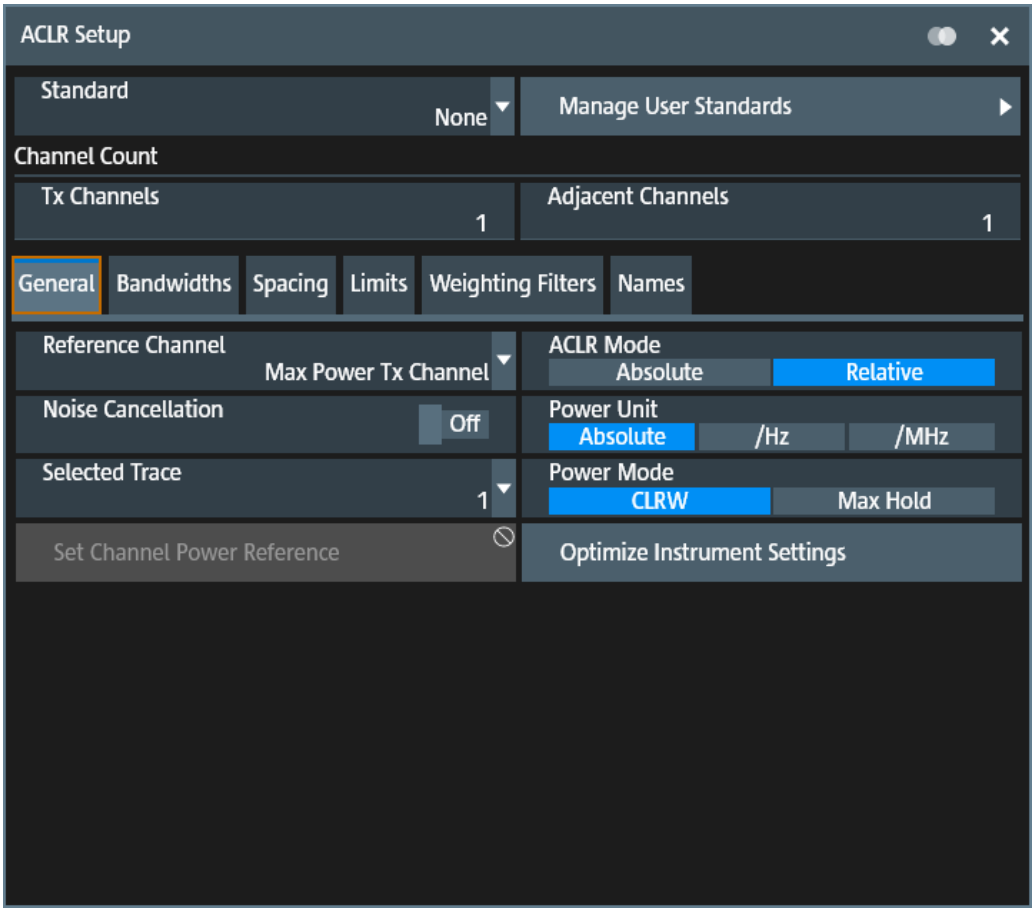
As the signal structure in multi-standard radio signals can vary considerably, you can define the channels flexibly for the ACLR measurement with the FSWX. The FSWX does not check or limit the channel definitions, apart from the maximum number of channels you can define. Thus, you are not notified if transmit channels for a specific subblock lie outside the defined frequency range for the subblock, or if transmit and gap channels overlap.

5.3.5.4 Channel power configuration

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Configuration"

Both Channel Power (CP) and Adjacent-Channel Power (ACLR) measurements are available.

If you select the "Multi-Standard Radio" standard (see "Standard" on page 1100), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box. See "General settings" on page 1099 for a description of these settings.



The remote commands required to perform these tasks are described in Section 5.5.1.3, "Measuring the channel power and ACLR", on page 1236.

- General settings 1099
- Bandwidths 1104
- Spacing 1105
- Limits 1107
- Weighting Filters 1108
- Names 1109

General settings

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Configuration" > "General"

Standard 1100
  └ Predefined standards 1100
  └ Managing user standards 1100
Channel count: TX Channels, Adjacent Channels 1101
Reference Channel 1102
Noise Cancellation 1102
Selected Trace 1102
Set Channel Power Reference 1102
Absolute and relative values (ACLR Mode) 1103

Channel power level and density (Power Unit)..... 1103
Power Mode..... 1103
Optimize Instrument Settings..... 1103
Sweep Time.....1104

Standard
You can store the main measurement settings as a standard file. When the FSWX loads such a standard, it automatically sets the required channel and general measurement settings. However, you can change the settings. The FSWX provides predefined standards for standard measurements, but you can also create standard files with user-defined configurations.

Note: If you select the "Multi-Standard Radio" standard, the FSWX replaces the "ACLR Setup" dialog box by the "MSR ACLR Setup" dialog box (see Section 5.3.5.5, "MSR ACLR configuration", on page 1110).
If you select any other predefined standard (or "NONE"), the FSWX restores the "ACLR Setup" dialog box (see Section 5.3.5.4, "Channel power configuration", on page 1098).

Note that the FSWX does not save changes in the configuration when it exchanges the dialog boxes.

Predefined standards ← Standard
Predefined standards contain the main measurement settings for standard measurements. When the FSWX loads such a standard, it automatically sets the required channel and general measurement settings. However, you can change the settings.

The predefined standards contain the following settings:

- Channel bandwidths
- Channel spacings
- Detector
- Trace average setting
- Resolution bandwidth (RBW)
- Weighting filter

For details on the available standards, see Section 5.3.5.9, "Reference: predefined CP/ACLR standards", on page 1129.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236

Managing user standards ← Standard
Access: "CP/ACLR Configuration" > "General Settings" tab > "Manage User Standards"

In addition to the predefined standards, you can save your own standards with your specific measurement settings in an XML file so you can use them again later. User-defined standards are stored on the instrument in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/acp_std` directory.

The FSWX provides a sample file for an MSR ACLR measurement (`MSR_ACLRExample.xml`). The file sets up the measurement for the MSR signal generator waveform described in the file `var/lib/rohde-schwarz/esmain/fswx/user/waveform/MSRA_GSM_WCDMA_LTE_GSM.wv`.

User-defined standard files include the following parameter definitions:

- Number of adjacent channels
- Channel bandwidth of transmission (TX), adjacent (Adj) and alternate (Alt) channels
- Channel spacings
- Weighting filters
- Resolution bandwidth
- Video bandwidth
- Detector
- ACLR limits and their state
- Sweep time and sweep time coupling
- Trace and power mode
- (MSR only: Subblock and gap channel definition)

You can save the current measurement settings as a user-defined standard, load a stored measurement configuration, or delete an existing configuration file.

For details see "How to manage user-defined configurations" on page 1125.

Remote command:
To query all available standards:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:STANdard:CATalog?` on page 1237
To load a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236
To save a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:STANdard:SAVE` on page 1237
To delete a standard:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:STANdard:DELete` on page 1237

Channel count: TX Channels, Adjacent Channels
You can define up to 18 carrier channels and up to 12 adjacent channels.

The measurement provides results for the TX channel and the number of defined adjacent channels *above and below* the TX channel. If you configure more than one TX channel, you must define the carrier channel that the relative adjacent-channel power values refer to (see "Reference Channel" on page 1102).

Note: If you enable several carriers (TX channels) for the measurement, the FSWX increases the number of sweep points to ensure that adjacent-channel powers are measured with adequate accuracy.

For more information on how the number of channels affects the measured powers, see Section 5.3.5.2, "Channel power results", on page 1086.

Remote command:
Number of TX channels:
[SENSe:]POWer:ACHannel:TXCHannel:COUNt on page 1242
Number of adjacent channels:
[SENSe:]POWer:ACHannel:ACPairs on page 1238

Reference Channel
The results can show the measured power values in the adjacent channels relative to the transmission (TX) channel. If you configure more than one TX channel, define which one to use as a reference channel.

TX Channel 1	Transmission channel 1 is used. (Not available for MSR ACLR)
Min Power TX Channel	The transmission channel with the lowest power is used as a reference channel.
Max Power TX Channel	The transmission channel with the highest power is used as a reference channel (Default).
Lowest & Highest Channel	The outer left-hand transmission channel is the reference channel for the lower adjacent channels. The outer right-hand transmission channel is the reference channel for the upper adjacent channels.

Remote command:
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual on page 1246
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO on page 1245

Noise Cancellation
The FSWX can correct the results by removing the inherent noise of the analyzer, which increases the dynamic range.

See "Noise Cancellation" on page 184.

Remote command:
[SENSe:]POWer:NCORrection on page 614

Selected Trace
You can perform the CP/ACLR measurement on any active trace.

Remote command:
[SENSe:]POWer:TRACe on page 1235

Set Channel Power Reference
If you configure only one TX channel and no adjacent channels, you can use the currently measured channel power as a fixed reference value for subsequent channel power measurements.

When you select this function, the FSWX stores the currently measured TX channel power as a fixed reference power. In the following channel power measurements, the power is indicated relative to the fixed reference power. The reference value is displayed in the "Reference" field (in relative ACLR mode). The default value is 0 dBm.

Note: In adjacent-channel power measurement, the power is always referenced to a transmission channel (see "Reference Channel" on page 1102). Thus, this function is not available.

Remote command:
`[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE` on page 1245

Absolute and relative values (ACLR Mode)
The powers of the adjacent channels are output in absolute values, or relative to the specified reference TX channel.

"Abs" The absolute power in the adjacent channels is displayed in the unit of the y-axis, e.g. in dBm, dBµV.

"Rel" The level of the adjacent channels is displayed relative to the level of the transmission channel in dBc.

Remote command:
`[SENSe:]POWer:ACHannel:MODE` on page 1293

Channel power level and density (Power Unit)
By default, the channel power is displayed in absolute values. If you select "/Hz" or "/MHz", the channel power *density* is displayed instead. Thus, the absolute unit of the channel power is switched from dBm to dBm/Hz or dBm/MHz.

Note: The channel power density in dBm/Hz corresponds to the power inside a bandwidth of 1 Hz and is calculated as follows:
"channel power density = channel power – $\log_{10}$(channel bandwidth)"

Thus you can measure the signal/noise power density, for example, or use the additional functions Absolute and relative values (ACLR Mode) and Reference Channel to obtain the signal to noise ratio.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult:PHZ` on page 1291
LTE and 5G NR:`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult:UNIT` on page 1292

Power Mode
Determines which power values are displayed in the results.

"Clear/Write" The measured power values for each trace are displayed.

"Max Hold" The maximum values over a series of measurements are displayed. The measurement compares the power value from the current trace with the previous power value. The higher value is retained.
Note that the *trace* mode remains unaffected by this setting.
"Pwr Max" is indicated in the table header.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:MODE` on page 1231

Optimize Instrument Settings
The FSWX can optimize all instrument settings for the selected channel setup (channel bandwidth, channel spacing) automatically.

The FSWX only adjusts the settings once. If necessary, you can change the instrument settings later.

The following settings are optimized:

- "Frequency span" on page 1090
- "Resolution bandwidth (RBW)" on page 1091
- "Video bandwidth (VBW)" on page 1092
- "Detector" on page 1092
- "Trace averaging" on page 1092

Note: This function does not change the reference level. To adjust the reference level automatically, use the Setting the reference level automatically (Perform Auto Level) function in the [Auto Set] menu.

Remote command:
`[SENSe:]POWer:ACHannel:PRESet` on page 1235

Sweep Time
With the RMS detector, a longer sweep time increases the stability of the measurement results. For recommendations on setting this parameter, see "Sweep Time" on page 1090.

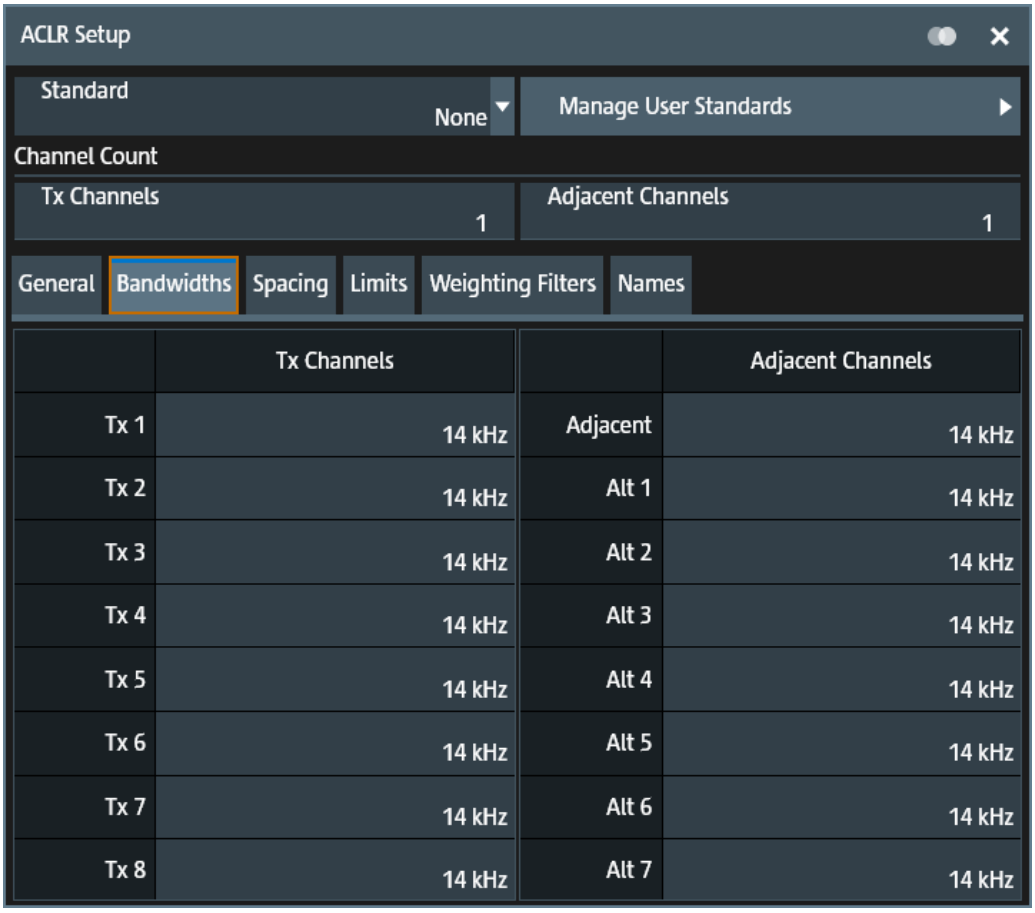
Define the "Sweep Time" in the "Channel Power" menu. The "Sweep Time" is identical to the general setting in the "Sweep Configuration" dialog box.

Remote command:
`[SENSe<ip>:]SWEep:TIME` on page 1427

Bandwidths

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Configuration" > "Bandwidths"

Usually, the transmission standard defines the TX channel bandwidth. The FSWX sets the correct bandwidth for the selected standard automatically. A colored bar in the display indicates the bandwidth for each channel.



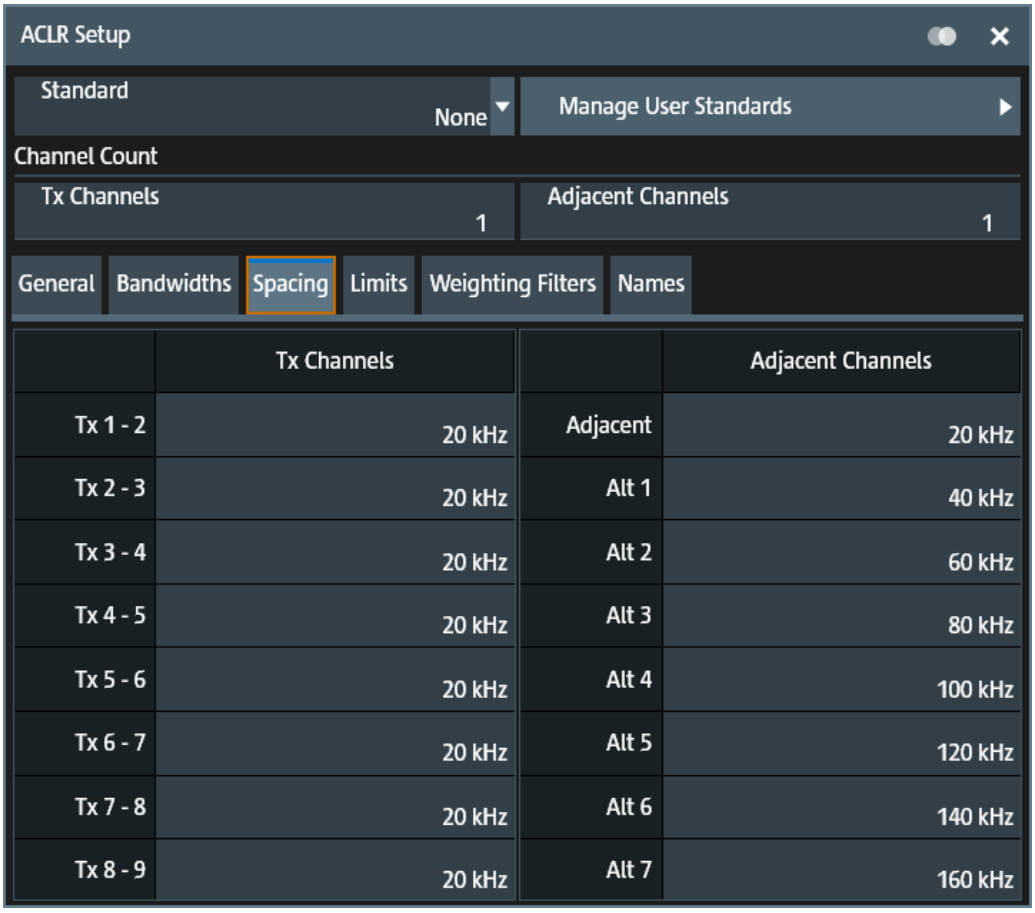
The value you enter for any TX channel is automatically used for all subsequent TX channels. Thus, only enter one value if all TX channels have the same bandwidth.

The value you enter for any adjacent or alternate channel is automatically also used for all alternate (Alt) channels. Thus,only enter one value if all adjacent channels have the same bandwidth.

Spacing

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Configuration" > "Spacing"

Usually, the transmission standard defines the channel spacings. However, you can change them.



If the spacings are not equal, the channel distribution in relation to the center frequency is as follows:

Odd number of TX channels	The middle TX channel is centered to center frequency.
Even number of TX channels	The FSWX calculates the frequency between the two TX channels in the middle. This frequency is aligned to the center frequency.

You can define the spacings between all TX channels individually. When you change the spacing for one channel, the value is automatically also defined for all subsequent TX channels. This allows you to set up a system with equal TX channel spacing quickly. For different spacings, set up the channels from top to bottom.

Tx1-2	Spacing between the first and the second carrier
Tx2-3	Spacing between the second and the third carrier
…	…

If you change the adjacent-channel spacing (ADJ), all higher adjacent channelspacings (ALT1, ALT2, …) are multiplied by the same factor (new spacingvalue/old spacing value). Again, only enter one value for equalchannel spacing. For different spacing, configure the spacings from top to bottom.

For details, see "How to set up the channels" on page 1123

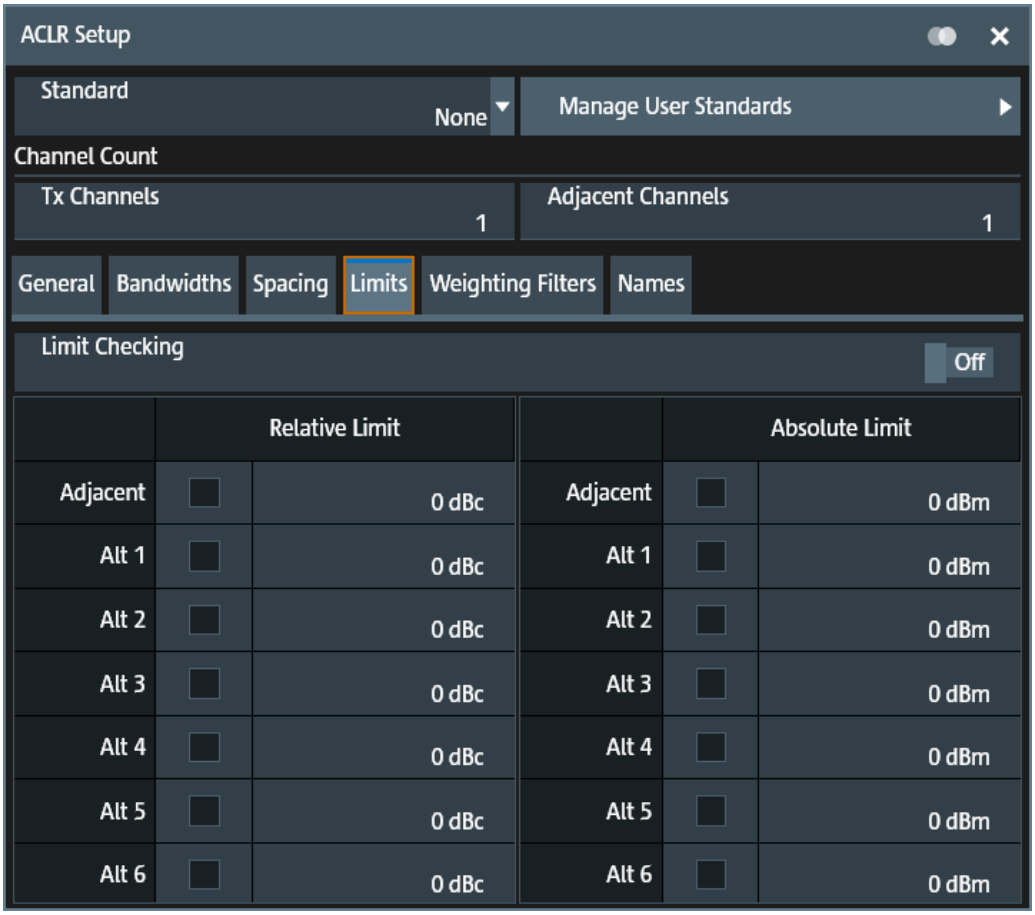
Limits

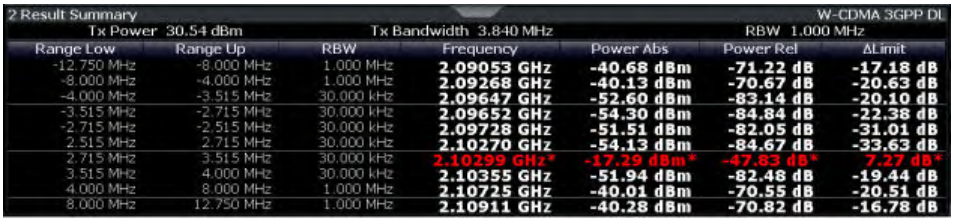
Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Configuration" > "Limits"

An ACLR measurement can check whether the power values exceed user-defined or standard-defined limits. You can define relative and absolute limits for each channel. The measurement checks both limit types, regardless whether the measured levels are absolute or relative values. You can enable the limit check for each limit value independently.

If the measured value exceeds any active limit value, it is displayed in red and marked by a preceding asterisk in the result table.

If you change the limit settings after the measurement, you have to refresh the measurement.





2 Result Summary — W-CDMA 3GPP DL
Tx Power 30.54 dBm — Tx Bandwidth 3.840 MHz — RBW 1.000 MHz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-12.750 MHz	-8.000 MHz	1.000 MHz	2.09053 GHz	-40.68 dBm	-71.22 dB	-17.18 dB
-8.000 MHz	-4.000 MHz	1.000 MHz	2.09268 GHz	-40.13 dBm	-70.67 dB	-20.63 dB
-4.000 MHz	-3.515 MHz	30.000 kHz	2.09647 GHz	-52.60 dBm	-83.14 dB	-20.10 dB
-3.515 MHz	-2.715 MHz	30.000 kHz	2.09652 GHz	-54.30 dBm	-84.84 dB	-22.38 dB
-2.715 MHz	-2.515 MHz	30.000 kHz	2.09728 GHz	-51.51 dBm	-82.05 dB	-31.01 dB
2.515 MHz	2.715 MHz	30.000 kHz	2.10270 GHz	-54.13 dBm	-84.67 dB	-33.63 dB
2.715 MHz	3.515 MHz	30.000 kHz	2.10299 GHz*	-17.29 dBm*	-47.83 dB*	7.27 dB*
3.515 MHz	4.000 MHz	30.000 kHz	2.10355 GHz	-51.94 dBm	-82.48 dB	-19.44 dB
4.000 MHz	8.000 MHz	1.000 MHz	2.10725 GHz	-40.01 dBm	-70.55 dB	-20.51 dB
8.000 MHz	12.750 MHz	1.000 MHz	2.10911 GHz	-40.28 dBm	-70.82 dB	-16.78 dB

The results of the power limit checks are also stated in the `STAT:QUES:ACPL` status registry (see "STATus:QUEStionable:ACPLimit register" on page 497).

Limits for ACLR measurement in LTE and 5G application

If you change the limit evaluation method after the measurement, you have to refresh the measurement.

The selected method affects the contents of the following result displays.

- "ACLR result summary"

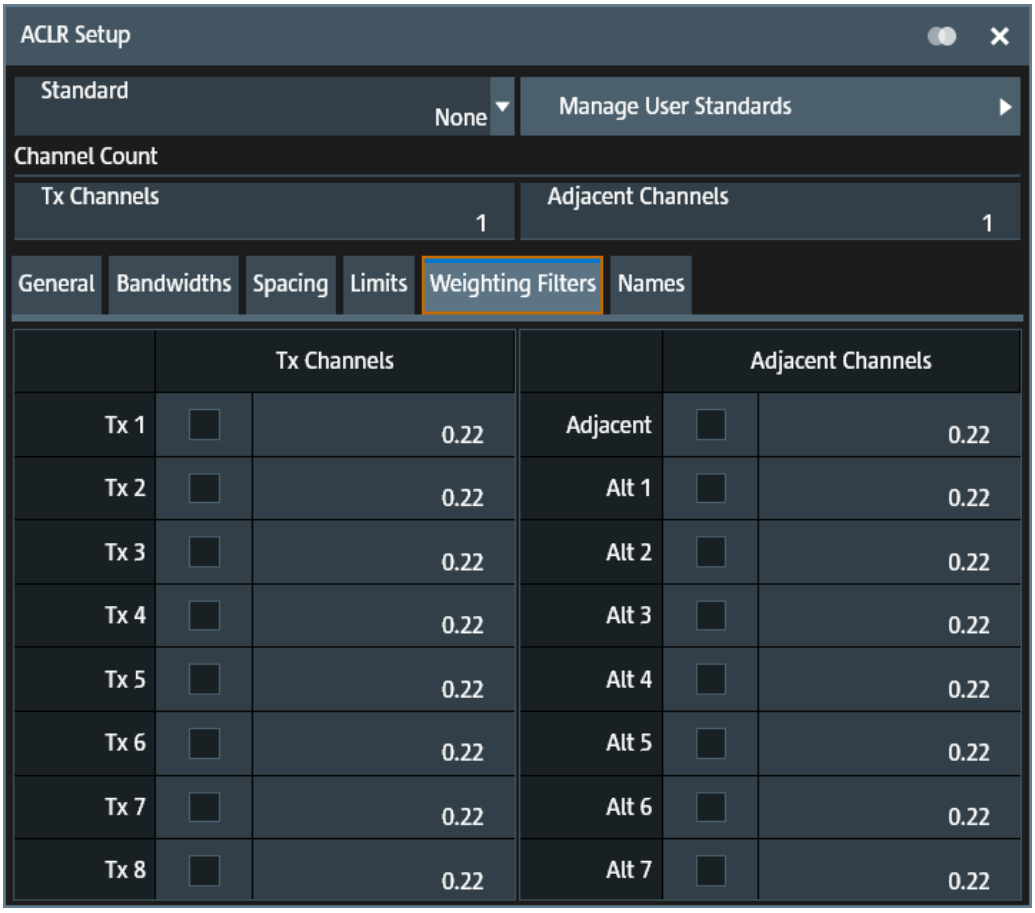
The default value complies with 3GPP 38.141-1/2.

- "Absolute and Relative"
  The signal passes the limit check only if the signal level remains within both the absolute and the relative limits.
- "Absolute or Relative"
  The signal passes the limit check if the signal level remains within either the absolute or the relative limits.

Weighting Filters

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Configuration" > "Weighting Filters"

Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel, you can enable or disable the use of the weighting filter and define an individual weighting factor ("Alpha" value).

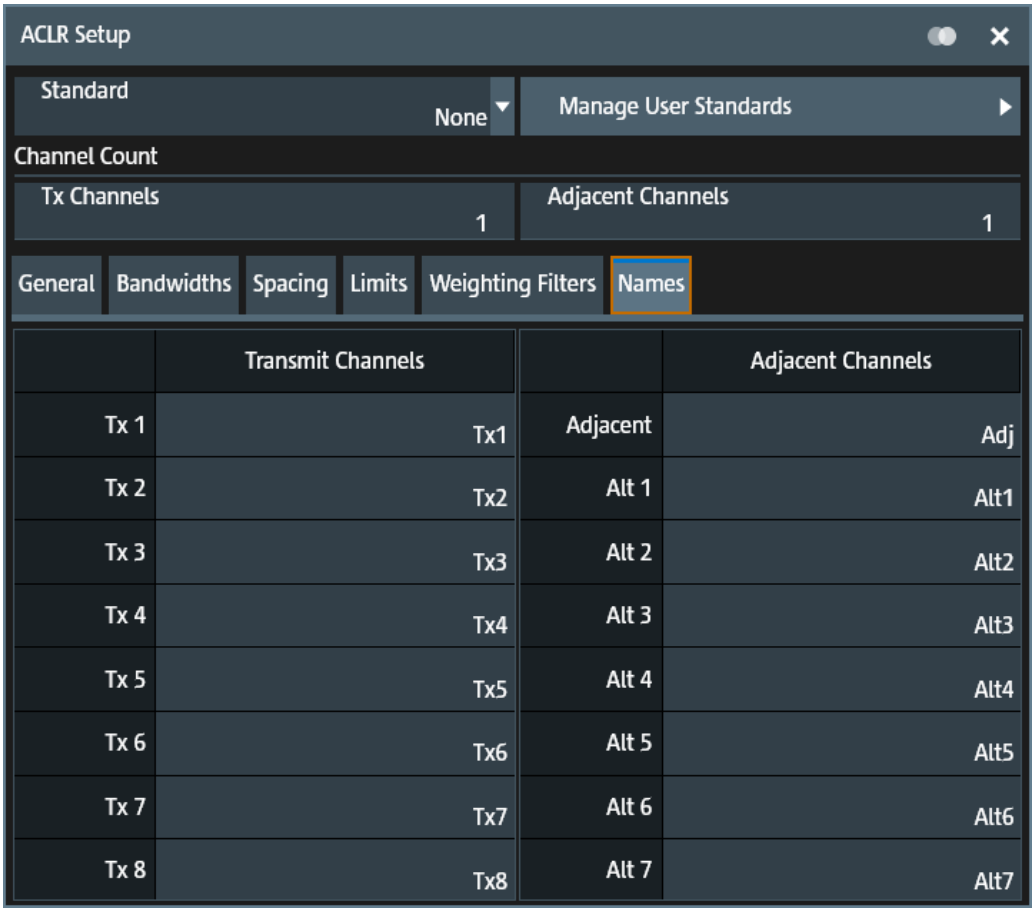


Weighting filters are not available for all supported standards and cannot always be defined manually where they are available.

Names

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Configuration" > "Names"

In the "ACLR" result display, carrier channels are labeled "TX" by default. The first neighboring channel is labeled "Adj" (adjacent) channel. All other channels are labeled "Alt" (alternate) channels. You can define user-specific channel names for each channel. The channel names are displayed in the "ACLR" result display and the "Result Summary".



5.3.5.5 MSR ACLR configuration

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Configuration"

You can also perform ACLR measurements on input containing multiple signals for different communication standards (MSR = Multistandard radio). Using a special measurement standard, you can define multiple discontiguous transmit channels at specified frequencies, independent from the selected center frequency. If you select the "Multi-Standard Radio" standard (see "Standard" on page 1100), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box.

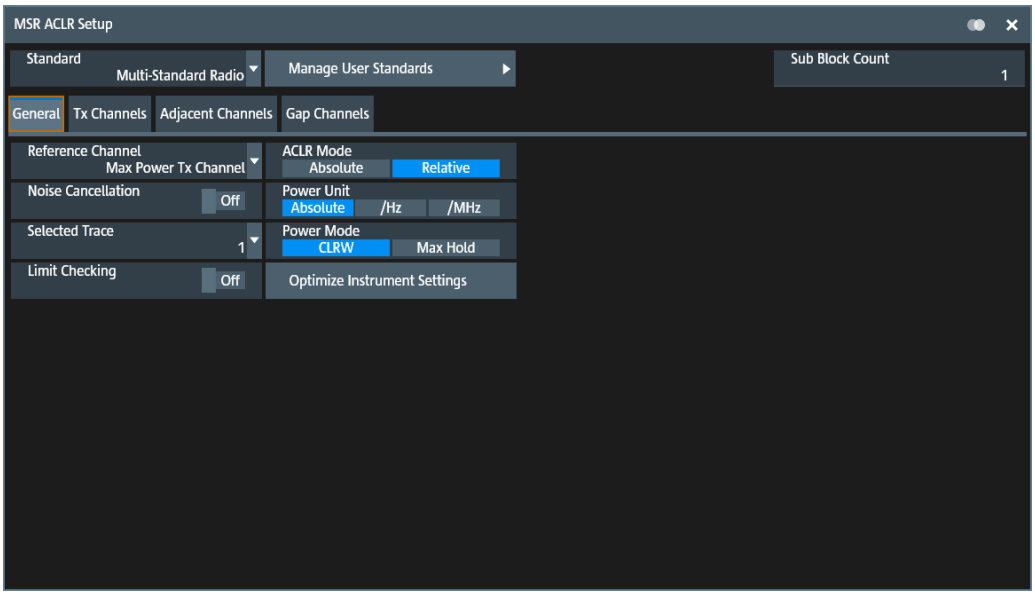
For more information, see "Multi-standard radio (MSR) signals" on page 1093.

The remote commands required to perform these tasks are described in "Configuring MSR ACLR measurements" on page 1258.

- General MSR ACLR measurement settings 1111
- MSR subblock and TX channel settings 1112
- MSR adjacent channel settings 1115
- MSR gap channel settings 1118

General MSR ACLR measurement settings

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Configuration" > "MSR General Settings" tab



In addition to the General settings, the MSR ACLR measurements provide the following settings.

Number of subblocks (Sub Block Count)..... 1111
Symmetrical Adjacent Setup..... 1111
Relative Limit/Absolute Limit..... 1112

Number of subblocks (Sub Block Count)
Defines the number of subblocks, i.e. groups of transmission channels in an MSR signal.

For more information, see "Multi-standard radio (MSR) signals" on page 1093.

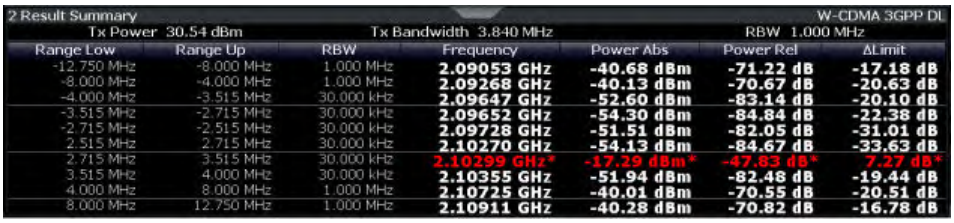
Remote command:
[SENSe:]POWer:ACHannel:SBCount on page 1260

Symmetrical Adjacent Setup
If enabled, the upper and lower adjacent and alternate channels are defined symmetrically. This is the default behavior.

If disabled, you can configure the upper and lower channels configured differently. This is particularly useful if the lowest TX channel and highest TX channel use different standards. In this case, they require different bandwidths for adjacent channel power measurement.

Remote command:
[SENSe:]POWer:ACHannel:SSETup on page 1264

Relative Limit/Absolute Limit
An ACLR measurement can check whether the power values exceed user-defined or standard-defined limits. You can define a relative or absolute limit, or both. The measurement checks both limit types, regardless whether the measured levels are absolute or relative values. You can enable the limit check for both limit values independently. If the measured value exceeds any active limit value, it is displayed in red and marked by a preceding asterisk in the result table.



The results of the power limit checks are also stated in the `STAT:QUES:ACPL` status registry (see "STATus:QUEStionable:ACPLimit register" on page 497).

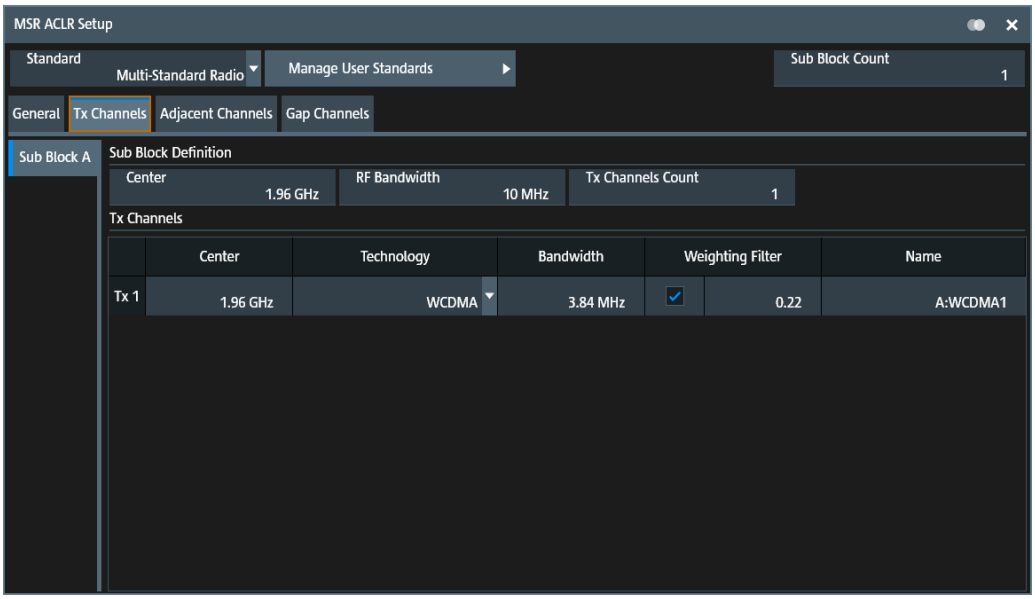
Note that you must enable limit checks both for the individual channels and globally in the general measurement settings.

Remote command:
`CALCulate<n>:LIMit<li>:ACPower[:STATe]` on page 1252
"Checking the results of a limit check" on page 775
`CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult?` on page 1248

MSR subblock and TX channel settings

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Configuration" > "TX Channels" tab

The "TX Channels" tab provides all the channel settings to configure subblocks and TX channels in MSR ACLR measurements.



For details on MSR signals, see "Multi-standard radio (MSR) signals" on page 1093.

For details on setting up channels, see "How to configure an MSR ACLR measurement" on page 1124.

You configure the TX channel settings for the individual subblocks in individual subtabs of the "TX Channels" tab.

- MSR subblock definition 1113
- MSR TX channel setup 1113

MSR subblock definition

Subblocks are groups of transmit channels in an MSR signal. Up to 8 subblocks can be defined. They are defined as an RF bandwidth around a center frequency with a specific number of transmit channels (max. 18).

Subblocks are named "Sub Block A/B/C" and are indicated by a slim blue bar along the frequency axis.

Subblock Center frequency
Defines the center of an MSR subblock. Note that the position of the subblock also affects the position of the adjacent gap channels.

Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer` on page 1261

RF Bandwidth
Defines the bandwidth of the individual MSR subblock. Note that subblock ranges also affect the position of the adjacent gap channels.

Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth` on page 1262

Number of TX channels (TX Channels Count)
Defines the number of transmit channels that the specific subblock contains. The maximum is 18 TX channels.

Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:TXCHannel:COUNt` on page 1263

MSR TX channel setup

Common ACLR channels are defined by a spacing relative to the (common) center frequency. For MSR ACLR measurements, the TX channels are defined at absolute frequencies. You can assign a different technology to each transmit channel, which is used to predefine the required bandwidth.

You configure the TX channel settings for the individual subblocks in individual subtabs of the "TX Channels" tab.

For details on configuring MSR TX channels, see "How to configure an MSR ACLR measurement" on page 1124.

TX Center frequency
Defines the (absolute) center frequency of an MSR TX channel. Each TX channel is defined independently of the others. The FSWX does not space the channels automatically as in common ACLR measurements.

Note that the position of the adjacent channels is also affected by:

- The position of the first TX channel in the first subblock
- The position of last TX channel in the last subblock

Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>]`
on page 1260

Technology used for transmission
You can define the technology used for transmission for each individual channel. The FSWX then presets the required channel bandwidth and use of a weighting filter automatically according to the selected technology standard.

"GSM"	Transmission according to GSM standard
"WCDMA"	Transmission according to WCDMA standard
"LTE_xxx"	Transmission according to LTE standard for different channel bandwidths
"USER"	User-defined transmission; no automatic preconfiguration possible

Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>]`
on page 1262

TX Bandwidth
Usually, the transmission technology standard defines the TX channel bandwidth. The FSWX presets the correct bandwidth automatically for the selected technology. Each TX channel is defined independently of the others. The FSWX does not space subsequent channels automatically as in common ACLR measurements.

The bandwidth for each channel is indicated by a colored bar in the display.

Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth[:CHANnel<ch>]`
on page 1260

TX Weighting Filters
Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel, you can enable or disable the use of the weighting filter and define an individual weighting factor ("Alpha" value).

Remote command:
Enabling/Disabling:
`[SENSe:]POWer:ACHannel:FILTer[:STATe]:SBLock<sb>:CHANnel<ch>`
on page 1259
Alpha value:
`[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch>`
on page 1259

Name
You can define a customized name for each channel in each subblock. Note that the names are not checked for uniqueness.

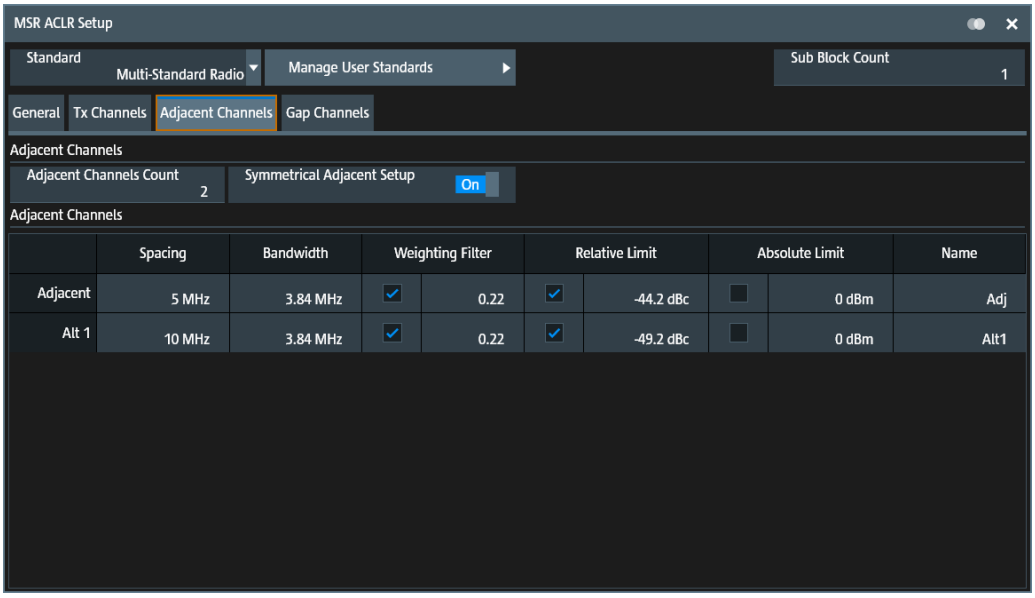
Remote command:
`[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>]` on page 1288
`[SENSe:]POWer:ACHannel:NAME:ACHannel` on page 1240

MSR adjacent channel settings

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Configuration" > "Adjacent Channels" tab

The "Adjacent Channels" tab provides all the channel settings to configure adjacent and gap channels in MSR ACLR measurements.

For symmetrical channel definition (see "Symmetrical Adjacent Setup" on page 1111), the upper and lower channels are identical. Thus, the dialog box is reduced.



You can configure a maximum of 12 channels adjacent to the transmission channel block in MSR signals.

For MSR signals, adjacent channels are defined in relation to the center frequency of the first and last transmission channel in the entire block, i.e.:

- The lower adjacent channels are defined in relation to the center frequency of the first TX channel in the first subblock.
- The upper adjacent channels are defined in relation to the center frequency of the last TX channel in the last subblock.

Adjacent channels are named "Adj" and "Alt1" to "Alt11" by default. You can change the names manually (see "Name" on page 1117).

In all other respects, channel definition is identical to common ACLR measurements.

For details on setting up channels, see "How to configure an MSR ACLR measurement" on page 1124.

Number of adjacent channels (Adj Count)....1116
Adjacent channel Spacing....1116
Adjacent channel Bandwidth....1116
Adjacent channel Weighting Filters....1116
Relative Limit/Absolute Limit....1117
Name....1117

Number of adjacent channels (Adj Count)
Defines the number of adjacent channels *above and below* the TX channel block in an MSR signal. You must define the carrier channel to which the relative adjacent-channel power values refer (see "Reference Channel" on page 1102).

Remote command:
`[SENSe:]POWer:ACHannel:ACPairs` on page 1238

Adjacent channel Spacing
Usually, the selected Technology used for transmission defines the channel spacings. However, you can change them.

For MSR signals, adjacent channels are defined in relation to the center frequency of the first and last transmission channel in the entire block, i.e.:

- The spacing of the lower adjacent channels is defined in relation to the center frequency of the first TX channel in the first subblock.
- The spacing of the upper adjacent channels is defined in relation to the center frequency of the last TX channel in the last subblock.

For details, see "How to configure an MSR ACLR measurement" on page 1124

Remote command:
`[SENSe:]POWer:ACHannel:SPACing[:ACHannel]` on page 1241
`[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>` on page 1241
`[SENSe:]POWer:ACHannel:SPACing:UACHannel` on page 1263
`[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch>` on page 1263

Adjacent channel Bandwidth
Usually, the transmission standard defines the adjacent channel bandwidth.

The FSWX sets the correct bandwidth for the selected standard automatically. A colored bar in the display indicates the bandwidth for each channel.

Remote command:
`[SENSe:]POWer:ACHannel:BANDwidth:ACHannel` on page 1239
`[SENSe:]POWer:ACHannel:BANDwidth:ALTernate<ch>` on page 1239
`[SENSe:]POWer:ACHannel:BANDwidth:UACHannel` on page 1264
`[SENSe:]POWer:ACHannel:BANDwidth:UALTernate<ch>` on page 1265

Adjacent channel Weighting Filters
Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel, you can enable or disable the use of the weighting filter and define an individual weighting factor ("Alpha" value).

Remote command:
Enabling/Disabling:
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel on page 1244
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch> on page 1244
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel on page 1266
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch> on page 1266
Alpha value:
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel on page 1243
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch> on page 1243
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel on page 1265
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch> on page 1265

Relative Limit/Absolute Limit
An ACLR measurement can check whether the power values exceed user-defined or standard-defined limits. You can define a relative or absolute limit, or both. The measurement checks both limit types, regardless whether the measured levels are absolute or relative values. You can enable the limit check for both limit values independently. If the measured value exceeds any active limit value, it is displayed in red and marked by a preceding asterisk in the result table.

2 Result Summary — W-CDMA 3GPP DL
Tx Power 30.54 dBm — Tx Bandwidth 3.840 MHz — RBW 1.000 MHz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-12.750 MHz	-8.000 MHz	1.000 MHz	2.09053 GHz	-40.68 dBm	-71.22 dB	-17.18 dB
-8.000 MHz	-4.000 MHz	1.000 MHz	2.09268 GHz	-40.13 dBm	-70.67 dB	-20.63 dB
-4.000 MHz	-3.515 MHz	30.000 kHz	2.09647 GHz	-52.60 dBm	-83.14 dB	-20.10 dB
-3.515 MHz	-2.715 MHz	30.000 kHz	2.09652 GHz	-54.30 dBm	-84.84 dB	-22.38 dB
-2.715 MHz	-2.515 MHz	30.000 kHz	2.09728 GHz	-51.51 dBm	-82.05 dB	-31.01 dB
2.515 MHz	2.715 MHz	30.000 kHz	2.10270 GHz	-54.13 dBm	-84.67 dB	-33.63 dB
2.715 MHz	3.515 MHz	30.000 kHz	2.10299 GHz*	-17.29 dBm*	-47.83 dB*	7.27 dB*
3.515 MHz	4.000 MHz	30.000 kHz	2.10355 GHz	-51.94 dBm	-82.48 dB	-19.44 dB
4.000 MHz	8.000 MHz	1.000 MHz	2.10725 GHz	-40.01 dBm	-70.55 dB	-20.51 dB
8.000 MHz	12.750 MHz	1.000 MHz	2.10911 GHz	-40.28 dBm	-70.82 dB	-16.78 dB

The results of the power limit checks are also stated in the STAT:QUES:ACPL status registry (see "STATus:QUEStionable:ACPLimit register" on page 497).

Note that you must enable limit checks both for the individual channels and globally in the general measurement settings.

Remote command:
CALCulate<n>:LIMit<li>:ACPower[:STATe] on page 1252
"Checking the results of a limit check" on page 775
CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult? on page 1248

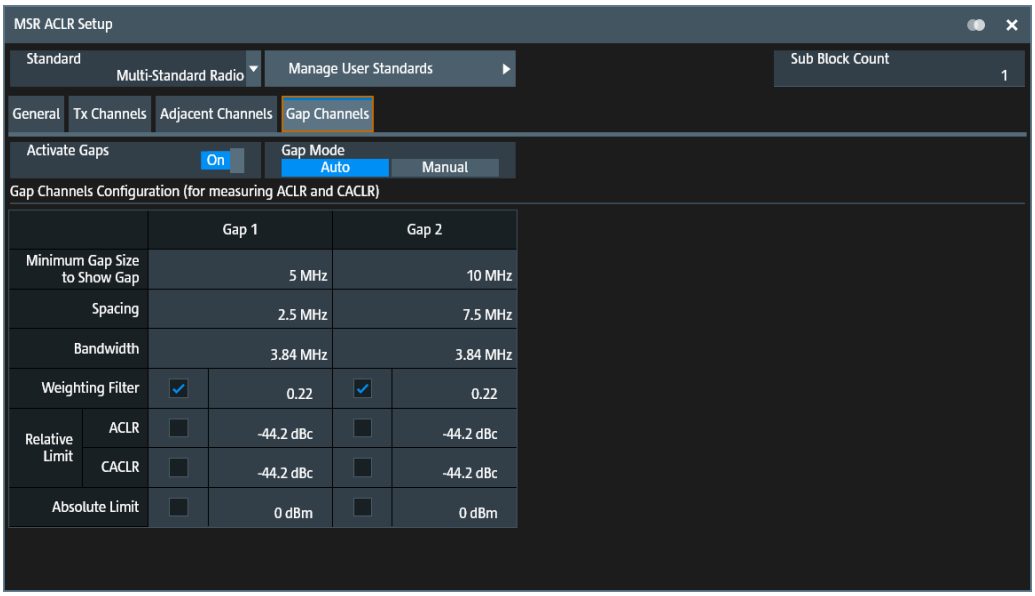
Name
You can define a customized name for each channel in each subblock. Note that the names are not checked for uniqueness.

Remote command:
[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>] on page 1288
[SENSe:]POWer:ACHannel:NAME:ALTernate<ch> on page 1240
[SENSe:]POWer:ACHannel:NAME:UACHannel on page 1288
[SENSe:]POWer:ACHannel:NAME:UALTernate<ch> on page 1288

MSR gap channel settings

Access: "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Configuration" > "Gap Channels" tab

The "Gap Channels" tab provides all the channel settings to configure gap channels in MSR ACLR measurements.



For details on MSR signals, see "Multi-standard radio (MSR) signals" on page 1093.

For details on setting up channels, see "How to configure an MSR ACLR measurement" on page 1124.

Activate Gaps 1118
Gap Mode 1118
Gap channel configuration 1119
Minimum Gap Size to Show Gap 1119
Gap Channel Active 1119
Gap channel Spacing 1120
Gap channel Bandwidth 1120
Gap channel Weighting Filters 1121
Limit Checking 1121
└ Relative Limit/Absolute Limit 1121

Activate Gaps
If enabled, the ACLR measurement displays the gap channels and calculates the gap channel power results. The "Result Summary" includes gap channel results.

Remote command:
`[SENSe:]POWer:ACHannel:AGCHannels` on page 1266

Gap Mode
Determines how gap channels are configured.

In "Auto" mode, upper and lower gap channels are configured identically. You only have to configure two channels (gap 1, gap 2). If you define more than 2 subblocks, the gap channels are configured identically for all gaps. Depending on the defined minimum gap size, the ACLR measurement determines the actual number of evaluated gap channels automatically.

In "Manual" mode, the configured gap channels are always evaluated, regardless of the gap size. You can configure up to four channels individually for each gap.

Remote command:
`[SENSe:]POWer:ACHannel:GAP<gap>:MODE` on page 1267

Gap channel configuration
Between two subblocks in an MSR signal, two gaps are defined: a *lower gap* and an *upper gap*. Each gap in turn can contain two channels, the *gap channels*.

By default ("Auto" gap mode, see "Gap Mode" on page 1118), the ACLR measurement assumes the channels in the upper gap are identical to those in the lower gap, but inverted. Thus, you only have to configure two gap channels. The measurement configures all other gap channels automatically.

In manual gap mode, you can define up to four different gap channels per gap individually. Each gap is configured on a separate subtab. Only gaps between defined subblocks are available. If only one subblock is defined, gap channels cannot be defined manually.

Gap channels are indicated using the following syntax:
- The names of the surrounding subblocks (e.g. "AB" for the gap between subblocks A and B)
- The channel name ("Gap1" or "Gap2")
- "L" (for lower) or "U" (for upper)

Minimum Gap Size to Show Gap
If the gap between the subblocks does not exceed the specified bandwidth, the measurement result diagram does not show the gap channels. The measurement does not calculate the gap channel results, thus they are not included in the result summary.

This command is only available for symmetrical gap channels in "Auto" gap mode (see "Gap Mode" on page 1118).

Remote command:
`[SENSe:]POWer:ACHannel:GAP<gap>[:AUTO]:MSIZe` on page 1272

Gap Channel Active
Defines which gap channels are active in the specified gap if you configure gap channels manually (asymmetrical configuration).

Remote command:
`[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:LOWer` on page 1285
`[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:UPPer` on page 1286

Gap channel Spacing
Usually, the MSR standard defines the gap channel spacings. However, you can change them.

Gap channels are defined using bandwidths and spacings, relative to the outer edges of the surrounding subblocks.

You can determine the required spacing according to the following equation (indicated for lower channels):

Spacing = [CF of gap channel] - [left subblock CF] + ([RF bandwidth of left sub-block] /2)

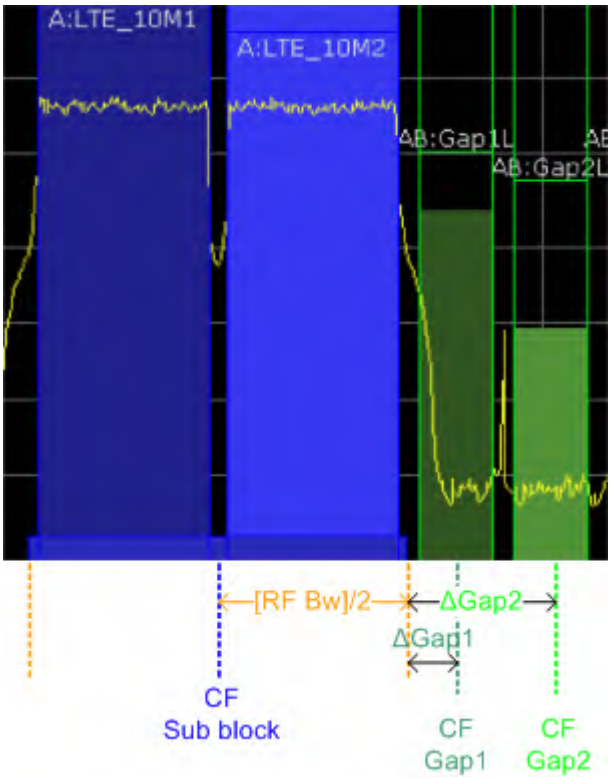


Figure 5-42: Gap channel definition for lower gap

For details, see "How to configure an MSR ACLR measurement" on page 1124.

Remote command:
`[SENSe:]POWer:ACHannel:SPACing:GAP<gap>[:AUTO]` on page 1272
For manual (asymmetrical) configuration:
`[SENSe:]POWer:ACHannel:SPACing:GAP<gap>:MANual:LOWer` on page 1286
`[SENSe:]POWer:ACHannel:SPACing:GAP<gap>:MANual:UPPer` on page 1287

Gap channel Bandwidth
Usually, the transmission standard defines the gap channel bandwidth. The FSWX sets the correct bandwidth for the selected standard automatically. A colored bar in the display indicates the bandwidth for each channel (if the gap is not too narrow, see "Minimum Gap Size to Show Gap" on page 1119).

Remote command:
[SENSe:]POWer:ACHannel:SPACing:GAP<gap>[:AUTO] on page 1272
For manual (asymmetrical) configuration:
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>:MANual:LOWer
on page 1281
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>:MANual:UPPer
on page 1282

Gap channel Weighting Filters
Weighting filters allow you to determine the influence of individual channels on the total measurement result. For each channel, you can enable or disable the use of the weighting filter and define an individual weighting factor ("Alpha" value).

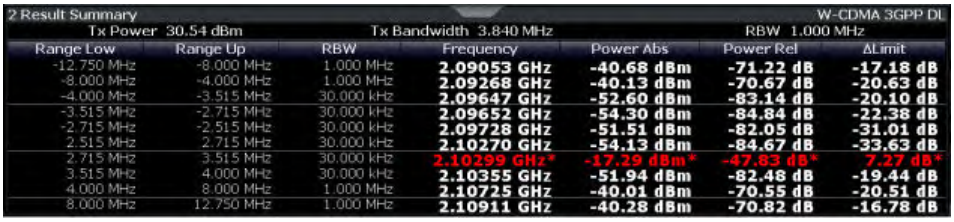
Remote command:
[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>[:AUTO] on page 1271
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>[:AUTO] on page 1271
For manual (asymmetrical) configuration:
[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>:MANual:LOWer
on page 1283
[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>:MANual:UPPer
on page 1283
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>:MANual:LOWer
on page 1284
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>:MANual:UPPer
on page 1284

Limit Checking
An ACLR measurement can check whether the power values exceed user-defined or standard-defined limits. You can define a relative or absolute limit, or both. The measurement checks both limit types, regardless whether the measured levels are absolute or relative values. You can enable the limit check for both limit values independently. Furthermore, you can define and enable relative limits individually for ACLR or CACLR power levels.

If the measured value exceeds any active limit value, it is displayed in red and marked by a preceding asterisk in the result table.

Remote command:
CALCulate<n>:LIMit<li>:ACPower[:STATe] on page 1252
CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult? on page 1248
"Checking limits" on page 1246

Relative Limit/Absolute Limit ← Limit Checking
An ACLR measurement can check whether the power values exceed user-defined or standard-defined limits. You can define a relative or absolute limit, or both. The measurement checks both limit types, regardless whether the measured levels are absolute or relative values. You can enable the limit check for both limit values independently. If the measured value exceeds any active limit value, it is displayed in red and marked by a preceding asterisk in the result table.



2 Result Summary — W-CDMA 3GPP DL
Tx Power 30.54 dBm — Tx Bandwidth 3.840 MHz — RBW 1.000 MHz

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-12.750 MHz	-8.000 MHz	1.000 MHz	2.09053 GHz	-40.68 dBm	-71.22 dB	-17.18 dB
-8.000 MHz	-4.000 MHz	1.000 MHz	2.09268 GHz	-40.13 dBm	-70.67 dB	-20.63 dB
-4.000 MHz	-3.515 MHz	30.000 kHz	2.09647 GHz	-52.60 dBm	-83.14 dB	-20.10 dB
-3.515 MHz	-2.715 MHz	30.000 kHz	2.09652 GHz	-54.30 dBm	-84.84 dB	-22.38 dB
-2.715 MHz	-2.515 MHz	30.000 kHz	2.09728 GHz	-51.51 dBm	-82.05 dB	-31.01 dB
2.515 MHz	2.715 MHz	30.000 kHz	2.10270 GHz	-54.13 dBm	-84.67 dB	-33.63 dB
2.715 MHz	3.515 MHz	30.000 kHz	2.10299 GHz*	-17.29 dBm*	-47.83 dB*	7.27 dB*
3.515 MHz	4.000 MHz	30.000 kHz	2.10355 GHz	-51.94 dBm	-82.48 dB	-19.44 dB
4.000 MHz	8.000 MHz	1.000 MHz	2.10725 GHz	-40.01 dBm	-70.55 dB	-20.51 dB
8.000 MHz	12.750 MHz	1.000 MHz	2.10911 GHz	-40.28 dBm	-70.82 dB	-16.78 dB

The results of the power limit checks are also stated in the `STAT:QUES:ACPL` status registry (see "STATus:QUEStionable:ACPLimit register" on page 497).

Note that you must enable limit checks both for the individual channels and globally in the general measurement settings.

Remote command:
`CALCulate<n>:LIMit<li>:ACPower[:STATe]` on page 1252
"Checking the results of a limit check" on page 775
`CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult?` on page 1248

5.3.5.6 How to perform channel power measurements

The following step-by-step instructions demonstrate the most common tasks when performing channel power measurements.



For remote operation, see "Programming examples for channel power measurements" on page 1293.

- How to perform a standard channel power measurement 1122
- How to set up the channels 1123
- How to configure an MSR ACLR measurement 1124
- How to manage user-defined configurations 1125
- How to compare the TX channel power in successive measurements 1126

How to perform a standard channel power measurement

Performing a channel power or ACLR measurement according to common standards is an easy and straightforward task with the FSWX.

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. Select [MEAS] or select "Overview" > "Select Measurement".
2. Select "Channel Power ACLR".

   The measurement starts immediately with the default settings.
3. Select "CP / ACLR Standard".
4. Select a standard from the list.

   The measurement starts with the predefined settings for the selected standard.

5. If necessary, edit the settings for your specific measurement as described in "How to set up the channels" on page 1123, or load a user-defined configuration (see "To load a user-defined configuration" on page 1126).

How to set up the channels

Defining channels is the basis for measuring power levels in certain frequency ranges. Usually, the power levels in one or more transmission (TX) channels and possibly the adjacent channels are of interest. You can define up to 18 transmission channels and up to 12 adjacent channels.

When you select a measurement standard, the ACLR measurement configures all settings including the channel bandwidths and channel spacings according to the selected standard. Select a standard in the "Channel Power" menu or the "ACLR Setup" dialog box. You can adjust the settings afterwards.

Channel definition consists of the following settings:

- The number of transmission (TX) and adjacent channels
- The bandwidth of each channel
- For multicarrier ACLR measurements: which TX channel is used as a reference
- The spacing between the individual channels
- Optionally: the names of the channels displayed in the diagram and result table
- Optionally: the influence of individual channels on the total measurement result ("Weighting Filter")
- Optionally: limits for a limit check on the measured power levels



You can store changes to an existing standard as a user-defined standard, see "To store a user-defined configuration" on page 1125.

To configure the channels

► Select "Channel Power" > "CP / ACLR Configuration".



In the "ACLR Setup" dialog box, you can define the channel settings for all channels, independent of the defined number of *used* TX or adjacent channels.

To define channel spacings

Usually, the selected standard defines the cChannel spacings. However, you can change them.

► Select "ACLR Setup" > "Spacing".
The measurement automatically uses the value you enter for any TX channel also for all subsequent TX channels. Thus, only enter one value if all TX channels have the same spacing.
If you change the channel spacing for the adjacent or an alternate channel, the measurement also automatically adapts all higher alternate channel spacings. All channel spacings are multiplied by the same factor (new spacing value/old spacing

value). The lower adjacent channel spacings remain unchanged. Only enter one value for equal channel spacing.

Example: Defining channel spacing

In the default setting, the adjacent channels have the following spacing: 20 kHz ("ADJ"), 40 kHz ("ALT1"), 60 kHz ("ALT2"), 80 kHz ("ALT3"), 100 kHz ("ALT4"), …

Set the spacing of the first adjacent channel ("ADJ") to *40 kHz*. For all other adjacent channels, the spacing is multiplied by factor 2: 80 kHz ("ALT1"), 120 kHz ("ALT2"), 160 kHz ("ALT3"), …

Starting from the default setting, set the spacing of the fifth adjacent channel ("ALT4") to *150 kHz*. For all higher adjacent channels, the spacing is multiplied by factor 1.5: 180 kHz ("ALT5"), 210 kHz ("ALT6"), 240 kHz ("ALT7"), …

How to configure an MSR ACLR measurement

You configure ACLR measurements on MSR signals in a special configuration dialog box on the FSWX.

1. Select [MEAS] or select "Overview" > "Select Measurement".
2. Select "Channel Power ACLR".

   The measurement starts immediately with the default settings.
3. Select "CP / ACLR Standard".
4. Select the "Multi-Standard Radio" standard from the list.
5. Select "CP / ACLR Configuration" to configure general MSR settings, including the number of subblocks (up to 8).
   To configure asymmetric adjacent channels, disable the "Symmetrical Adjacent Setup" option in the MSR "General" settings.
6. Select the "TX Channels" tab to configure the subblocks and transmission channels.
   For each subblock:
   a) Define the (center frequency) position and bandwidth of the subblock, as well as the number of transmission channels it contains.
   b) For each transmission channel in the subblock:
      - Define the center frequency.
      - Select the technology used for transmission.
      - Check the bandwidth.
      - If necessary, define the use of a weighting filter for the channel.
7. Select the "Adjacent Channels" tab to configure the adjacent channels.
8. Define the number of adjacent channels and the settings for each channel:
   - The spacing, defined as the distance of the center frequency from the center frequency of the first transmission channel in the first subblock.

For asymmetrical channels, define the upper adjacent channel spacing as the distance from the center frequency of the last transmission channel in the last subblock.
- The bandwidth
- If necessary, a weighting filter
- Optionally, define *and enable* relative or absolute limits, or both, against which the power levels of the channel are checked.

9. Select the "Gap Channels" tab to configure the gap channels.
10. Define the following settings for the two (upper or lower) gap channels. Since the upper and lower channels are identical, it is only necessary to configure two channels.
    - The spacing, defined as the distance of the center frequency from the outer edge of the subblock to the left or right of the gap. You can determine the required spacing as follows:
      Spacing = [CF of the gap channel] - [left subblock center] + ([RF bandwidth of left subblock] /2)
    - The bandwidth
    - If necessary, a weighting filter
    - Optionally, define *and enable* relative or absolute limits, or both, against which the power levels of the channel are checked.
11. Optionally, store the settings for the MSR ACLR measurement as a user-defined standard as described in "To store a user-defined configuration" on page 1125. Otherwise, the configuration is lost when you select a different measurement standard.

How to manage user-defined configurations

You can define measurement configurations independently of a predefined standard and save the current ACLR configuration as a "User Standard" in an XML file. You can then load the file and thus the settings again later.

User-defined standards are not supported for multicarrier ACLR measurements.

To store a user-defined configuration

1. In the "Channel Power" menu, select "CP / ACLR Configuration".

   The "ACLR Setup" dialog box is displayed.
2. Configure the measurement as required (see also "How to set up the channels" on page 1123).
3. In the "General Settings" tab, select "Manage User Standards".

   The "Manage" dialog box is displayed.
4. Define a filename and storage location for the user standard.
   By default, the XML file is stored in `home/instrument/.local/share/rohde-schwarz/esmain/fswx/acp_std`. However, you can define any other storage location.

5. Select "Save".

To load a user-defined configuration

1. In the "ACLR Setup" > "General Settings" tab, select "Manage User Standards".

   The "Manage" dialog box is displayed.

2. Select the user standard file.

3. Select "Load".

   The ACLR measurement automatically configures the stored settings and restarts the measurement with the new parameters.

How to compare the TX channel power in successive measurements

For power measurements with only one TX channel and no adjacent channels, you can define a fixed reference power and compare subsequent measurement results to the stored reference power.

1. Configure a measurement with only one TX channel and no adjacent channels (see also "How to set up the channels" on page 1123).
2. Select "ACLR Setup" > "Set CP Reference".

   The measurement stores the channel power currently measured on the TX channel as a fixed reference power. The reference value is displayed in the "Reference" field of the result table (in relative ACLR mode).

3. Start a new measurement.

   The resulting power is indicated relative to the fixed reference power.

4. Repeat these steps for any number of measurements.
5. To start a new measurement without the fixed reference, temporarily define a second channel, or preset the application instance.

5.3.5.7 Measurement examples

The FSWX provides test routines for simple channel and adjacent channel power measurements. These routines provide quick results without any complex or tedious setting procedures.

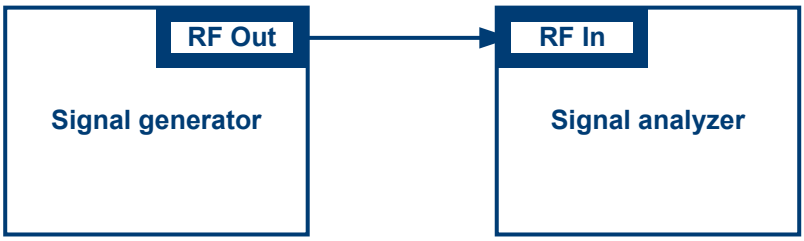


A programming example demonstrating an ACLR measurement in a remote environment is provided in "Programming examples for channel power measurements" on page 1293.

- Measurement example 1 – ACPR measurement on a 5G DL signal..... 1127

Measurement example 1 – ACPR measurement on a 5G DL signal

Test setup:



Signal generator settings (e.g. R&S SMW):

Frequency:	2.3 GHz
Level:	5 dBm
Modulation:	5G NR DL FR1 100 MHz

Procedure:

1. Preset the FSWX.
2. Set the center frequency to *2.3 GHz*.
3. Set the reference level to *+5 dBm*.
4. Select [MEAS] or "Overview" > "Select Measurement".
5. Select the "Channel Power ACLR" measurement function.

   The "ACLR Setup" dialog box is displayed.
6. Select "CP/ACLR Standard" > "5G NR DL FR1 100 MHz" for adjacent channel power measurement.

   The FSWX sets the channel configuration according to the 5G NR DL standard with 2 adjacent channels above and 2 below the transmit channel. The spectrum is displayed in the upper part of the screen, the numeric values of the results and the channel configuration in the lower part of the screen. The various channels are represented by vertical lines on the graph.
   To obtain stable results, the measurement uses the RMS detector.
7. Set the optimal reference level and RF attenuation for the applied signal level using the "Auto Level" function in the [Auto Set] menu.

   The FSWX sets the optimal RF attenuation and the reference level based on the transmission channel power to obtain the maximum dynamic range.
   Figure 5-43 shows the result of the measurement.



Figure 5-43: Adjacent channel power measurement on a CDMA2000 signal

5.3.5.8 Optimizing and troubleshooting the measurement

If the results do not meet your expectations, or if you want to minimize the measurement duration, try the following methods to optimize the measurement:

- Only enable as many **adjacent channels** as necessary to minimize the required span and thus the required measurement time for the measurement.
- Increase the **RBW** to minimize the measurement time. However, consider the requirements of the standard if you need to measure according to standard. The automatic settings always comply with the standard.
- Take advantage of the **speed optimization mode** in the "Sweep" settings if you do not require the larger dynamic range (see "Sweep Optimization (expert parameter)" on page 970).
- Reduce the **"Sweep Time"** and thus the amount of data to be captured and calculated. However, consider the requirements regarding the standard deviation.
- To improve the **stability of the measured results**, increase the "Sweep Time", which also leads to more averaging steps.
- Instead of **trace averaging**, use an RMS detector with a higher "Sweep Time" to obtain better average power results in less time.
- To determine a **channel power level** quickly, use the **Time domain power measurement** (TDP) rather than a channel power measurement. The TDP measurement is a zero span measurement where the sweep time determines the measurement time. Due to the FFT measurement, duplicate averaging is performed, providing stable results quickly.

Note, however, that for TDP measurements, channel filters are not available and a fixed RBW is used. Thus, for some test cases, the measurement does not comply with the standard.

5.3.5.9 Reference: predefined CP/ACLR standards

When you use predefined standards for ACLR measurement, the FSWX configures the test parameters for the channel and adjacent-channel measurements automatically.

You can select a predefined standard via "Channel Power" > "CP / ACLR Standard" or the selection list in "ACLR Setup" > "General Settings" (see "Standard" on page 1100).

Table 5-17: Predefined CP / ACLR standards with remote command parameters

Standard	Remote parameter
None	NONE
Multi-Standard Radio	MSR
EUTRA/LTE Square	EUTRa
EUTRA/LTE Square/RRC	REUTra
5G NR DL FR1 20MHz	F1D20nr5g
5G NR DL FR1 100MHz	F1D100nr5g
5G NR UL FR1 20MHz	F1U20nr5g
5G NR UL FR1 100MHz	F1U100nr5g
5G NR DL FR2 100MHz	F2D100nr5g
5G NR DL FR2 200MHz	F2D200nr5g
5G NR UL FR2 100MHz	F2U100nr5g
5G NR UL FR2 200MHz	F2U200nr5g
WCDMA 3GPP FWD	FW3Gppcdma
WCDMA 3GPP REV	RW3Gppcdma
CDMA IS95A FWD	F8CDma
CDMA IS95A REV	R8CDma
CDMA IS95C Class 0 FWD*)	FIS95c0
CDMA IS95C Class 0 REV*)	RIS95c0
CDMA J-STD008 FWD	F19Cdma
CDMA J-STD008 REV	R19Cdma
CDMA IS95C Class 1 FWD*)	FIS95c1
CDMA IS95C Class 1 REV*)	RIS95c1
CDMA2000	S2CDma
TD-SCDMA FWD	FTCDma
TD-SCDMA REV	TRCDma

Standard	Remote parameter
WLAN 802.11A	AWLAN
WLAN 802.11B	BWLAN
WIMAX	WIMax
WiBro	WIBRo
GSM	GSM
RFID 14443	RFID14443
TETRA	TETRa
PDC	PDC
PHS	PHS
CDPD	CDPD
APCO-25 P2	PAPCo25
User Standard	USER
Customized Standard	<string>

For the FSWX, the channel spacing is defined as the distance between the center frequency of the adjacent channel and the center frequency of the transmission channel. The standards IS95C and CDMA 2000 define the adjacent-channel spacing differently. These standards define the adjacent-channel spacing from the center of the transmission channel to the closest border of the adjacent channel. This definition is also used by the FSWX for the standards marked with an asterisk ***)**.

5.3.5.10 Reference: predefined ACLR user standard XML files

In addition to the predefined standards, the FSWX provides some user standards with specific measurement settings for common ACLR measurements in XML file in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/acp_std` directory.

In particular, a sample file for an MSR ACLR measurement is provided (`MSR_ACLRExample.xml`). It sets up the measurement for the MSR signal generator waveform described in the file `var/lib/rohde-schwarz/esmain/fswx/user/waveform/MSRA_GSM_WCDMA_LTE_GSM.wv`.

Furthermore, the following XML files are provided:

5GNR/DL

- 5GNR/DL/5GNR_DL_FR1_20MHz
- 5GNR/DL/5GNR_DL_FR1_100MHz
- 5GNR/DL/5GNR_DL_FR2_100MHz
- 5GNR/DL/5GNR_DL_FR2_200MHz

5GNR/UL

- 5GNR/UL/5GNR_UL_FR1_20MHz
- 5GNR/UL/5GNR_UL_FR1_100MHz
- 5GNR/UL/5GNR_UL_FR2_100MHz
- 5GNR/UL/5GNR_UL_FR2_200MHz

LTE/DL

- LTE/DL/LTE_DL_5MHZ.XML
- LTE/DL/LTE_DL_10MHZ.XML
- LTE/DL/LTE_DL_15MHZ.XML
- LTE/DL/LTE_DL_20MHZ.XML

LTE/UL

- LTE/UL/LTE_UL_5MHZ.XML
- LTE/UL/LTE_UL_10MHZ.XML
- LTE/UL/LTE_UL_15MHZ.XML
- LTE/UL/LTE_UL_20MHZ.XML

WLAN

- WLAN/802_11ac/802_11ac_20MHZ.XML
- WLAN/802_11ac/802_11ac_40MHZ.XML
- WLAN/802_11ac/802_11ac_80MHZ.XML
- WLAN/802_11ac/802_11ac_160MHZ.XML

To load a stored measurement configuration, select "ACLR Setup" > "General Settings" > "Manage User Standards" to display the "Manage" dialog box. Select the user standard file, then "Load".

The FSWX automatically configures the stored settings and starts the measurement with the new parameters.

For details, see "How to manage user-defined configurations" on page 1125.

5.3.6 Carrier-to-noise measurements

Measures the carrier-to-noise ratio. "C/N_0" measurements normalize the ratio to a 1 Hz bandwidth.

- About the measurement 1131
- Carrier-to-noise results 1132
- Carrier-to-noise configuration 1133
- How to determine the carrier-to-noise ratio 1134

5.3.6.1 About the measurement

The carrier is the strongest signal in the frequency span. When you enable the "C/N" or "C/N_0" function, the FSWX searches for the (unmodulated) carrier using a peak

detector. It sets a fixed reference marker to the detected carrier frequency, indicated by "FXD".

To determine the noise power, the FSWX analyzes a channel with a defined bandwidth at the defined center frequency. The FSWX integrates the power within this channel to obtain the noise power level. If the carrier is within this channel, you have to switch off the carrier to determine the correct noise power level. To determine the noise power, the FSWX requires an RMS detector. To switch detectors, you must adjust the settings between the two measurements (see "Optimize Settings" on page 1134).

The FSWX subtracts the noise power of the channel from the maximum carrier signal level. For a "C/N_0" measurement, the FSWX normalizes the result to a 1 Hz bandwidth.

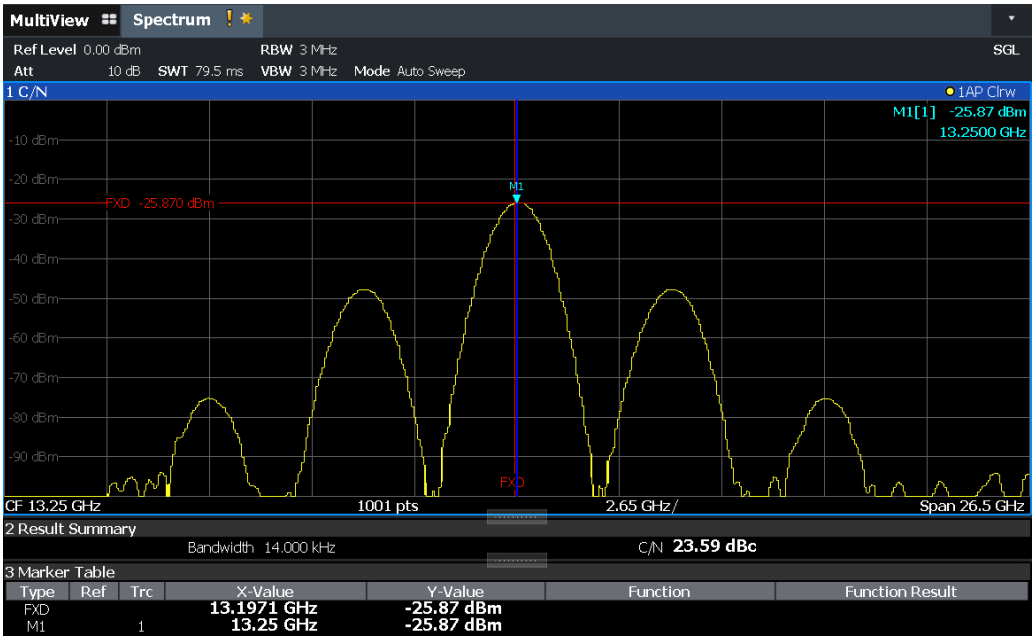
The carrier-to-noise measurements are only available in the frequency domain (span >0).

Frequency span

To measure the carrier-to-noise ratio correctly, set the frequency span to approximately twice the channel bandwidth. The "Adjust Settings" function automatically uses that value.

5.3.6.2 Carrier-to-noise results

As a result of the carrier-to-noise measurement, the evaluated bandwidth and the calculated carrier-to-noise ratio are displayed in the result window. For a "C/N_0" measurement, the ratio normalized to a 1 Hz bandwidth is displayed. The fixed reference marker for the (unmodulated) carrier is indicated in the diagram.



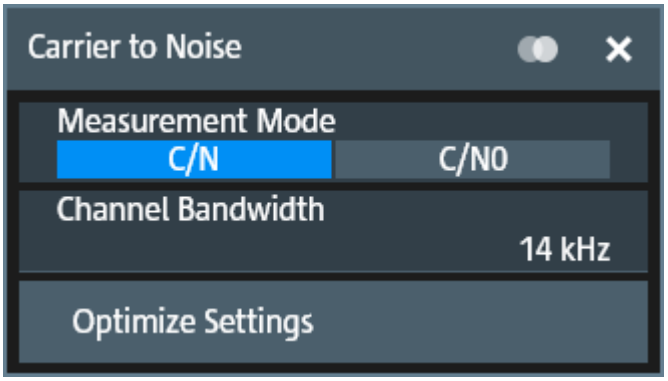
Remote command:

```
CALC:MARK:FUNC:POW:RES? CN
CALC:MARK:FUNC:POW:RES? CN0
```

See CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult on page 1231 .

5.3.6.3 Carrier-to-noise configuration

Access: "Overview" > "Select Measurement" > "C/N"/"C/N_0" > "Carrier to Noise Configuration"



When you select the "C/N"/"C/N_0" measurement, a measurement is automatically started. If no marker is active, marker 1 is enabled. The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use Marker > "Marker to Trace" (see "Trace" on page 1185).

Carrier-to-noise measurements are not available in zero span mode.

The easiest way to configure a measurement is using the configuration "Overview", see Section 4.1.3, "Configuration overview", on page 114.

The remote commands required to perform these tasks are described in Section 5.5.1.4, "Measuring the carrier-to-noise ratio", on page 1301.

Measurement Mode....1133
Channel Bandwidth....1134
Optimize Settings....1134

Measurement Mode
Toggles between a basic carrier-to-noise ratio measurement ("C/N") and a carrier-to-noise ratio in relation to the bandwidth ("C/N_0").

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SELect on page 1233
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult on page 1231
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>[:STATe] on page 1234

Channel Bandwidth
Defines the channel bandwidth in which the carrier and noise powers are calculated.

The default setting is 14 kHz.

Remote command:
`[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>]` on page 1239

Optimize Settings
Enables the RMS detector and adjusts the span to twice the selected channel bandwidth.

The FSWX only adjusts the value once. If necessary, you can change the setting later.

Remote command:
`[SENSe:]POWer:ACHannel:PRESet` on page 1235

5.3.6.4 How to determine the carrier-to-noise ratio

The following step-by-step instructions demonstrate how to determine the carrier-to-noise ratio.



For remote operation, see "Programming example: Measuring the carrier-to-noise ratio" on page 1301.

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. Select [Meas].
2. To configure the measurement without reference to the bandwidth, select "C/N".
   To configure the measurement with reference to the bandwidth, select "C/N_0".
3. To change the channel bandwidth to analyze, select "Channel Bandwidth".
4. Select [Run Single].

   A fixed reference marker is set to the detected (unmodulated) carrier. The marker is indicated in the diagram as "FXD".
5. If the carrier signal is located within the analyzed channel bandwidth, switch off the carrier signal so that only the noise is displayed in the channel.
6. To optimize the settings for the selected channel configuration and use the RMS detector, select "Optimize Settings".
7. Select [Run Single] to perform a second measurement.

   The carrier-to-noise ratio is displayed after the measurement finishes.

5.3.7 Occupied bandwidth measurement (OBW)

An important characteristic of a modulated signal is its occupied bandwidth. The occupied bandwidth is defined as the bandwidth containing a defined percentage of the

total transmitted power.. In a radio communications system, for instance, the occupied bandwidth must be limited to enable distortion-free transmission in adjacent channels.

Remote commands:

`CALC:MARK:FUNC:POW:SEL OBW` `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SELect` on page 1233

Results:

`CALC:MARK:FUNC:POW:RES? OBW`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult` on page 1231

Section 5.5.1.5, "Measuring the occupied bandwidth", on page 1302

- About the measurement 1135
- OBW results 1136
- OBW configuration 1137
- How to determine the occupied bandwidth 1139
- Measurement example 1140

5.3.7.1 About the measurement

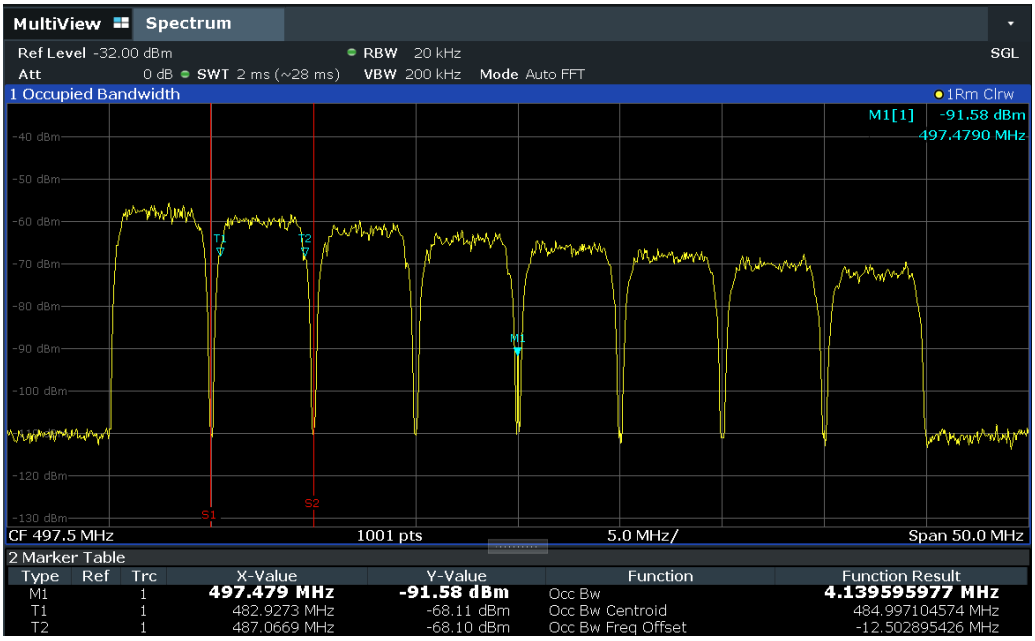
The occupied bandwidth is defined as the bandwidth containing a defined percentage of the total transmitted power. You can define a percentage between 10 % and 99.9 %.

Measurement principle

The bandwidth containing 99% of the signal power is to be determined, for example. The algorithm first calculates the total power of all displayed points of the trace. In the next step, the points from the right edge of the trace are summed up until 0.5 % of the total power is reached. Auxiliary marker 1 is positioned at the corresponding frequency. Then the points from the left edge of the trace are summed up until 0.5 % of the power is reached. Auxiliary marker 2 is positioned at this point. 99 % of the power is now between the two markers. The distance between the two frequency markers is the occupied bandwidth, which is displayed in the marker field.

OBW within defined search limits - multicarrier OBW measurement in one sweep

You can also determine the occupied bandwidth of the signal within defined search limits instead of for the entire signal. Thus, only a single sweep is required to determine the OBW for a multicarrier signal. For this meaurement, you define search limits for an individual carrier. The OBW measurement is restricted to the frequency range contained within those limits. Then you adjust the search limits for the next carrier. The FSWX automatically recalculates the OBW for the new range, wihtout performing a new sweep.



For step-by-step instructions, see "How to determine the OBW for a multicarrier signal using search limits" on page 1140.

Prerequisites

To ensure correct power measurement, especially for noise signals, and to obtain the correct occupied bandwidth, the following prerequisites and settings are necessary:

- Only the signal to be measured is displayed in the window, or search limits are defined to include only one (carrier) signal. An additional signals falsify the measurement.
- RBW is significantly smaller than the occupied bandwidth (approximately 1/20 of occupied bandwidth, for voice communication type: 300 Hz or 1 kHz)
- VBW at least 3 times RBW
- Span at least 2 to 3 times occupied bandwidth
- Trace detector: RMS

Some measurement specifications (e.g. PDC, RCR STD-27B) require measuring the occupied bandwidth using a peak detector. In this case, you have to change the trace detector setting of the FSWX.

5.3.7.2 OBW results

As a result of the OBW measurement, the occupied bandwidth ("Occ BW") is indicated in the marker results. Furthermore, the marker at the center frequency and the temporary markers are indicated.

The FSWX measures the OBW on the trace with marker 1. To evaluate another trace, place marker 1 on another trace (see Trace).

If you change the Search Limits(Left / Right), the FSWX recalculates the OBW, without performing a new sweep. Thus, you can determine the OBW for a multicarrier signal using only one sweep.

Centroid frequency

The centroid frequency is defined as the point in the center of the occupied bandwidth. It is calculated using the temporary OBW markers T1 and T2. This frequency is indicated as a function result in the marker table ("Occ BW Centroid").

Frequency offset

The offset of the calculated centroid frequency to the defined center frequency of the FSWX is indicated as a function result in the marker table ("Occ BW Freq Offset").

A frequency offset defined in the "Frequency" settings is not considered for the centroid frequency result.

Remote command:

You can query the determined occupied bandwidth using the remote command `CALC:MARK:FUNC:POW:RES? OBW` or `CALC:MARK:FUNC:POW:RES? AOBW`. While the `OBW` parameter returns only the occupied bandwidth, the `AOBW` parameter also returns the position and level of the temporary markers T1 and T2 used to calculate the occupied bandwidth.

`CALC:MARK:FUNC:POW:SEL OBW`, see`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SELect` on page 1233

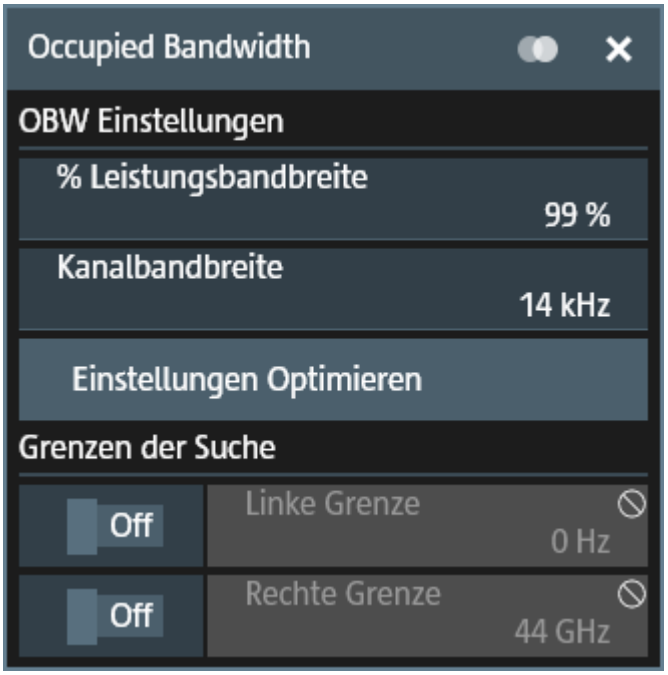
`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>[:STATe]` on page 1234

`CALC:MARK:FUNC:POW:RES? OBW`, see`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult` on page 1231

`CALC:MARK:FUNC:POW:RES? COBW`, see`CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult` on page 1231

5.3.7.3 OBW configuration

Access: "Overview" > "Select Measurement" > "OBW" > "OBW Configuration"



This measurement is not available in zero span.

Configuring search limits for OBW measurement

The OBW measurement uses the same search limits as defined for marker search (see "Search Limits" on page 1190). However, only the left and right limits are considered.

The remote commands required to perform these tasks are described in Section 5.5.1.5, "Measuring the occupied bandwidth", on page 1302.

% Power Bandwidth 1138
Channel Bandwidth 1138
Optimize Settings 1139
Search Limits(Left / Right) 1139

% Power Bandwidth

Defines the percentage of total power in the displayed frequency range used to calculate the occupied bandwidth. Values from 10 % to 99.9 % are supported.

Remote command:

`[SENSe:]POWer:BANDwidth` on page 1303

Channel Bandwidth

Defines the channel bandwidth for the transmission channel in single-carrier measurements. This bandwidth is used to optimize the test parameters (for details see "Optimize Settings" on page 1139). The default setting is 14 kHz.

For measurements according to a specific transmission standard, define the bandwidth specified by the standard for the transmission channel.

For multicarrier measurements, this setting is irrelevant.

Remote command:
[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>] on page 1239

Optimize Settings
Optimizes the instrument settings for the measurement of the occupied bandwidth according to the specified channel bandwidth.

This function is only useful for single carrier measurements.

All instrument settings relevant for power measurement within a specific frequency range are optimized:

- Frequency span: 3 × channel bandwidth
- RBW: maximum 1/40 of channel bandwidth
- VBW: at least 3 times RBW
- Trace detector: RMS

The reference level is not affected by "Adjust Settings". For an optimum dynamic range, select the reference level such that the signal maximum is close to the reference level.

(See "Setting the reference level automatically (Perform Auto Level)" on page 266).

The FSWX only adjusts the values once. If necessary, you can change the settings later.

Remote command:
[SENSe:]POWer:ACHannel:PRESet on page 1235

Search Limits(Left / Right)
If enabled, limit lines are defined and displayed for the search. The measurement only considers results within the limited search range.

For details on limit lines for searches, see "Peak search limits" on page 313.

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 707
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT on page 708
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt on page 708

5.3.7.4 How to determine the occupied bandwidth

The following step-by-step instructions demonstrate how to determine the occupied bandwidth.



For remote operation, see Section 5.5.1.5, "Measuring the occupied bandwidth", on page 1302

How to determine the OBW for a single carrier

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. Select [Meas], or "Overview" > "Select Measurement".
2. Select the "OBW" measurement function.

The measurement starts immediately with the default settings.

3. Select "OBW Configuration".
   The "Occupied Bandwidth" configuration dialog box is displayed.
4. Define the percentage of power you want to determine the bandwidth for ("% Power Bandwidth").
5. If necessary, change the channel bandwidth for the transmission channel.
6. To optimize the settings for the selected channel configuration, select "Adjust Settings".
7. Start a sweep.

   The result is displayed as OBW in the marker results.

How to determine the OBW for a multicarrier signal using search limits

1. Select [MEAS], or "Overview" > "Select Measurement".
2. Select the "OBW" measurement function.
3. Select "OBW Configuration".
4. Define the percentage of power you want to determine the bandwidth for ("% Power Bandwidth").
5. Define search limits so the search area contains only the first carrier signal:
   a) Enter values for the left or right limits, or both.
   b) Enable the use of the required limits.
6. Start a sweep.

   The result for the first carrier is displayed as OBW in the marker results.
7. Change the search limits so the search area contains the next carrier signal as described in step 5.

   The OBW is recalculated and the result for the next carrier is displayed. A new sweep is not necessary.
8. Repeat these steps until all carriers have been measured.

5.3.7.5 Measurement example

In the following example, we determine the bandwidth that occupies 99 % of the total power of a PDC signal at 800 MHz, level 0 dBm.



A programming example demonstrating an OBW measurement in a remote environment is provided in "Programming example: OBW measurement" on page 1303.

1. Preset the FSWX.
2. Set the "Center Frequency" to *800 MHz*.

3. Set the "Reference level" to *-10 dBm*.
4. Select [Meas], or "Overview" > "Select Measurement".
5. Select the "OBW" measurement function.
6. Select "OBW Configuration".
7. Set the "% Power Bandwidth" to *99 %*.
8. Set the "Channel Bandwidth" to *21 kHz* as specified by the PDC standard.
9. Select "Adjust Settings" to optimize the settings for the selected channel configuration.
10. In the [Auto Set] menu, select "Perform Auto Level" to adjust the reference level to the measured total power.
11. The PDC standard requires the peak detector for OBW measurement. In the "Trace Configuration" dialog, set the trace detector to "Positive Peak".
12. Start a sweep.

    The result is displayed as OBW in the marker results.

5.3.8 Time domain power measurement

The "Time Domain Power" measurement determines the power of a signal in the time domain.

The time domain power can only be measured in zero span mode.

- About the measurement 1141
- Time domain power results 1142
- Time domain power basics - range definition using limit lines 1142
- Time domain power configuration 1143
- How to measure powers in the time domain 1144
- Measurement example 1145

5.3.8.1 About the measurement

The "Time Domain Power" measurement determines the power of a signal in zero span mode. The FSWX adds up the power at the individual measurement points and divides the result by the number of measurement points. Thus, you can measure the power of TDMA signals during transmission, for example, or during the muting phase. You can measure both the mean power and the RMS power.

For this measurement, we recommend using the sample detector. The sample detector is enabled automatically if the detector is in "Auto" mode.

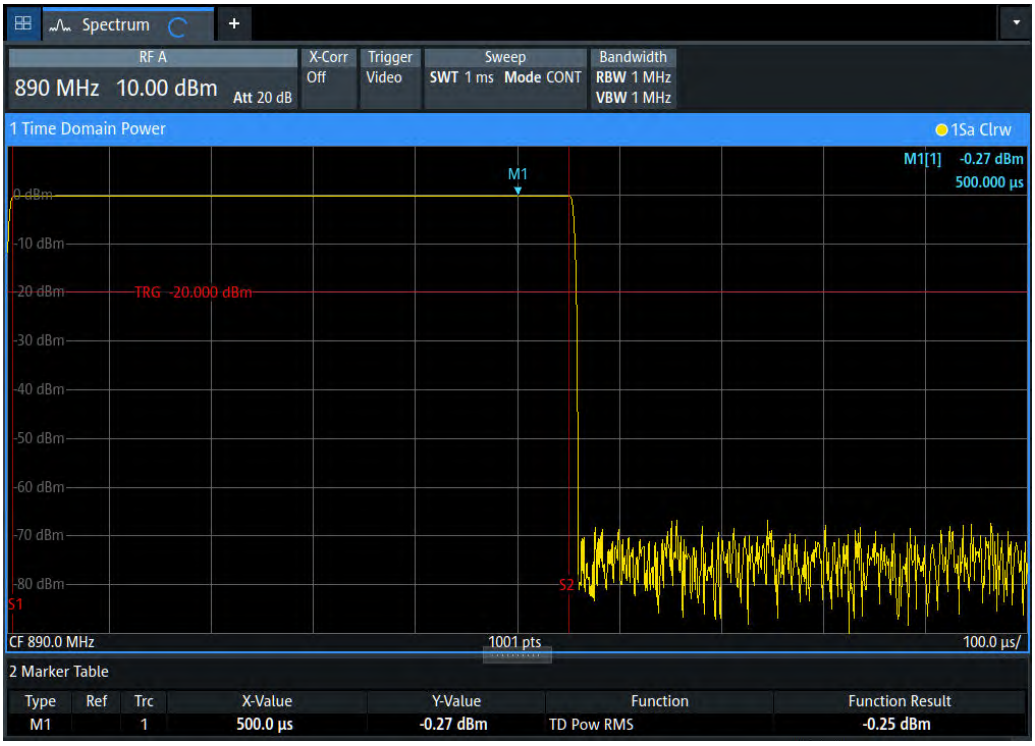
5.3.8.2 Time domain power results

The "Time Domain Power" measurement determines several different power results simultaneously:

Result	Description
"Peak"	Peak value from the points or a segment of the displayed trace.
"RMS"	RMS value from the points or a segment of the displayed trace.
"Mean"	Mean value from the points or a segment of the displayed trace. The linear mean value of the equivalent voltages is calculated. For example, to measure the mean power during a GSM burst
"Standard Deviation"	The standard deviation of the measurement points from the mean value.

The result is displayed in the "Marker Table", indicated by "Power" and the selected power result, e.g. "RMS".

In addition, the "Time Domain Power" window shows a power vs. time diagram.



To query the results, use the remote commands described in "Retrieving measurement results" on page 1388.

5.3.8.3 Time domain power basics - range definition using limit lines

You can restrict the range of the measured signal to evaluate for the power measurement using limit lines. The left and right limit lines (S1, S2) define the evaluation range.

They are indicated by vertical red lines in the diagram. If enabled, the power results are only calculated from the levels within the limit lines.

For example, if both the on and off phases of a burst signal are displayed, you can restrict the measurement range to the transmission or to the muting phase. Thus, you can measure the ratio between the signal and the noise power of a TDMA signal, for instance. Measure the complete signal once to obtain the power + noise level. Then vary the measurement range to obtain the power level in the on phase and the noise level in the off phase.

To get stable measurement results for a limited evaluation range, you usually require a trigger.

5.3.8.4 Time domain power configuration

Access: "Overview" > "Select Measurement" > "Time Domain Power" > "Time Domain Power Configuration"



The remote commands required to perform these tasks are described in Section 5.5.1.10, "Measuring the time domain power", on page 1384.

Results....1144
Limits State....1144
Left/ Right Limits....1144

Results
If enabled, the "Time Domain Power" measurement determines the power result for the displayed trace or a limited area of the trace.

"Peak"	Peak power over several measurements (uses trace averaging, "Max Hold")
"RMS"	RMS value from the points or a segment of the displayed trace.
"Mean"	Mean value from the points or a segment of the displayed trace. The linear mean value of the equivalent voltages is calculated.
"Standard Deviation"	The standard deviation of the measurement points from the mean value. The "Mean" result is automatically also enabled.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe]` on page 1387
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult?` on page 1390
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe]` on page 1387
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult?` on page 1391
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe]` on page 1386
`CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult?` on page 1389

Limits State
Enables or disables the use of limits for the evaluation range.

If disabled (default), the measurement evaluates the entire sweep time.

If enabled, the evaluation range is defined by the left and right limit. By default, the left limit is set to the start frequency. The right limit is set to the stop frequency.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 707

Left/ Right Limits
Defines the beginning and end of the evaluation range and thus the position of line S1 (left) and S2 (right).

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 708
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt` on page 708

5.3.8.5 How to measure powers in the time domain

The step-by-step procedure to measure powers in the time domain is described here in detail.

To measure the power in the time domain

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. Select [Meas], or "Overview" > "Select Measurement".
2. Select the "Time Domain Power Configuration" measurement function.

3. Select the type of power measurement results to determine.
4. To restrict the power evaluation range, define limits:
   a) Select "Time Domain Power Configuration".
      The "Time Domain Power Configuration" configuration dialog box is displayed.
   b) Enable the use of the limits by setting the limit state to "On".
      The limit lines S1 and S2 are displayed.
   c) Define the left limit (limit line S1), the right limit (S2), or both.
5. Start a sweep.

   The measured powers are displayed in the "Marker Table".

5.3.8.6 Measurement example

This measurement example demonstrates the time domain power calculation for a GSM burst.



For remote operation, see "Programming example: time domain power" on page 1393.

Test setup

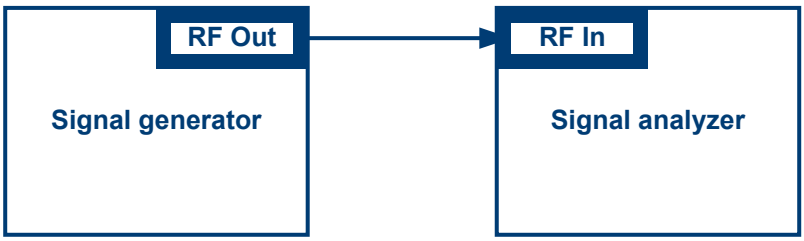


Table 5-18: Signal generator settings (e.g. R&S SMW)

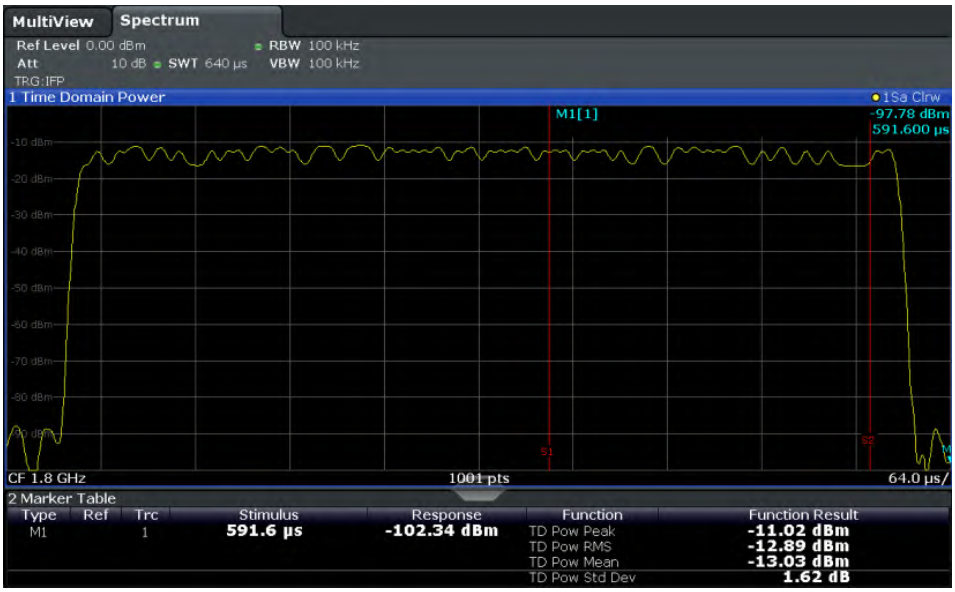
Frequency:	1.8 GHz
Level:	-10 dBm
Modulation:	GSM/EDGE

To determine the time domain power for a GSM burst

1. Preset the FSWX.
2. Set the center frequency to *1.8 GHz*.
3. Set the RBW to *100 kHz*.
4. Set the sweep time to *640 µs*.
5. Set the trigger source to "Power".
6. Define a trigger offset of *-50 µs*.
7. Select [Meas], or "Overview" > "Select Measurement".

8. Select the "Time Domain Power Configuration" measurement function.
9. In the "Time Domain Power Configuration" dialog box, set all four results to "On".
10. Set the limits state to "On".
11. Define the left limit at *326 µs* and the right limit at *538 µs*.
    This range corresponds to the useful part of the GSM burst.

    The mean power of the useful part of the GSM burst is calculated to be -13 dBm.



5.3.9 Harmonic distortion measurement

The "Harmonic Distortion" measurement measures harmonics and their distortion to the input signal, including the total harmonic distortion.

- About the measurement 1146
- Harmonic distortion basics 1147
- Harmonic distortion results 1150
- Harmonic distortion configuration 1151
- How to determine the harmonic distortion 1152

5.3.9.1 About the measurement

The "Harmonic Distortion" measurement determines the harmonics of a signal easily, for example due to a VCO. In addition, the total harmonic distortion (THD) is calculated.

For measurements in the frequency domain, the "Harmonic Distortion" measurement starts with an automatic search for the first harmonic (= peak) within the defined frequency range. The FSWX sets the center frequency to this frequency and adjusts the reference level accordingly.

For measurements in zero span, the center frequency remains unchanged.

The "Harmonic Distortion" measurement then performs zero span sweeps at the center frequency and at each harmonic, i.e. at frequencies that are a multiple of the center frequency.

As a result, the zero span sweeps on all harmonics are shown, as well as the RMS values and the total harmonic distortion (THD).



An application note discussing harmonics measurement is available from the Rohde & Schwarz website:

1EF78: Measurement of Harmonics using Spectrum Analyzers

5.3.9.2 Harmonic distortion basics

Measuring the harmonics of a signal is a frequent problem which you can solve best using a signal analyzer. In general, every signal contains harmonics. Harmonics are generated by nonlinear characteristics, which add frequencies to a pure sine wave. They can often be reduced by lowpass filters. The signal analyzer itself has a nonlinear characteristic, for example in its first mixer. Thus, the FSWX must ensure that harmonics produced in the signal analyzer do not cause spurious results. If necessary, it must use a highpass filter to attenuate only the fundamental wave, but not the other harmonics. Harmonics are particularly critical regarding high-power transmitters such as transceivers, because large harmonics can interfere with other radiocommunications services.

Harmonic distortion can refer to different results:

- The level of the individual components
- The root mean square of all components together, known as the total harmonic distortion (THD)
  The THD is set in relation to the power of the fundamental frequency (= center frequency).

Obtainable dynamic range

When you measure harmonics, the dynamic range you can obtain depends on the second harmonic intercept of the signal analyzer. The second harmonic intercept is a virtual input level at the RF input mixer. It is the input level at which the level of the second harmonic becomes equal to the level of the fundamental wave. In practice, however, applying a level of this magnitude would damage the mixer. Nevertheless, the second harmonic intercept is useful to determine the available dynamic range for measuring the harmonic distortion of a DUT.

As shown in Figure 5-44, the level of the second harmonic drops by 20 dB if the level of the fundamental wave is reduced by 10 dB.

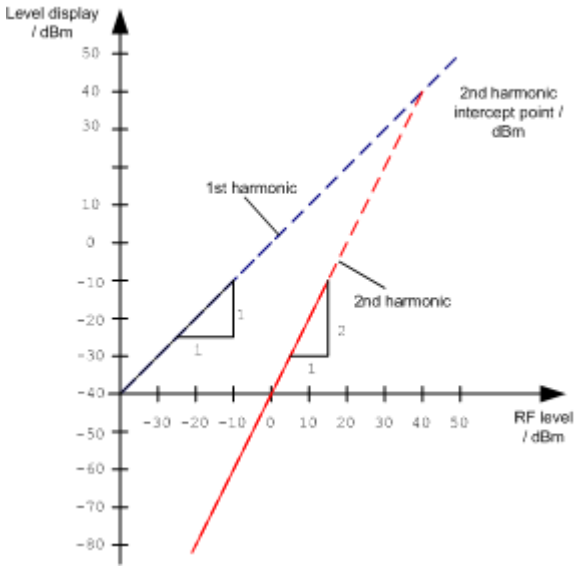


Figure 5-44: Extrapolation of the first and second harmonics to the second harmonic intercept point at 40 dBm

The following equation for the obtainable harmonic distortion d_2 in dB is derived from the linear equations of the harmonics and the given intercept point:

$$d_2 = IP2 - P_M$$

Figure 5-45: Equation for the obtainable harmonic distortion

d_2 = harmonic distortion
IP2 = second harmonic intercept
P_M = mixer level in dBm

The mixer level is the RF level at the RF input minus the defined RF attenuation.

The equation for the internally generated level P_1 at the second harmonic in dBm is:

$$P_1 = 2 * P_M - IP2$$

Figure 5-46: Equation for the internally generated level P1 at the second harmonic

The lower measurement limit for the harmonic is the noise floor of the signal analyzer. If the harmonic of the measured DUT is sufficiently averaged using a video filter, it is at least 4 dB above the noise floor. Thus, the measurement error due to the input noise is less than 1 dB.

Rules for measuring high harmonic ratios

The following rules for measuring high harmonic ratios can be derived:

- Select the smallest possible IF bandwidth for a minimal noise floor.
- Select an RF attenuation which is high enough to measure the harmonic ratio only.

The maximum harmonic distortion is obtained if the level of the harmonic equals the intrinsic noise level of the receiver. The level applied to the mixer, according to the Equation for the internally generated level P1 at the second harmonic, is:

$$P_M = \frac{P_{noise}/dBm + IP2}{2}$$

Figure 5-47: Equation for the power applied to the mixer

Example:

Assume the following values:

- Resolution bandwidth: 10 Hz
- Noise level: -143 dBm
- IP2: 40 dBm

Then the optimum mixer level is – 51.5 dBm.

According to the Equation for the obtainable harmonic distortion, the maximum measurable harmonic distortion is:

40 dBm -(– 51.5 dBm) = 91.5 dB

The obtainable dynamic range for the harmonic distortion measurement is thus:

91.5 dB minus a minimum S/N ratio of 4 dB = 87.5 dB

Detecting the origin of harmonics

If the harmonics emerges from noise sufficiently (approximately >15 dB), it is easy to determine their origin. They either originate from the DUT or they are generated internally by the signal analyzer. You increase the RF attenuation by 10 dB and the harmonic level remains constant, then the harmonic originates from the DUT. Only the displayed noise increases by 10 dB due to the additional attenuation. If the harmonic is exclusively generated by the signal analyzer, the level of the harmonic is reduced by 20 dB or is lost in noise. If both the DUT and the signal analyzer contribute to the harmonic, the harmonic level is reduced less.

High-sensitivity harmonics measurements

If the harmonics levels are very low, you must reduce the resolution bandwidth to measure them considerably. Therefore, the sweep time is increased considerably. In this case, the FSWX uses a small span to measure individual harmonics. Only to measure the frequency range around the harmonics, the FSWX uses a small resolution bandwidth.

Required measurement time

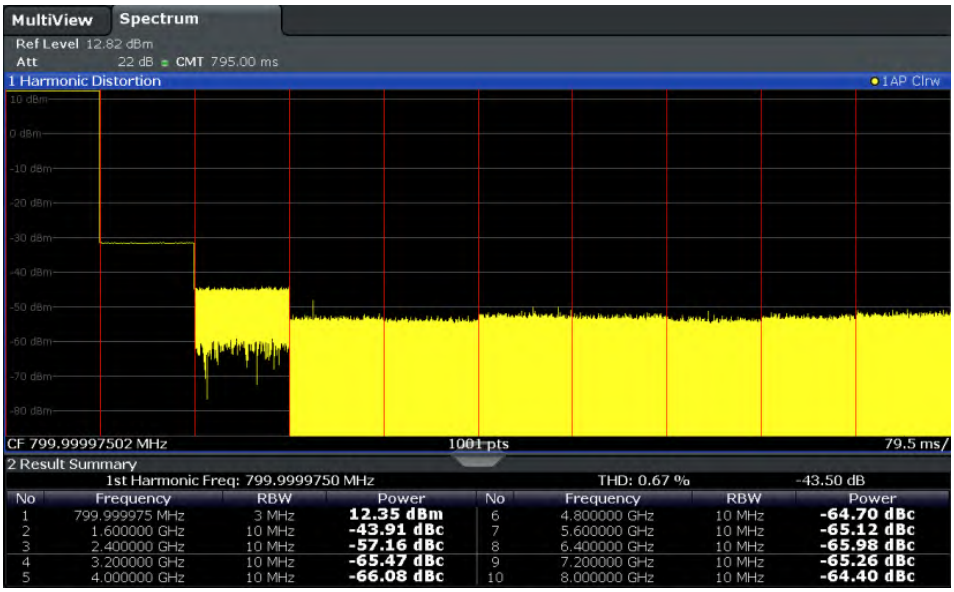
During the "Harmonic Distortion" measurement, the FSWX performs zero span sweeps at the center frequency and at each harmonic. You can define the duration of each sweep ("Harmonic Sweep Time", "SWT") and the "Number of Harmonics" (n). Thus, the required measurement time for the "Harmonic Distortion" measurement (*cumulated measurement time*, "CMT") is:

*CMT = n*SWT*

The required measurement time is indicated as "CMT" in the application panel.

5.3.9.3 Harmonic distortion results

As a result of the "Harmonic Distortion" measurement, the powers measured in the zero span sweeps of all detected harmonics are shown in the "Harmonic Distortion" diagram. The individual sweeps are separated by red display lines.



In addition, a "Result Summary" provides the following information:

- First harmonic frequency
- THD (total harmonic distortion), relative and absolute values
- For each detected harmonic:
  - Frequency
  - RBW
  - Power

A frequency offset defined in the "Frequency" settings is not considered for the harmonic frequency results.

Remote commands

You can also query the results using remote commands.

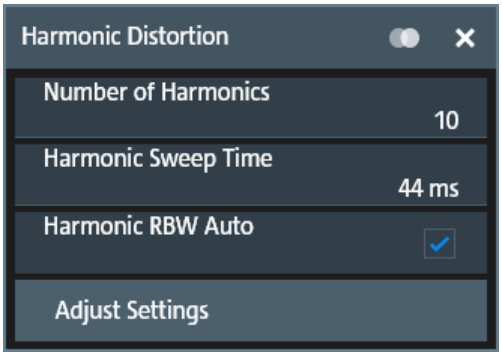
Query the first harmonic frequency using the general center frequency command `[SENSe<ip>:]FREQuency:CENTer` on page 612.

THD:`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion?` on page 1397

List of harmonics:`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST` on page 1397

5.3.9.4 Harmonic distortion configuration

Access: "Overview" > "Select Measurement" > "Harmonic Distortion" > "Harmonic Distortion Configuration"



The remote commands required to perform these tasks are described in Section 5.5.1.11, "Measuring the harmonic distortion", on page 1394.

Number of Harmonics....1151
Harmonic Sweep Time....1151
Harmonic RBW Auto....1151
Adjust Settings....1152

Number of Harmonics
Defines the number of harmonics to measure. The range is from 1 to 26. Default is 10.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics` on page 1396

Harmonic Sweep Time
Defines the sweep time for the zero span measurement on each harmonic frequency. This setting is identical to the normal sweep time for zero span, see also Section 4.3.3.7, "How long the data is measured: sweep time", on page 246.

Remote command:
`[SENSe:]SWEep:TIME:AUTO` on page 1427

Harmonic RBW Auto
Determines whether the RBW is defined automatically by the FSWX or manually by the user.

Auto mode is available for "Normal (3dB)" (Gaussian) and "5-Pole" filter types.

The RBW is set according to the following equation:

$RBW_n = RBW_1 * n$

If RBW_n is not available, the next higher value is used.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO`
on page 1395

Adjust Settings
The FSWX starts a new peak search in the frequency range that was set before you started the harmonic measurement. The FSWX then sets the center frequency to the peak frequency and adjusts the reference level accordingly.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet` on page 1396

5.3.9.5 How to determine the harmonic distortion



Section 4.8.2.3, "Measurement example: measuring harmonics using marker functions", on page 310 describes how to measure harmonics using marker functions. You can measure harmonics much easier using the "Harmonic Distortion" measurement, as described in the following procedure.

For remote operation, see "Example: measuring the harmonic distortion" on page 1397.

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. Select [Meas], or "Overview" > "Select Measurement".
2. Select the "Harmonic Distortion" measurement function.
3. Define the number of harmonics to determine ("Number of Harmonics").
4. Perform a sweep.

   The traces for the determined harmonics are displayed in the "Harmonic Distortion" diagram, separated by red display lines. The "Result Summary" indicates the measured power for each harmonic in relation to the fundamental.
5. If the signal changes significantly during or after the harmonics measurement, use the "Adjust Settings" function to adjust the settings automatically and restart the measurement.

5.3.10 Third order intercept (TOI) measurement

If you apply a two-tone signal with equal carrier levels to the input, you can determine the third order intercept point of the FSWX.

- About the TOI measurement 1153
- TOI basics 1153
- TOI results 1157
- TOI configuration 1159
- How to determine the third order intercept 1160
- Measurement example: Measuring the FSWX's intrinsic intermodulation 1160

5.3.10.1 About the TOI measurement

If several signals are applied to a two-port transmission device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the wanted signals, which intermodulate at the characteristic. The intermodulation products of lower order have a special effect, since their level is largest and they are near the wanted signals. The intermodulation product of third order causes the highest interference. It is the intermodulation product generated from one of the wanted signals and the second harmonic of the second wanted signal for two-tone modulation.

To measure the third order intercept point (TOI), the FSWX expects a two-tone signal with equal carrier levels at the input. The FSWX sets normal marker 1 and normal marker 2 to the maximum of the two signals. Marker 3 and marker 4 are placed on the intermodulation products.

The FSWX calculates the third order intercept point from the level difference between the first 2 markers and the markers 3 and 4, and displays it in the "Marker Table".

5.3.10.2 TOI basics

If several signals are applied to a two-port transmission device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the wanted signals, which intermodulate at the characteristic.

The frequencies of the intermodulation products are above and below the wanted signals. Figure 5-48 shows intermodulation products P_{S1} and P_{S2}, generated by the two wanted signals P_{U1} and P_{U2}.

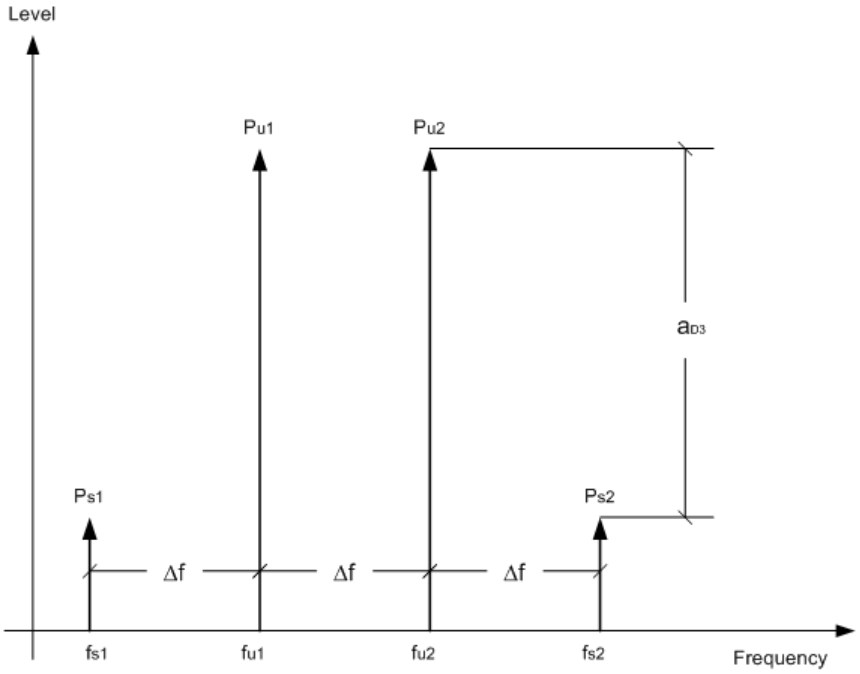


Figure 5-48: Intermodulation products Ps1 and Ps2

The intermodulation product at f_{s1} is generated by mixing the second harmonic of wanted signal P_{U1} and wanted signal P_{U2}.

$$f_{s1} = 2 * f_{u1} - f_{u2}$$

Figure 5-49: Equation for the intermodulation product at fs1

The intermodulation product at f_{s2} is generated by mixing the second harmonic of wanted signal P_{U2} and wanted signal P_{U1}.

$$f_{s2} = 2 * f_{u2} - f_{u1}$$

Figure 5-50: Equation for the intermodulation product at fs2

Dependency on level of wanted signals

The level of the intermodulation products depends on the level of the wanted signals. If you increase the two wanted signals by 1 dB, the level of the intermodulation products increases by 3 dB. Thus, the spacing a_{D3} between intermodulation signals and wanted signals is reduced by 2 dB, as shown in Figure 5-51.

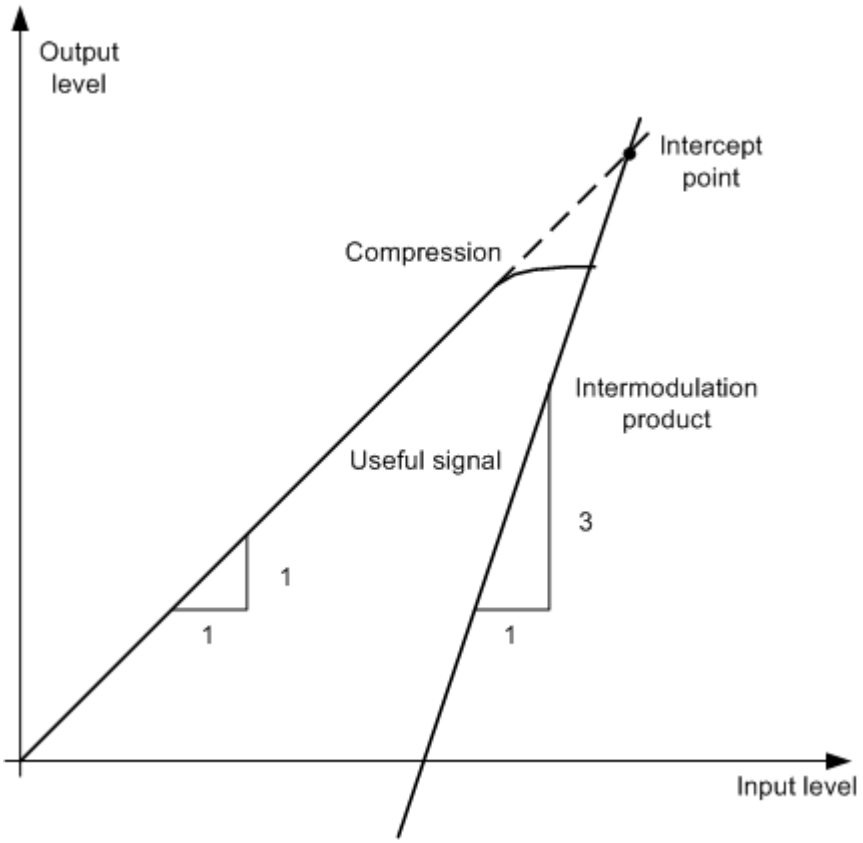


Figure 5-51: Dependency of intermodulation products on level of wanted signals

The wanted signals at the two-port output increase proportionally with the input level as long as the two-port is in the linear range. A level change of 1 dB at the input causes a level change of 1 dB at the output. Beyond a certain input level, the two-port goes into compression and the output level stops increasing. The intermodulation products of the third order increase three times as quickly as the wanted signals. The intercept point is the fictitious level where the two lines intersect. It cannot be measured directly, since the useful level is limited by the maximum two-port output power.

Calculation method

However, the intercept point can be calculated according to the following linear equation:

$$IP3 = \frac{a_{D3}}{2} + P_U$$

Figure 5-52: Equation for IP3

IP3 = Third intercept point
a_{D3} = measured spacing between intermodulation signals and wanted signals at a given level P_u

Example:

Assume that the measured spacing between intermodulation and the wanted signal is 60 dB at the input level P_U= -20 dBm. Then the third order intercept point (TOI) is calculated as:

$$IP3 = \frac{60}{2} + (-20dBm) = 10dBm$$

Intermodulation-free dynamic range

The *intermodulation-free dynamic range* is the level range in which no internal intermodulation products are generated when you measure two-tone signals. It is determined by the third order intercept point, the phase noise and the thermal noise of the signal analyzer. At high signal levels, the range is determined by intermodulation products. At low signal levels, intermodulation products disappear below the noise floor. Thus, the noise floor and the phase noise of the signal analyzer determine the range. The noise floor and the phase noise depend on the used resolution bandwidth. At the smallest resolution bandwidth, the noise floor and phase noise are at a minimum. The intermodulation-free dynamic range is at its maximum. However, small resolution bandwidths require a large increase in sweep time. It is therefore best to select the largest resolution bandwidth possible to obtain the required dynamic range. Phase noise decreases as the offset from the carrier increases. Thus, the influence of the phase noise decreases with increasing frequency offset from the wanted signals.

The following diagrams illustrate the intermodulation-free dynamic range for different offsets from the wanted signal as a function of:

- The selected bandwidth
- The level at the input mixer (= signal level – RF attenuation)

For typical values for your instrument, see the specifications document.

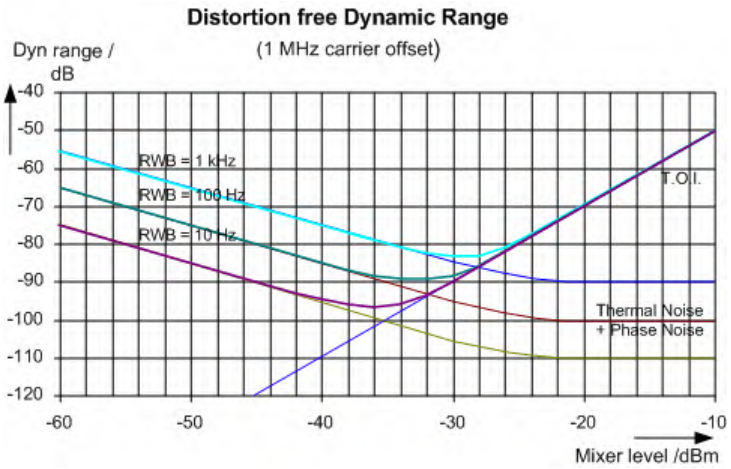


Figure 5-53: Intermodulation-free range as a function of level at the input mixer and resolution bandwidth

Sample values at 2 GHz:

- Wanted signal offset = 1 MHz
- DANL = -145 dBm/Hz
- TOI = 15 dBm

The optimum mixer level, i.e. the level at which the intermodulation distance is at its maximum, depends on the bandwidth. At a resolution bandwidth of 10 Hz, it is approximately -35 dBm. At 1 kHz, it increases to approximately -30 dBm.

Phase noise has a considerable influence on the intermodulation-free range at carrier offsets between 10 kHz and 100 kHz (see Figure 5-54). At greater bandwidths, the influence of the phase noise is greater than with small bandwidths. The optimum mixer level at the bandwidths under consideration becomes almost independent of bandwidth and is approximately -40 dBm.

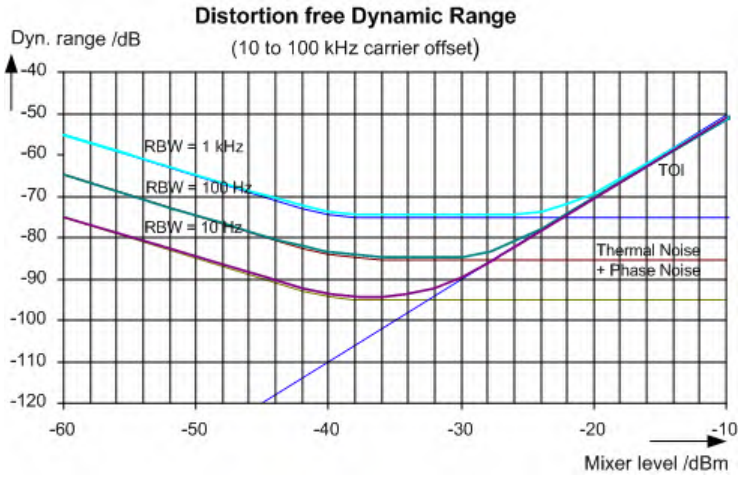


Figure 5-54: Intermodulation-free dynamic range as a function of level at the input mixer and resolution bandwidth

Sample values at 2 GHz:

- Wanted signal offset = 10 kHz to 100 kHz
- DANL = -145 dBm/Hz
- TOI = 15 dBm

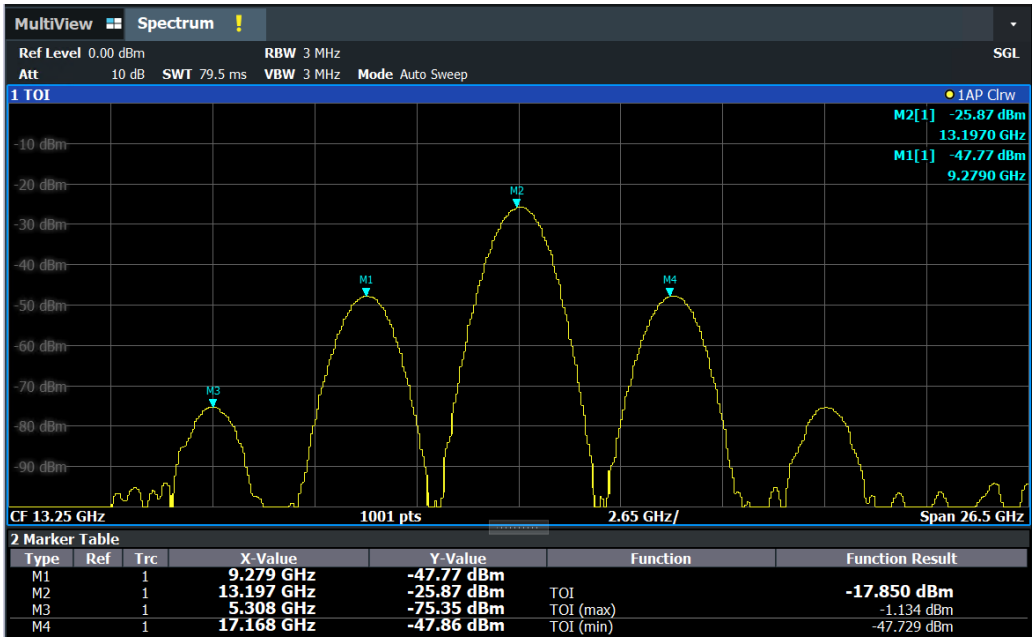
When you measure the intermodulation products of a DUT with a high dynamic range, you usually use a small resolution bandwidth. In this case, it is best to measure the levels of the wanted signals and the levels of the intermodulation products separately, using a small span. The measurement time is reduced, in particular if the offset of the wanted signals is large. To find signals reliably when the frequency span is small, it is best to synchronize the signal sources and the FSWX.

5.3.10.3 TOI results

The "Third Order Intercept" measurement provides the following results:

TOI diagram....1158
M1....1158
M2....1158
M3....1158
M4....1159
TOI....1159
TOI (max)....1159
TOI (min)....1159

TOI diagram
Spectrum of the measured two-tone signal and all measured distortions.



Remote command:
TRACe<n>[:DATA] on page 688

M1
Maximum of first wanted signal

Remote command:
CALC:MARK1:X?, see CALCulate<n>:MARKer<m>:X on page 703

M2
Maximum of second wanted signal

Remote command:
CALC:MARK2:X?, see CALCulate<n>:MARKer<m>:X on page 703

M3
First intermodulation product

Remote command:
CALC:MARK3:X?, see CALCulate<n>:MARKer<m>:X on page 703

M4
Second intermodulation product

Remote command:
`CALC:MARK4:X?`, see `CALCulate<n>:MARKer<m>:X` on page 703

TOI
Third-order intercept point for averaged levels (see also Section 5.3.10.3, "TOI results", on page 1157 and Figure 5-48):

$P_{U\text{-}AVG} + (P_{U\text{-}AVG} - P_{S\text{-}AVG})/2$

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult?` on page 1399 .

TOI (max)
Third-order intercept point for maximum levels:

$P_{U\text{-}MAX} + (P_{U\text{-}MAX} - P_{S\text{-}MIN})/2$

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult:MAXimum?` on page 1400

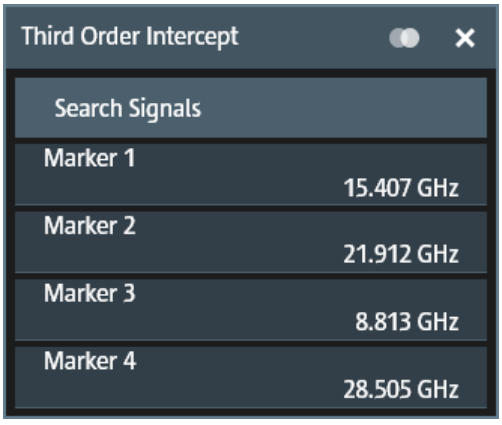
TOI (min)
Third-order intercept point for minimum levels:

$P_{U\text{-}MIN} + (P_{U\text{-}MIN} - P_{S\text{-}MAX})/2$

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult:MINimum?` on page 1400

5.3.10.4 TOI configuration

Access: "Overview" > "Select Measurement" > "Third Order Intercept" > "Third Order Intercept Configuration"



The remote commands required to perform these tasks are described in Section 5.5.1.12, "Measuring the third order intercept point", on page 1398.

Search Signals 1160
Marker 1/Marker 2/Marker 3/Marker 4 1160

Search Signals
Performs a new search on the input signals and recalculates the TOI according to the measured values.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:TOI:SEARchsignal ONCE` on page 1399

Marker 1/Marker 2/Marker 3/Marker 4
Indicates the detected characteristic values as determined by the TOI measurement (see Section 5.3.10.3, "TOI results", on page 1157).

If you move the markers, the FSWX recalculates the TOI according to the new marker values.

To reset all marker positions automatically, use the Search Signals function.

Remote command:
`CALCulate<n>:MARKer<m>:X` on page 703

5.3.10.5 How to determine the third order intercept

The precise TOI for the FSWX in relation to the input signals is provided in the specifications document.

For remote operation, see "Programming example: measuring the TOI" on page 1401.

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. Apply a two-tone signal with equal carrier levels to the FSWX input.
2. Select [Meas], or "Overview" > "Select Measurement".
3. Select the "Third Order Intercept" measurement function.

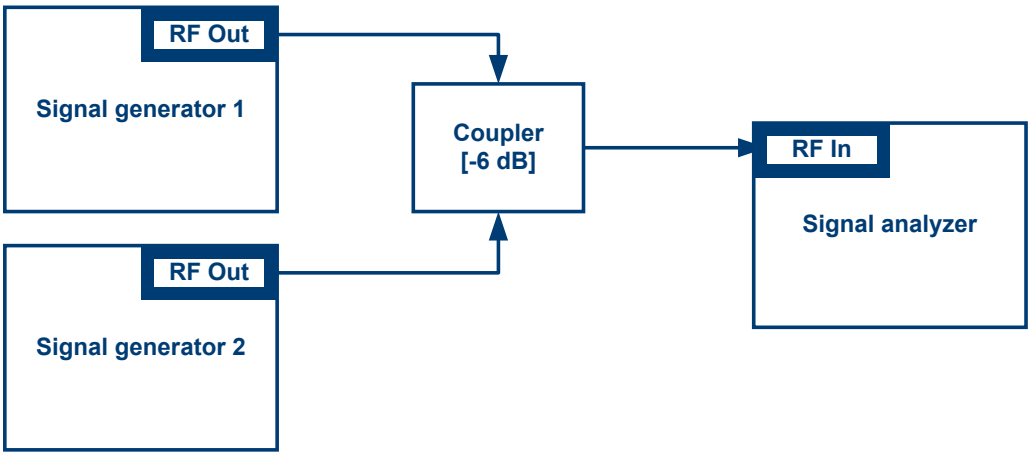
   The "Marker Table" shows the calculated TOI and the markers required for calculation.
4. If the signal changes significantly during or after the TOI measurement, use the "Search Signals" function to start a new signal search automatically.

   The TOI calculation restarts.

5.3.10.6 Measurement example: Measuring the FSWX's intrinsic intermodulation

A programming example demonstrating a TOI measurement in a remote environment is provided in "Programming example: measuring the TOI" on page 1401.

Test setup:



Signal generator settings (e.g. R&S SMW):

Device	Level	Frequency
Signal generator 1	-4 dBm	799.6 MHz
Signal generator 2	-4 dBm	800.4 MHz

Setting up the measurement

1. Preset the FSWX.
2. Set the center frequency to *800 MHz* and the frequency span to *3 MHz*.
3. Set the reference level to *-10 dBm* and RF attenuation to *0 dB*.
4. Set the resolution bandwidth to *10 kHz*.
   The noise is reduced, the trace becomes smoother and you can see the intermodulation products clearly.
5. Set the VBW to *1 kHz*.

Measuring intermodulation using the Third Order Intercept measurement function

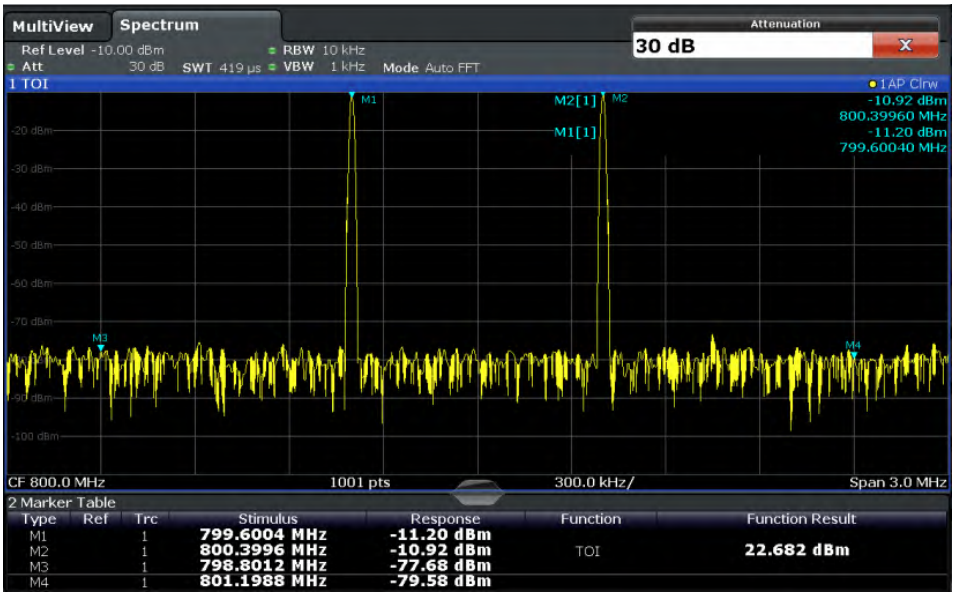
1. Select [Meas] > "Third Order Intercept".

   The FSWX enables four markers to measure the intermodulation distance. It places two markers on the wanted signals and two on the intermodulation products. The FSWX calculates the TOI from the level difference between the wanted signals and the intermodulation products. The "Marker Table" displays the results:



2. The level of a signal analyzer's intrinsic intermodulation products depends on the RF level of the wanted signals at the input mixer. When you increase the RF attenuation, the mixer level is reduced and the intermodulation distance increases. With an additional RF attenuation of 10 dB, the levels of the intermodulation products are reduced by 20 dB. The noise level is, however, increased by 10 dB. Increase the RF attenuation to 20 dB to reduce intermodulation products.

   The FSWX's intrinsic intermodulation products disappear below the noise floor.



5.3.11 AM modulation depth measurement

This measurement determines the AM modulation depth of an AM-modulated carrier.

For a list of available applications, FSWXsee Section 4.1.1.3, "Available applications", on page 105.

- About the measurement....1163
- AM modulation depth results....1163
- AM modulation depth configuration....1164
- Optimizing and troubleshooting the measurement....1165
- How to determine the AM modulation depth....1165

5.3.11.1 About the measurement

The AM modulation depth, also known as a modulation index, indicates how much the modulated signal varies around the carrier amplitude. It is defined as:

M_{Depth} = peak signal amplitude / unmodulated carrier amplitude

So for M_{Depth} = 0.5, for example, the carrier amplitude varies by 50% above and below its unmodulated level, and for M_{Depth} = 1.0 it varies by 100%.

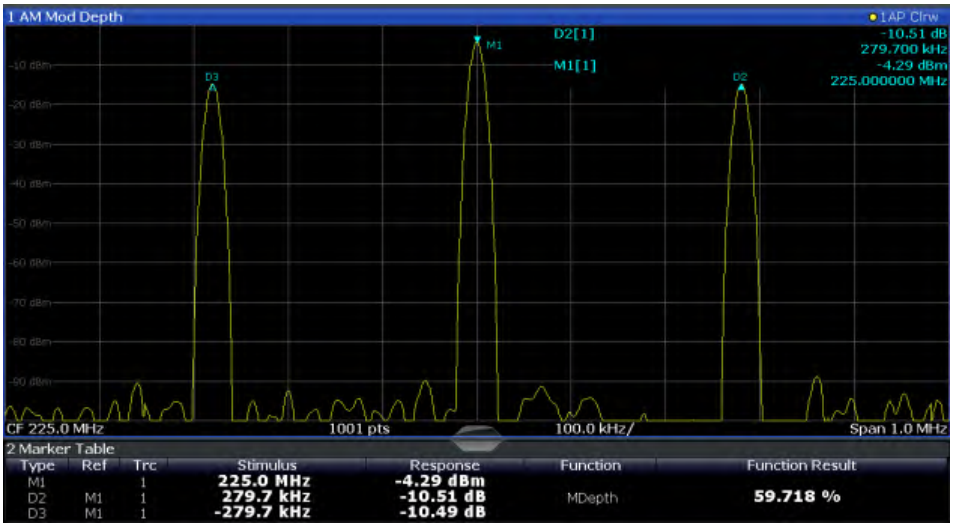
When you start this measurement, the FSWX sets marker 1 to the peak level, which is considered to be the carrier level. Delta markers 2 and 3 are automatically set symmetrically to the carrier on the adjacent peak values of the trace. You can move the markers manually, if necessary.

The FSWX calculates the power at the marker positions from the measured levels. The AM modulation depth is calculated as the ratio between the power values at the reference marker and at the delta markers. If the powers of the two AM sidebands are unequal, the mean value of the two power values is used to calculate the AM modulation depth.

5.3.11.2 AM modulation depth results

As a result of the "AM Modulation Depth" measurement, the "Marker Table" shows the following values:

Label	Description
MDepth	AM modulation depth in percent
M1	Maximum of the signal (= carrier level)
D2	Offset of next peak to the right of the carrier
D3	Offset of the next peak to the left of the carrier

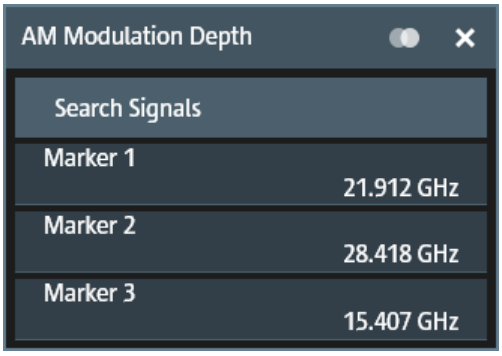


Remote command:

To query the AM modulation depth, use the remote command `CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult<t>?` on page 1402.

5.3.11.3 AM modulation depth configuration

Access: "Overview" > "Select Measurement" > "AM Modulation Depth" > "AM Modulation Depth Configuration"



The remote commands required to perform these tasks are described in Section 5.5.1.13, "Measuring the AM modulation depth", on page 1401.

Marker 1/Marker 2/Marker 3 1164
Search Signals 1165

Marker 1/Marker 2/Marker 3
Indicates the detected characteristic values as determined by the "AM Modulation Depth" measurement:

Marker	Description
"M1"	Maximum of the signal (= carrier level)
"D2"	Offset of next peak to the right of the carrier
"D3"	Offset of the next peak to the left of the carrier

If you move the markers, the FSWX recalculates the modulation depth according to the new marker values.

To reset all marker positions automatically, use the Search Signals function.

Note: Moving the marker positions manually. When you move the position of delta marker 2, delta marker 3 is moved symmetrically with respect to the reference marker 1.
You can move delta marker 3 for fine adjustment independently of marker 2.

You can also move marker 1 manually for re-adjustment without affecting the position of the delta markers.

Remote command:
`CALCulate<n>:MARKer<m>:X` on page 703
`CALCulate<n>:DELTamarker<m>:X` on page 700
`CALCulate<n>:DELTamarker<m>:X:RELative?` on page 701

Search Signals
Performs a new search on the input signal and recalculates the AM modulation depth according to the measured values.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARchsignal ONCE`
on page 1402

5.3.11.4 Optimizing and troubleshooting the measurement

If the results do not meet your expectations, try the following methods to optimize the measurement:

- Set the center frequency to the frequency of the device under test.
- Adjust the span so the peaks to the left and right of the carrier, produced by the AM modulated signal, are clearly visible.
  If the span is too wide, these signals can fall together with the carrier, and the measurement cannot be performed.
  If the span is too narrow, theses signals are outside of the measured span and the delta markers cannot find these peaks.
  The rule of thumb is to set the span to three times the value of the AM modulation frequency.

5.3.11.5 How to determine the AM modulation depth

The following step-by-step instructions demonstrate how to determine the AM modulation depth.



For remote operation, see "Example: measuring the AM modulation depth" on page 1403.

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. Apply a modulated carrier signal to the FSWX input.
2. Select [Meas], or "Overview" > "Select Measurement".
3. Select the "AM Modulation Depth" measurement function.

   The "Marker Table" indicates the calculated "AM Modulation Depth"and the markers required for calculation.
4. If the signal changes significantly during or after the "AM Modulation Depth" measurement, use the "Search Signals" function to start a new peak search automatically.

   The FSWX recalculates the AM modulation depth.

5.3.12 Noise power ratio (NPR) measurement

The "Noise Power Ratio" measurement is similar to the common "Channel Power ACLR" measurement, but less sophisticated and therefore easier to configure.

This optional measurement requires an additional license: Noise Power Ratio Measurements (R&S FSW3-KM620).

- About noise power ratio (NPR) measurements....1166
- NPR basics....1167
- NPR results....1168
- NPR general configuration....1170
- Notch Setup....1171
- Generator setup....1174
- Generator frequency coupling....1178
- How to perform NPR measurements....1180
- Measurement example....1181

5.3.12.1 About noise power ratio (NPR) measurements

The noise power ratio is defined as the relationship between the total power density in a channel and the noise power density. The noise power ratio is commonly used to describe the distortion caused by in-band multicarrier intermodulation in a wideband satellite channel. A satellite can be considered to be a "transparent transponder". It receives the uplink signal, amplifies it, translates the frequency, amplifies it more, and finally retransmits it. Typically, the signal contains many carriers. To measure the in-band distortions of specific carriers in a satellite DUT, notch filters are inserted inside the channel. Notch filters remove the effects of the underlying subcarriers from the signal. Thus, the distortion of these carriers caused by the others can be determined.

The "Noise Power Ratio" measurement allows you to specify your satellite channel and up to 25 notch filters in your measurement setup. For a more general measurement, you can select the bandwidth on which the total power density is based freely. As a result, the channel power density, the notch power density, and the noise power ratio are calculated.

5.3.12.2 NPR basics

Some background knowledge on basic terms and principles used in noise power ratio measurements is provided here for a better understanding of the required configuration settings.

Channel bandwidth, integration bandwidth and notch bandwidth

The "Channel Bandwidth" defines the width of the channel, or general measurement range. The displayed span usually depends on the channel bandwidth (span = channel bandwidth * 1.1)

The "Integration Bandwidth" defines the frequency range over which measurement results are calculated. By default, it is the same as the channel bandwidth, but you can define any other value, smaller or larger, as well.

The "Notch Bandwidth" defines the width of the notches, if you define any.

Notches and their effects on the measurement results

You can select from an automatic measurement mode that selects the integration bandwidth automatically, and a manual measurement mode that allows you to define a custom integration bandwidth.

In automatic measurement mode, the power within the notches is deducted from the total noise power density.

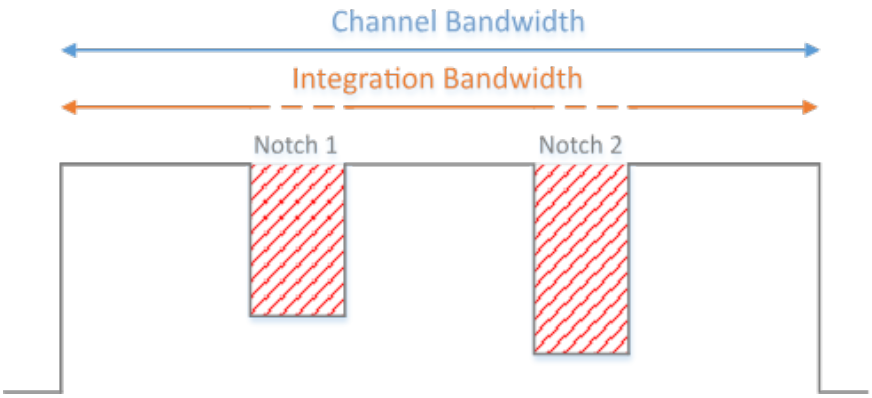


Figure 5-55: Auto mode: Integration bandwidth = channel bandwidth (notches deducted)

In manual measurement, however, the notch power is not deducted. In manual mode, the application simply integrates all measured powered levels over the integration bandwidth, including the power levels measured within the notches.

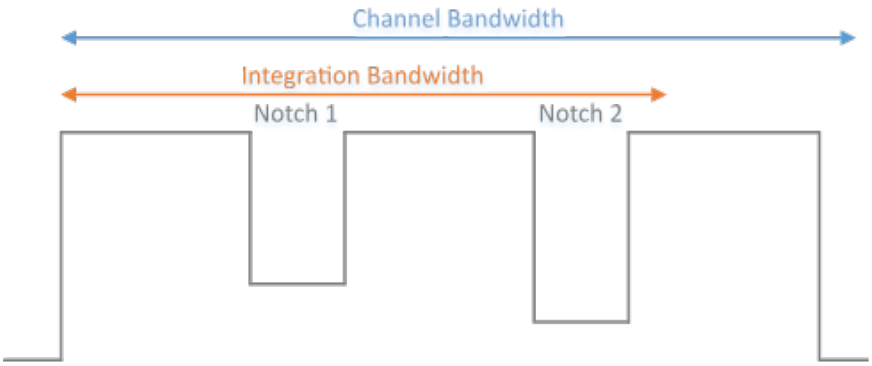


Figure 5-56: Manual mode: Integration bandwidth ≠ channel bandwidth (notches not deducted)

Overlapping notches or notches outside the channel bandwidth

Note that measurement results can become inaccurate when notches overlap or lie outside of the channel bandwidth.

NPR measurements with signal generator control

To test the NPR of a satellite channel with multiple notch filters using a signal generator, you must configure the same settings on the analyzer and on the generator. The FSWX can now take control of the connected generator, so that you only need to configure the notches once. The analyzer can then automatically set the generator to the same settings.

Generator control by the FSWX has the following preconditions on the signal generator:

- R&S SMW
- Notched Noise option (R&S SMW-K811) installed
- Either ARB waveforms or one of the standards supported by the K811 option active on the generator

Frequency-coupled NPR measurements

For NPR measurements, configuring and reconfiguring the carrier frequencies and notches both on the analyzer and on the generator can become tedious. Therefore, frequency coupling is provided in which the analyzer takes control of the generator. The frequency on the generator is automatically set to the analyzer frequency, possibly with a fixed factor or offset applied.

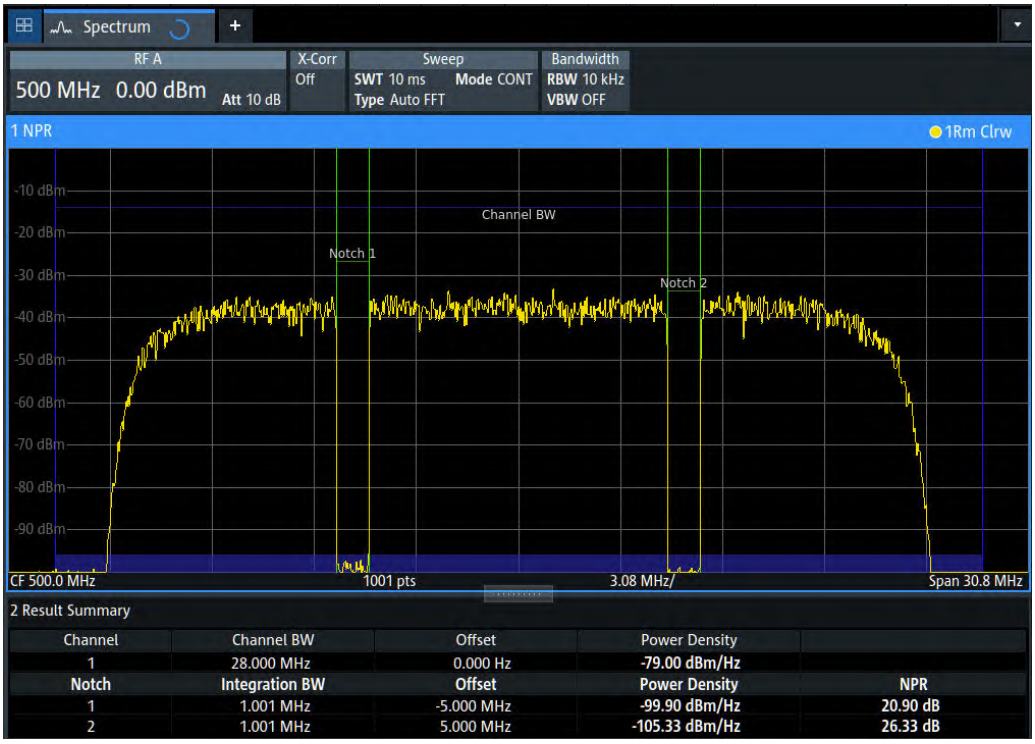
5.3.12.3 NPR results

The FSWX shows the measurement results in a diagram and a "Result Summary" in numerical form.

The diagram consists of several elements.

- A horizontal blue bar at the bottom of the diagram indicates the channel bandwidth.

- Two vertical blue lines indicate the integration range or integration bandwidth. It is the same as the channel bandwidth by default (it is labeled "Channel BW" in that case).
- Vertical green lines indicate notches and their bandwidth. The number of displayed notches is variable.



In the "Result Summary", the following results are provided for the specified channel and individual notches:

Table 5-19: Result Summary parameters for a Noise Power Ratio measurement

Parameter	Description
"Channel" / "Notch"	Channel or notch number
"Channel BW" / "Integration BW"	Specified channel bandwidth or manually defined integration bandwidth used as the basis for power density calculation in total channel or notch
"Offset"	Frequency offset of notch or integration bandwidth to center frequency
"Channel Power" / "Power density"	Power measured in channel or notch - absolute value or density (= power divided by the "Channel BW"/"Integration BW" in dBm/Hz)
"NPR"	(Notches only:) Ratio of total channel power density to notch power density in dB

Remote command:

Channel power (density), notch power density, power ratio:

`CALCulate<n>:NPRatio:RESult?` on page 1318

Measured power values for each sweep point (by default 1001):

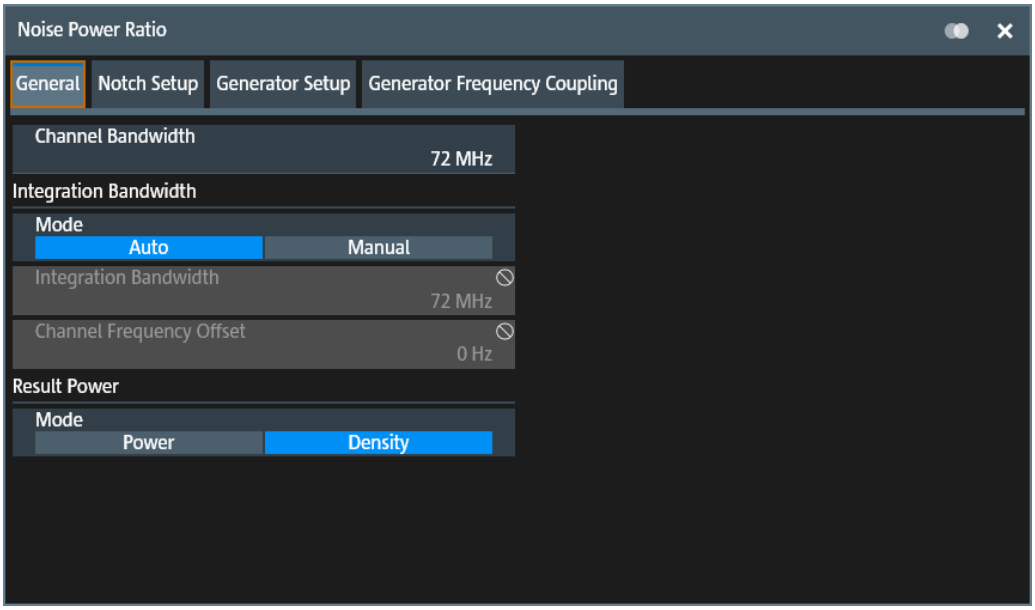
```
TRAC:DATA? TRACe1
```

See TRACe<n>[:DATA] on page 688.

5.3.12.4 NPR general configuration

Access: "Overview" > "Select Measurement" > "Noise Power Ratio" > "NPR Configuration" > "General" tab

The "Noise Power Ratio" measurement allows you to specify your satellite channel. For a more general measurement, you can select the bandwidth on which the total power density is based freely.



Channel Bandwidth 1170
Integration Bandwidth Mode 1170
Integration Bandwidth 1171
Channel Frequency Offset 1171
Result Power Mode 1171

Channel Bandwidth
Defines the channel bandwidth on which the total power density is based. The bandwidth is positioned around the currently defined "Center Frequency".

To specify a different bandwidth for total power density calculation, or to shift the bandwidth, define an Integration Bandwidth Mode manually.

Remote command:
[SENSe:]NPRatio:CHANnel:BWIDth on page 1304

Integration Bandwidth Mode
In "Auto" mode (default), the integration bandwidth is the same as the channel bandwidth. Notches are deducted from the results.

In "Manual" mode, you can customize the integration bandwidth. However, the results include the power levels measured within notches.

Remote command:
[SENSe:]NPRatio:CHANnel:INTegration:AUTO on page 1305

Integration Bandwidth
Defines a bandwidth other than the channel bandwidth to calculate the total power density.

The results include the power levels measured within notches.

Remote command:
[SENSe:]NPRatio:CHANnel:INTegration:BWIDth on page 1305

Channel Frequency Offset
Shifts the bandwidth away from the currently defined "Center Frequency".

Remote command:
[SENSe:]NPRatio:CHANnel:INTegration:FREQuency:OFFSet on page 1306

Result Power Mode
Determines whether the power measured in a channel or notch is indicated as a power or a density value.

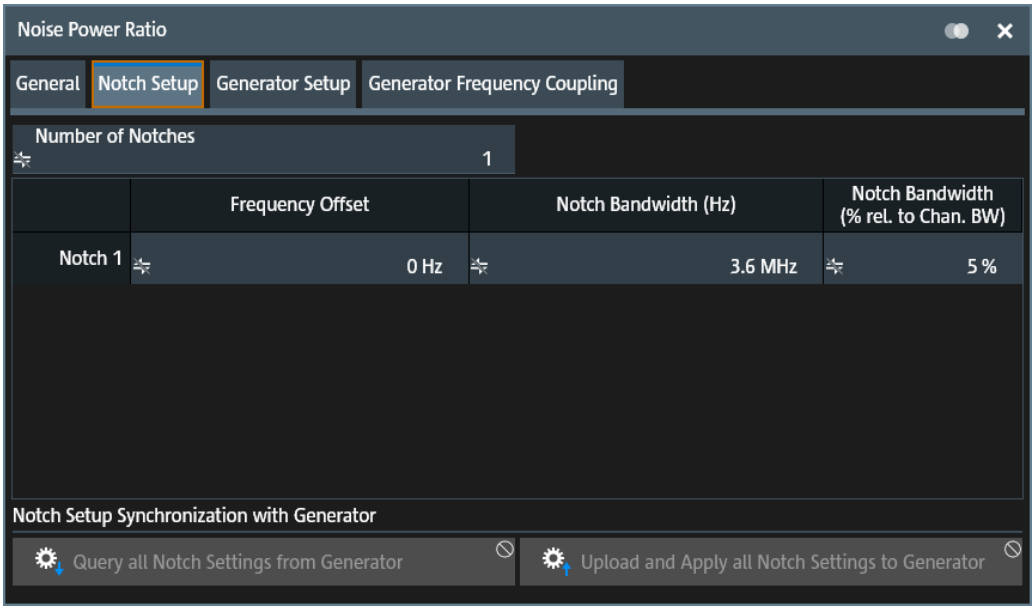
"Power" Absolute power measured in channel or notch in current amplitude unit

"Density" Power measured in channel or notch divided by the "Channel BW"/"Integration BW" in dBm/Hz

Remote command:
[SENSe:]NPRatio:MODE on page 1306

5.3.12.5 Notch Setup

The "Noise Power Ratio" measurement allows you to specify up to 25 notch filters in your measurement setup.



Number of Notches....1172
Generator Notch Filter State....1172
Frequency Offset per notch....1173
Notch Bandwidth (absolute / relative to channel bandwidth)....1173
Upload all Notch Settings to Generator....1173
Query all Notch Settings from Generator....1174

Number of Notches
Defines the number of notches for which results are determined. You can define a maximum of 25 notches. Note that you can define bandwidths for more than the specified number of notches. However, results are only calculated and displayed for the specified number of notches.

If Generator Control state is enabled in the generator settings, the specified number of notches are sent to the generator on upload.

See Section 5.3.12.3, "NPR results", on page 1168 for more information on how notches are treated in the measurement.

Remote command:
`[SENSe:]NPRatio:NOTCh<notch>:COUNt` on page 1307
`CONFigure:GENerator:NPRatio:NOTCh<notch>:COUNt:CSTate?` on page 1314

Generator Notch Filter State
Enables or disables a notch filter on the signal generator.

This setting is only available if Generator Control state is enabled. Its value is only sent to the signal generator when you select Upload all Generator Setup Settings to Generator.

Remote command:
`CONFigure:GENerator:NPRatio[:STATe]` on page 1316
`CONFigure:GENerator:NPRatio:STATe:CSTate?` on page 1316

Frequency Offset per notch
Defines the center position of the notch in relation to the currently defined "Center Frequency".

If Generator Control state is enabled, the frequency offset for the notch is sent to the generator on upload.

If you define variable frequencies, the defined factor (Numerator / Denominator) is also applied to the frequency offset per notch. See Section 5.3.12.7, "Generator frequency coupling", on page 1178.

$FreqOffset_{Gen}$ = Numerator / Denominator * $FreqOffset_{Analyzer}$

Remote command:
`[SENSe:]NPRatio:NOTCh<notch>:FREQuency:OFFSet` on page 1307
`CONFigure:GENerator:NPRatio:NOTCh<notch>:FREQuency:OFFSet:CSTate?` on page 1312

Notch Bandwidth (absolute / relative to channel bandwidth)
Defines the bandwidth of the individual notch, either as an absolute value, or as a percentage of the defined Channel Bandwidth.

If Generator Control state is enabled, the absolute notch bandwidth is sent to the generator on upload.

If you define variable frequencies, the defined factor (Numerator / Denominator) is also applied to the absolute notch bandwidth. See Section 5.3.12.7, "Generator frequency coupling", on page 1178.

$Notch_BW_{Gen}$ = Numerator / Denominator * $Notch_BW_{Analyzer}$

Remote command:
`[SENSe:]NPRatio:NOTCh<notch>:BWIDth[:ABSolute]` on page 1307
`[SENSe:]NPRatio:NOTCh<notch>:BWIDth:RELative` on page 1306
`CONFigure:GENerator:NPRatio:NOTCh<notch>:BWIDth:ABSolute:CSTate?` on page 1312

Upload all Notch Settings to Generator
Transmits the notch settings from the FSWX to the connected signal generator. The signal generator uses the settings to create an ARB waveform, which in turn is used as the input signal for the measurement.

In particular, the following settings are transmitted to the generator:
- Generator Notch Filter State
- Number of Notches

Per notch:
- Frequency Offset per notch
- Notch Bandwidth (absolute / relative to channel bandwidth)

Changes to the notch settings are not applied to the generator immediately. Since creating the waveform can take some time, it is better to upload after all notch settings have been defined, rather than after each individual setting.

Remote command:
`CONFigure:GENerator:NPRatio:SETTings:UPDate` on page 1316

Query all Notch Settings from Generator
Queries all currently defined notch settings on the connected signal generator and applies the settings to the FSWX.

This is useful directly after activating generator control, for example, or after changing the notch settings on the generator.

In particular, the following settings are transmitted to the analyzer:
- Generator Notch Filter State
- Number of Notches

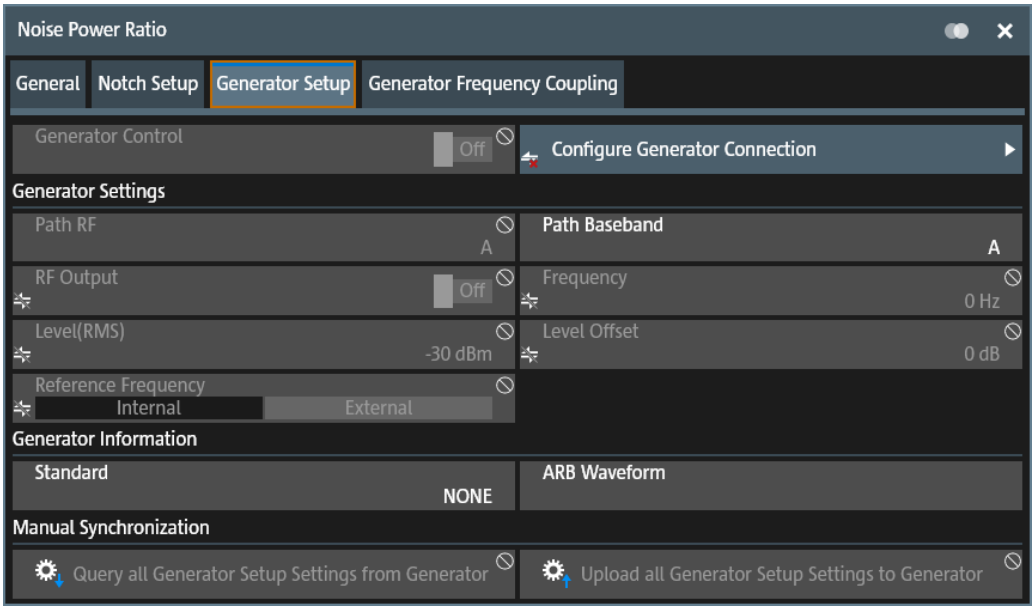
Per notch:
- Frequency Offset per notch
- Notch Bandwidth (absolute / relative to channel bandwidth)

Remote command:
`CONFigure:SETTings:NPRatio:NOTCh` on page 1318

5.3.12.6 Generator setup

Access: **Access**: "Overview" > "Select Measurement" > "Noise Power Ratio" > "NPR Configuration" > "Generator Setup" tab

Here you define the general settings required to control a connected signal generator by the FSWX. The control settings are only available if generator control is enabled and a connection to a signal generator has been established.



Remote command:

`CONFigure:GENerator:NPRatio:STATe:CSTate?` on page 1316

Generator Control state 1175
Configure Generator Connection 1175
└ IP Address or Host Name 1175
└ Device Type 1176

└ Connection State....1176
└ Connect....1176
Path RF/ Path Baseband....1176
RF Output state....1176
Frequency....1176
Level (RMS)....1177
Level Offset....1177
Reference Frequency....1177
Standard....1177
ARB Waveform File....1177
Query all Generator Setup Settings from Generator....1177
Upload all Generator Setup Settings to Generator....1178

Generator Control state
Enables or disables control of the signal generator by the FSWX.

If a connection was defined in another application instance, the connection is maintained when you switch to the current application instance. However, generator control is disabled to protect the DUT from possibly erroneous or damaging settings. Check the settings, then enable the control state.

Note:
While generator control is active, you cannot change the connection information.

Only one application instance can control a generator at any time. If you switch on generator control while it is still active in another application instance, for example for parameter coupling with a generator, the control is disabled in the other application instance.

Exception: The "SCPI Recorder" maintains control of the generator even if you switch application instances.

As long as the FSWX controls the signal generator, any (general) generator settings you define on the FSWX are automatically adapted on the generator. The opposite does not apply, that is: changes you make on the generator are not automatically applied to the FSWX. Use the Query all Notch Settings from Generator function to apply the generator settings on the FSWX.

Remote command:
`CONFigure:GENerator:NPRatio:CONTrol[:STATe]` on page 1310

Configure Generator Connection
Displays the settings to configure a signal generator connection, for example for external generator control or NPR measurements.

See Section 4.13.5.5, "Signal generator settings", on page 523.

IP Address or Host Name ← Configure Generator Connection
The IP address or computer name of the signal generator connected to the FSWX via LAN.

For tips on how to determine the default computer name, see the signal generator's user documentation.

Note:

You cannot change the connection information while a connection to a signal generator is established.

The IP address / computer name is maintained after [Preset], and is transferred between application instances. However, when you switch application instances, the control is disabled in the other application instances. Only one application instance can control a generator at any time.

If a connection to a signal generator is already configured, the connection data is provided for information only.

Remote command:
`CONFigure:GENerator:IPConnection:ADDRess` on page 864

Device Type ← Configure Generator Connection
If connected, the device type of the signal generator is indicated.

Connection State ← Configure Generator Connection
Indicates the state of the connection to the specified signal generator.

Remote command:
`CONFigure:GENerator:CONNection:CSTate?` on page 863

Connect ← Configure Generator Connection
The FSWX attempts to establish a connection to the specified signal generator.

If an instrument is connected, the following information is displayed:
- Device type
- Name and serial number
- Connection state

Remote command:
`CONFigure:GENerator:CONNection[:STATe]` on page 864

Path RF/ Path Baseband
Selects the RF signal path and indicates the baseband (BB) signal path of the generator to be used for signal generation.

Remote command:
`CONFigure:GENerator:TARGet:PATH:RF` on page 1317
`CONFigure:GENerator:TARGet:PATH:BB?` on page 1317

RF Output state
To protect the instrument from possibly erroneous or damaging settings, you must manually enable the RF output on the signal generator to start providing a signal. Check all settings on the signal generator, in particular the level settings, before activating the RF output.

Remote command:
`CONFigure:GENerator:RFOutput[:STATe]` on page 1317
`CONFigure:GENerator:NPRatio:RFOutput:STATe:CSTate?` on page 1315

Frequency
Defines the frequency of the signal provided by the signal generator.

If the Generator Frequency Coupling State is active, this value is read-only and indicates the resulting frequency setting on the generator.

Remote command:
CONFigure:GENerator:FREQuency:CENTer on page 1309
CONFigure:GENerator:NPRatio:FREQuency:CENTer:CSTate? on page 1310

Level (RMS)
(Default:) The specified power level is used for the output power by the connected signal generator.

Remote command:
CONFigure:GENerator:POWer:LEVel on page 1316
CONFigure:GENerator:NPRatio:POWer:LEVel:CSTate? on page 1314

Level Offset
Defines a fixed offset in the power level used by the generator, for example due to a gain from the DUT.

Remote command:
CONFigure:GENerator:POWer:LEVel:OFFSet on page 1317
CONFigure:GENerator:NPRatio:POWer:LEVel:OFFSet:CSTate?
on page 1315

Reference Frequency
Selects the source of the generator reference frequency.

The internal reference is that of the signal generator itself.

An external reference is provided via the EXT connectors on the generator, for example by the FSWX.

Remote command:
CONFigure:GENerator:EXTernal:ROSCillator on page 1308
CONFigure:GENerator:NPRatio:EXTernal:ROSCillator:CSTate?
on page 1310

Standard
For reference only: the standard currently used by the signal generator. If no standard is defined on the generator, notched signals are not available (see "Generator Notch Filter State" on page 1172).

Remote command:
CONFigure:GENerator:NPRatio:BB:STANdard? on page 1309

ARB Waveform File
For reference only: the ARB waveform file currently used by the signal generator.

Remote command:
CONFigure:GENerator:NPRatio:BB:ARBitrary:WAVeform:SELect?
on page 1309

Query all Generator Setup Settings from Generator
Queries all currently defined generator setup settings on the connected signal generator and applies the settings to the FSWX.

This is useful directly after activating generator control, for example, or when you change settings on the generator. The FSWX does *not* automatically adapt its settings when you change settings on the generator.

In particular, the following settings are transmitted to the analyzer:
- RF Output state
- Frequency
- Level (RMS)
- Level Offset
- Reference Frequency

Remote command:
`CONFigure:SETTings:NPRatio` on page 1318

Upload all Generator Setup Settings to Generator
Applies all generator setup settings defined on this tab to the connected signal generator once.

This is useful directly after activating generator control, for example, or when you change settings on the generator. When generator control is active, any changes to the general settings on the FSWX are immediately applied to the generator automatically.

In particular, the following settings are transmitted to the generator:
- RF Output state
- Frequency
- Level (RMS)
- Level Offset
- Reference Frequency

Remote command:
`CONFigure:GENerator:NPRatio:SETTings:UPDate` on page 1316

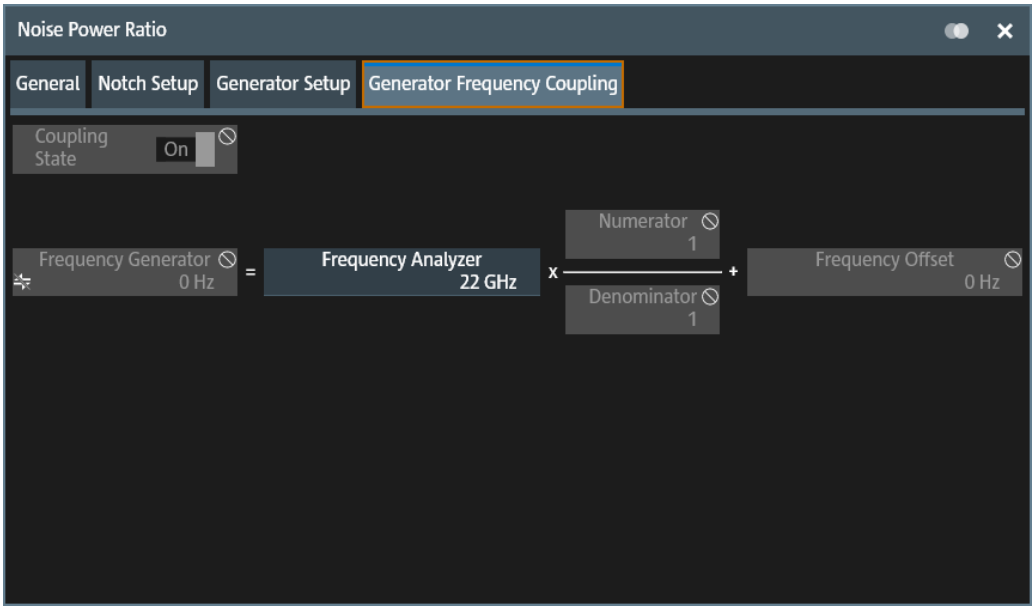
5.3.12.7 Generator frequency coupling

Access: **Access**: "Overview" > "Select Measurement" > "Noise Power Ratio" > "NPR Configuration" > "Generator Freq Coupling" tab

These settings are only available if generator control is enabled (see "Generator Control state" on page 1175).

Instead of defining a fixed frequency to be used by the signal generator, you can couple the frequency of the generator to the analyzer using a variable frequency definition.

Note that the frequency definition also affects the (absolute) notch bandwidth and the Frequency Offset per notch. See also "Notch Bandwidth (absolute / relative to channel bandwidth)" on page 1173.



Generator Frequency Coupling State....1179
Frequency Generator....1179
Frequency Analyzer....1180
Numerator....1180
Denominator....1180
Frequency Offset....1180

Generator Frequency Coupling State
Enables or disables frequency coupling between the FSWX and the connected generator.

If disabled, a fixed frequency is used by the generator.

Remote command:
`CONFigure:GENerator:NPRatio:FREQuency:COUPling[:STATe]`
on page 1311

Frequency Generator
Indicates the resulting frequency setting on the generator, depending on the other frequency parameters.

The generator frequency is defined as:

F_{Gen} = [$f_{Analyzer}$ * Numerator / "Denominator" on page 1180] + "Frequency Offset" on page 1180

Any changes to one of the interdependent parameters automatically affect the calculated signal levels on the connected generator.

If Generator Frequency Coupling State is disabled, define a fixed frequency to be used by the generator.

Remote command:
`CONFigure:GENerator:FREQuency:CENTer` on page 1309
`CONFigure:GENerator:NPRatio:FREQuency:CENTer:CSTate?` on page 1310

Frequency Analyzer
Sets the analyzer (center) frequency, which is used as a basis for the variable frequency definition.

Remote command:
`[SENSe<ip>:]FREQuency:CENTer` on page 612

Numerator
Defines the numerator of the frequency-defining factor.

Note that this factor also affects the (absolute) notch bandwidth and the "Frequency Offset per notch" on page 1173. See also "Notch Bandwidth (absolute / relative to channel bandwidth)" on page 1173.

Remote command:
`CONFigure:GENerator:NPRatio:FREQuency[:FACTor]:NUMerator`
on page 1312

Denominator
Defines the denominator of the frequency-defining factor.

Note that this factor also affects the (absolute) notch bandwidth and the Frequency Offset per notch. See also "Notch Bandwidth (absolute / relative to channel bandwidth)" on page 1173.

Remote command:
`CONFigure:GENerator:NPRatio:FREQuency[:FACTor]:DENominator`
on page 1311

Frequency Offset
Defines a fixed offset to be applied to the generator frequency.

Remote command:
`CONFigure:GENerator:NPRatio:FREQuency:OFFSet` on page 1311

5.3.12.8 How to perform NPR measurements

Measuring the noise power ratio is an easy and straightforward task with the FSWX.

Prerequisite: You have configured the input signal as described in Section 4.2.2.1, "How to capture RF data", on page 189.

1. From the "Overview", select "Frequency".
2. Define the "Center Frequency" of your channel.
3. From the "Overview", select "Select Measurement".
4. Select "Noise Power Ratio".

   The measurement is started immediately with the default settings.
5. Select "NPR Configuration".
6. Specify the "Channel Bandwidth" of your entire channel.
7. If necessary, define an appropriate span.

8. Select "Notch Setup".
9. Enter the "Number of notches" in your signal.
10. For each notch, define the bandwidth (absolute or relative to the channel bandwidth) and its position (relative to the center frequency).

    The channel and notches are indicated in the spectrum diagram, and the power results are indicated in the result summary.

5.3.12.9 Measurement example

Assume a satellite channel with a bandwidth of 28 MHz at a center frequency of 500 MHz. Notch filters are located around the subcarrier frequencies 487.8 MHz and 512.2 MHz, with a bandwidth of 3.6 MHz.

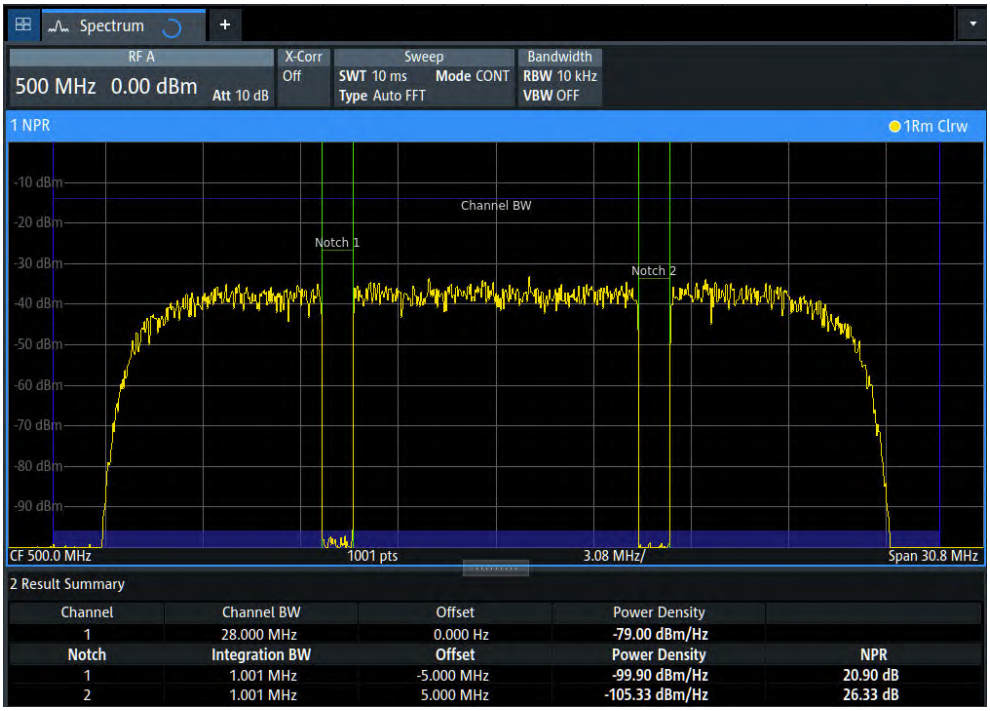
We will demonstrate how to determine the distortion caused by each subcarrier on the other, defined as the noise power ratio for each notch.



How to perform this measurement in a remote environment is described in "Programming example: measuring the noise power ratio" on page 1319.

1. From the "Overview", select "Frequency".
2. Define the "Center Frequency" = *500 MHz*.
3. Define a "Span" = *30 MHz*.
4. From the "Overview", select "Select Measurement".
5. Select "Noise Power Measurement".
6. Select "NPR Config".
7. Specify the "Channel Bandwidth" = *28 MHz*.
8. Enter the "Number of notches" = *2*.
9. For notch 1, define:
   - "Frequency Offset" = *-5 MHz*
   - "Notch Bandwidth Absolute" = *3.6 MHz*
10. For notch 2, define:
    - "Frequency Offset" = *+5 MHz*
    - "Notch Bandwidth Absolute" = *3.6 MHz*

    The channel and two notches are indicated in the spectrum diagram, and the noise power ratio for each notch is indicated in the result summary.



5.4 Result evaluation for spectrum analysis

- Marker settings....1182
- Marker search settings and positioning functions....1187
- Marker (measurement) functions....1193
- Trace evaluation....1215

5.4.1 Marker settings

Access: "Overview" > "Analysis" > "Markers"

Or: [Marker] > "Markers"

The remote commands required to define these settings are described in "Setting up individual markers" on page 696.

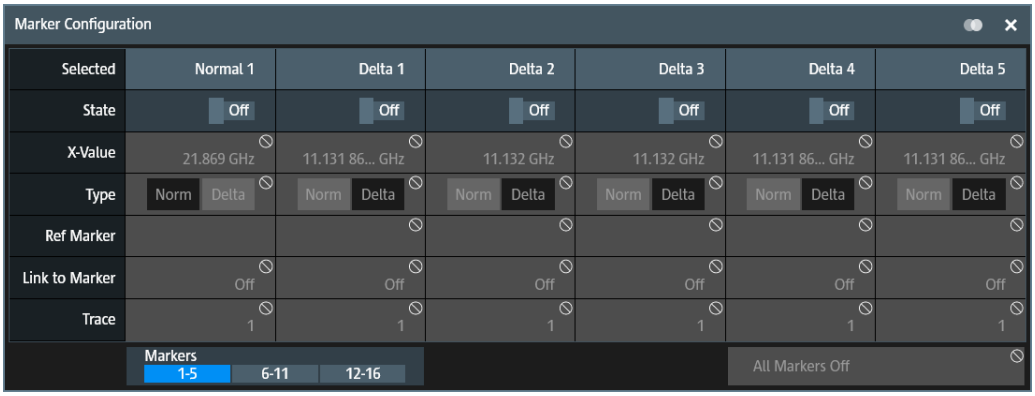
- Individual marker setup....1182
- General marker settings....1185

5.4.1.1 Individual marker setup

Access: "Overview" > "Analysis" > "Markers"

Or: [Marker] > "Markers"

You can enable up to 17 markers or delta markers for each window simultaneously.



The markers are distributed among 3 pages for a better overview. By default, the first marker is defined as a normal marker. All other markers are defined as delta markers with reference to the first marker. All markers are assigned to trace 1, but only the first marker is enabled.

Marker <x> 1183
Marker State 1184
Marker Position X-Value 1184
Frame (Spectrogram only) 1184
Marker Type 1184
Ref Marker 1184
Link to Marker 1185
Trace 1185
All Markers Off 1185

Marker <x>
Toggles the state of the corresponding marker. If enabled, an input field indicates the marker position (x-value).

When you initially open the [Marker] menu, normal marker 1 is automatically enabled and placed on the peak of trace 1 in the active window.

If normal marker 1 is the active marker and you select "Marker Type", an additional delta marker 1 is enabled.

Normal marker 1 is always the default reference marker for relative measurements. If enabled, markers 2 to 16 are delta markers by default, which refer to marker 1. Convert these markers to normal markers with absolute values using the "Marker Type" on page 1184 function.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 702
`CALCulate<n>:MARKer<m>:X` on page 703
`CALCulate<n>:MARKer<m>:Y?` on page 718
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 699
`CALCulate<n>:DELTamarker<m>:X` on page 700
`CALCulate<n>:DELTamarker<m>:X:RELative?` on page 701
`CALCulate<n>:DELTamarker<m>:Y` on page 718

Marker State
Enables or disables the marker in the diagram.

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 702
CALCulate<n>:DELTamarker<m>[:STATe] on page 699

Marker Position X-Value
Defines the position (x-value) of the marker in the diagram. For normal markers, the absolute position is indicated. For delta markers, the position relative to the reference marker is provided.

To create a delta marker in a fixed distance to another marker, define the distance as the x-value for the delta marker. Then link the delta marker to another marker using the Link to Marker function.

Remote command:
CALCulate<n>:MARKer<m>:X on page 703
CALCulate<n>:DELTamarker<m>:X on page 700

Frame (Spectrogram only)
Spectrogram frame the marker is assigned to.

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe on page 720
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe on page 724

Marker Type
Toggles the marker type.

The type for normal marker 1 is always "Normal". The type for delta marker 1 is always "Delta". You cannot change those types.

If normal marker 1 is the active marker and you select "Marker Type", an additional delta marker 1 is enabled. For any other marker, toggling the marker type does not enable an additional marker, it only toggles the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 702
CALCulate<n>:DELTamarker<m>[:STATe] on page 699

Ref Marker
Defines a marker as the reference marker which is used to determine relative analysis results (delta marker values).

If you disable the reference marker, any delta markers that refer to it are also disabled.

If you configured a fixed reference point, you can also select the reference point ("FXD") to use instead of another marker.

For more information, see Section 5.4.3.5, "Defining a fixed reference", on page 1204.

Remote command:
CALCulate<n>:DELTamarker<m>:MREFerence on page 699

Link to Marker
Links the current marker to another marker. Select the second marker from the list of active markers. If the x-axis value of the initial marker changes, the linked marker follows to the same position on the x-axis. Linking is disabled by default.

Using this function, you can set two markers on different traces to measure the difference between the results. For example, you can determine the difference between a "Max Hold" trace and a "Min Hold" trace, or between a measurement and a reference trace.

For linked delta markers, the x-value of the delta marker is 0 Hz by default. To create a delta marker in a fixed distance to another marker, define the distance as the x-value for the linked delta marker.

Remote command:
CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> on page 702
CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> on page 698
CALCulate<n>:DELTamarker<m>:LINK on page 697

Trace
Assigns the selected marker to an active trace. The trace determines which result the marker shows at the marker position. If the marker was previously assigned to a different trace, the marker remains on the previous frequency or time, but indicates the result (y-value) of the new trace.

If you disable a trace, the assigned markers and marker functions are also disabled.

Remote command:
CALCulate<n>:MARKer<m>:TRACe on page 703

All Markers Off
Disables all markers in one step.

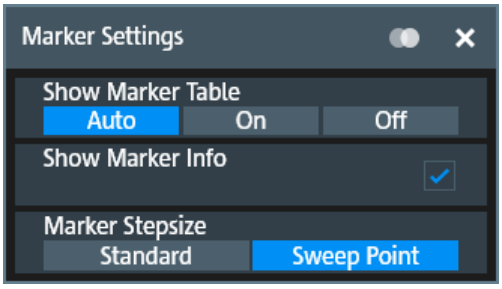
Remote command:
CALCulate<n>:MARKer<m>:AOFF on page 701

5.4.1.2 General marker settings

Access: "Overview" > "Analysis" > "Marker"> "Marker Settings"

Or: [Marker] > "Marker Settings"

Some general marker settings allow you to influence the marker behavior for all markers.



Show Marker Table....1186
Show Marker Info....1186
Marker Stepsize....1186

Show Marker Table
Defines whether the marker table is displayed.

For more information, see "Marker results" on page 306.

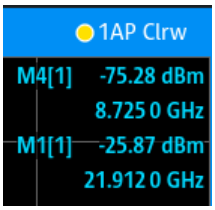
"On" Displays the marker information in a table in a separate result display.

"Off" No separate marker table is displayed.

"Auto" (Default) If you enable more than two markers, the marker table is displayed automatically.

Remote command:
`DISPlay[:WINDow<n>]:MTABle` on page 704

Show Marker Info
Shows or hides the marker information in the diagram. The information for the two most recently enabled or moved markers is displayed.



Remote command:
`DISPlay[:WINDow<n>]:MINFo[:STATe]` on page 705

Marker Stepsize
Defines the size of the steps that the marker position moves when you use the rotary knob.

"Standard" The marker position is moved in steps of (Span/1000), which corresponds approximately to the number of pixels for the default display of 1001 sweep points. This setting is most suitable to move the marker over a larger distance.

"Sweep Point" The marker position is moved from one sweep point to the next. This setting is required to position a marker precisely if the FSWX collects more sweep points than the number of pixels that are displayed on the screen. It is the default mode.

Remote command:
CALCulate<n>:MARKer<m>:X:SSIZe on page 705

5.4.2 Marker search settings and positioning functions

Access: "Overview" > "Analysis" > "Marker" > "Search"

Or: [Marker To] > "Marker Search"

The FSWX provides several functions to set the marker to a specific position quickly and easily. You can also use the current marker position to define a specific measurement setting. To determine the required marker position, you can perform a search on the measurement results. You can influence the search results by special settings.

For more information on searching for signal peaks, see Section 5.4.3.1, "Marker peak list", on page 1195.

The remote commands required to define these settings are described in "Positioning the marker" on page 710.

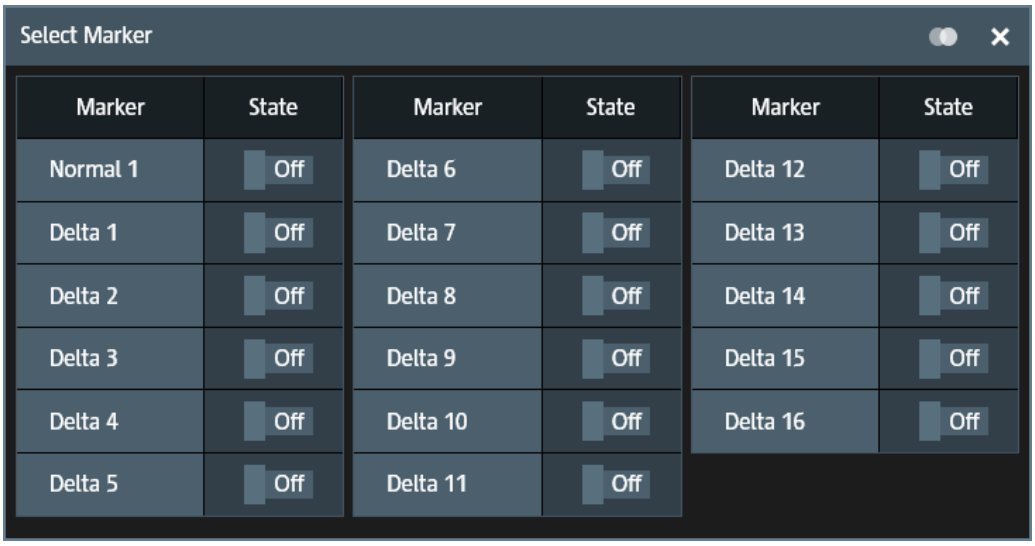
- Select marker 1187
- Marker search settings 1188
- Marker search settings for spectrograms 1190
- Positioning functions 1192

5.4.2.1 Select marker

Access: [Marker To] > "Select Marker"

All search and positioning functions apply to the selected marker, which is indicated on the softkey.

Select Marker
Opens a dialog to select and enable or disable one or more markers quickly. The selected marker is highlighted.



To change the marker type, select [Marker] > "Marker Type".

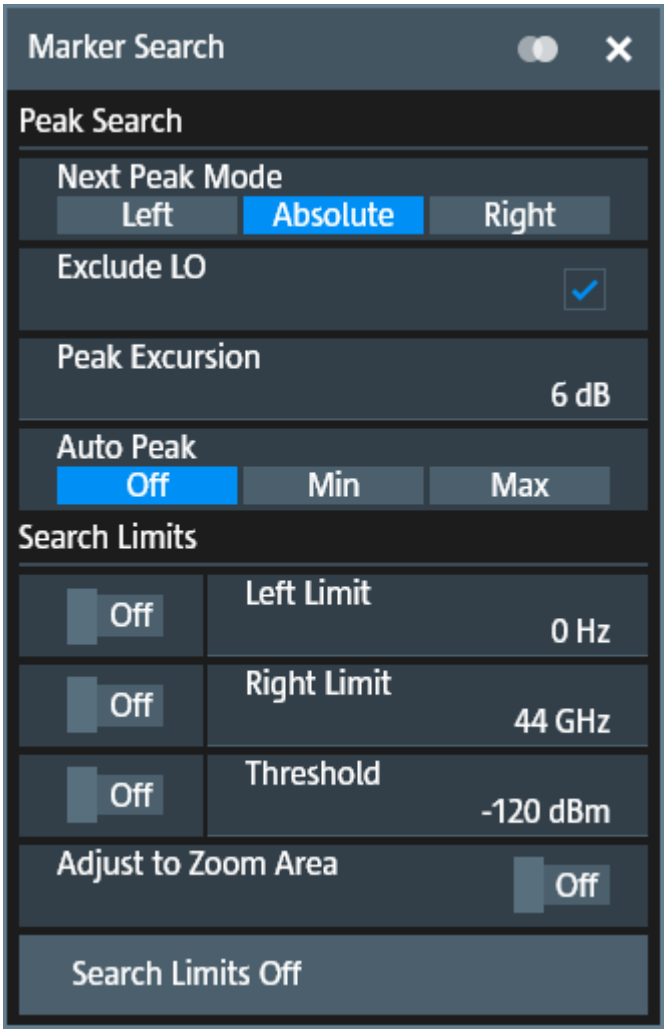
Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 702
CALCulate<n>:DELTamarker<m>[:STATe] on page 699

5.4.2.2 Marker search settings

Access: [Marker To] > "Marker Search"

Markers are commonly used to determine peak values, i.e. maximum or minimum values, in the measured signal. Marker search settings allow you to influence the peak search results.

The search settings apply to all markers, not only the currently selected one.



Next Peak Mode....1189
Exclude LO....1189
Peak Excursion....1189
Auto Peak....1189

Search Limits....1190
└ Left Limit / Right Limit....1190
└ Threshold....1190
└ Adjust to Zoom Area....1190
└ Search Limits Off....1190

Next Peak Mode
Selects the search mode for the next peak search.

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

Remote command:
"Positioning the marker" on page 710

Exclude LO
Determines whether the frequency range for the marker search functions is restricted to exclude the LO frequency.

"On" The minimum frequency included in the peak search range is ≥ 5 × <resolution bandwidth> (RBW).
The first local oscillator causes an interference to the first intermediate frequency at the input mixer. Thus, the LO is represented as a signal at 0 Hz. To avoid the peak marker jumping to the LO signal at 0 Hz, this frequency is excluded from the peak search.

"Off" No restriction to the search range. The frequency 0 Hz is included in the marker search functions.

Remote command:
`CALCulate<n>:MARKer<m>:LOEXclude` on page 706

Peak Excursion
Defines the minimum distance between two level values to detect a peak.

Enter a value from 0 dB to 80 dB. The resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For details on limit lines for searches, see "Peak search limits" on page 313.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 706

Auto Peak
Determines whether the FSWX performs a peak search automatically for marker 1 after each sweep.

For spectrogram displays, define which frame the peak is to be searched in.

"Off" No peak search is performed automatically.

"Min" Marker 1 is automatically set to the signal minimum.

"Max" Marker 1 is automatically set to the signal maximum.

Remote command:
CALCulate<n>:MARKer<m>:MAXimum:AUTO on page 711
CALCulate<n>:MARKer<m>:MINimum:AUTO on page 712

Search Limits
You can restrict the search results by limiting the search area or adding search conditions.

Left Limit / Right Limit ← Search Limits
If enabled, limit lines are defined and displayed for the search. The FSWX only considers results within the limited search range.

For details on limit lines for searches, see "Peak search limits" on page 313.

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 707
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT on page 708
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt on page 708

Threshold ← Search Limits
Defines an absolute threshold as an additional condition for the peak search. If enabled, the FSWX only detects peaks that exceed the threshold.

Remote command:
CALCulate<n>:THReshold:STATe on page 710
CALCulate<n>:THReshold on page 709

Adjust to Zoom Area ← Search Limits
If enabled, the peak search is restricted to the active zoom area that you defined using the single zoom function.

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] on page 709

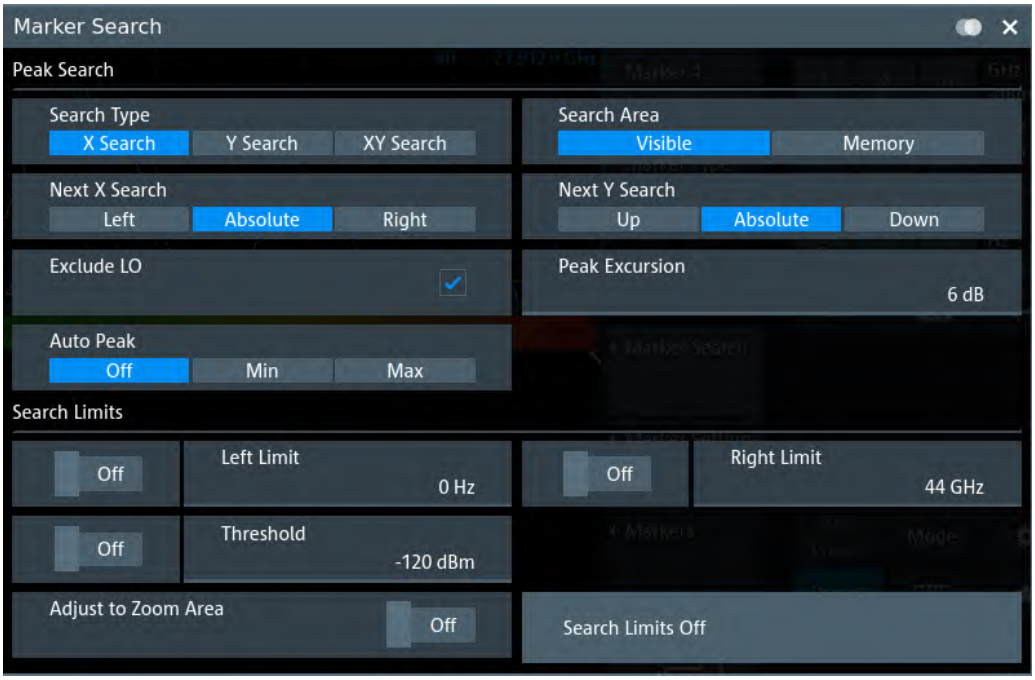
Search Limits Off ← Search Limits
Disables the search range limits.

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 707
CALCulate<n>:THReshold:STATe on page 710

5.4.2.3 Marker search settings for spectrograms

Access: [Marker To] > "Marker Search"

Spectrograms show not only the current sweep results, but also the sweep history. Thus, when searching for peaks, you must define the search criteria within a single timeframe (x-direction) and within several timeframes (y-direction).



The following settings are available for spectrograms only.

Search Type..... 1191
Search Area..... 1191
Next X Search..... 1191
Next Y Search..... 1192

Search Type
Defines which data is searched in the spectrogram.

"X Search" Searches only within the currently selected frame (x-values).

"Y Search" Searches within all frames but only at the current frequency position (y-values).

"XY Search" Searches in all frames at all positions (x and y-values).

Remote command:
Defined by the search function, see "Marker search (spectrograms)" on page 718.

Search Area
Defines which frames the search is performed in.

"Visible" Only the visible frames are searched.

"Memory" All frames stored in the memory are searched.

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:SAREa` on page 720
`CALCulate<n>:DELTamarker<m>:SPECtrogram:SAREa` on page 725

Next X Search
Selects the search mode for the next peak search within the currently selected frame (x-values).

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

Remote command:
"Positioning the marker" on page 710

Next Y Search
Selects the search mode for the next peak search within all frames at the current marker position (y-values).

"Up" Determines the next maximum/minimum above the current peak (in more recent frames).

"Absolute" Determines the next maximum/minimum above or below the current peak (in all frames).

"Down" Determines the next maximum/minimum below the current peak (in older frames).

Remote command:
`CALCulate:MARKer|DELTamarker:SPECtrogram:Y:MAX|MIN...`, see "Marker search (spectrograms)" on page 718

5.4.2.4 Positioning functions

Access: [Marker To]

You can set the currently selected marker to the result of a peak search. You can also set measurement settings to the current marker result.

Set to Peak / [Peak Search] 1192
Set to Next Peak 1192
Set to Minimum 1193
Set to Next Minimum 1193
Set Center Freq to Marker Freq 1193
Set Ref Level to Marker Level 1193

Set to Peak / [Peak Search]
Sets the selected marker or delta marker to the maximum of the trace. If no marker is enabled, marker 1 is enabled.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 712
`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 715

Set to Next Peak
Sets the selected marker or delta marker to the next (lower) maximum of the assigned trace. If no marker is enabled, marker 1 is enabled.

Remote command:
CALCulate<n>:MARKer<m>:MAXimum:NEXT on page 712
CALCulate<n>:MARKer<m>:MAXimum:RIGHt on page 712
CALCulate<n>:MARKer<m>:MAXimum:LEFT on page 711
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 715
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt on page 715
CALCulate<n>:DELTamarker<m>:MAXimum:LEFT on page 714

Set to Minimum
Sets the selected marker or delta marker to the minimum of the trace. If no marker is enabled, marker 1 is enabled.

Remote command:
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 714
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 716

Set to Next Minimum
Sets the selected marker or delta marker to the next (higher) minimum of the selected trace. If no marker is enabled, marker 1 is enabled.

Remote command:
CALCulate<n>:MARKer<m>:MINimum:NEXT on page 713
CALCulate<n>:MARKer<m>:MINimum:LEFT on page 713
CALCulate<n>:MARKer<m>:MINimum:RIGHt on page 714
CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 716
CALCulate<n>:DELTamarker<m>:MINimum:LEFT on page 716
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt on page 717

Set Center Freq to Marker Freq
Sets the center frequency to the selected marker or delta marker frequency. For example, you can set the center frequency to a detected peak. Then you can analyze it in detail with a smaller span.

This function is not available for zero span measurements.

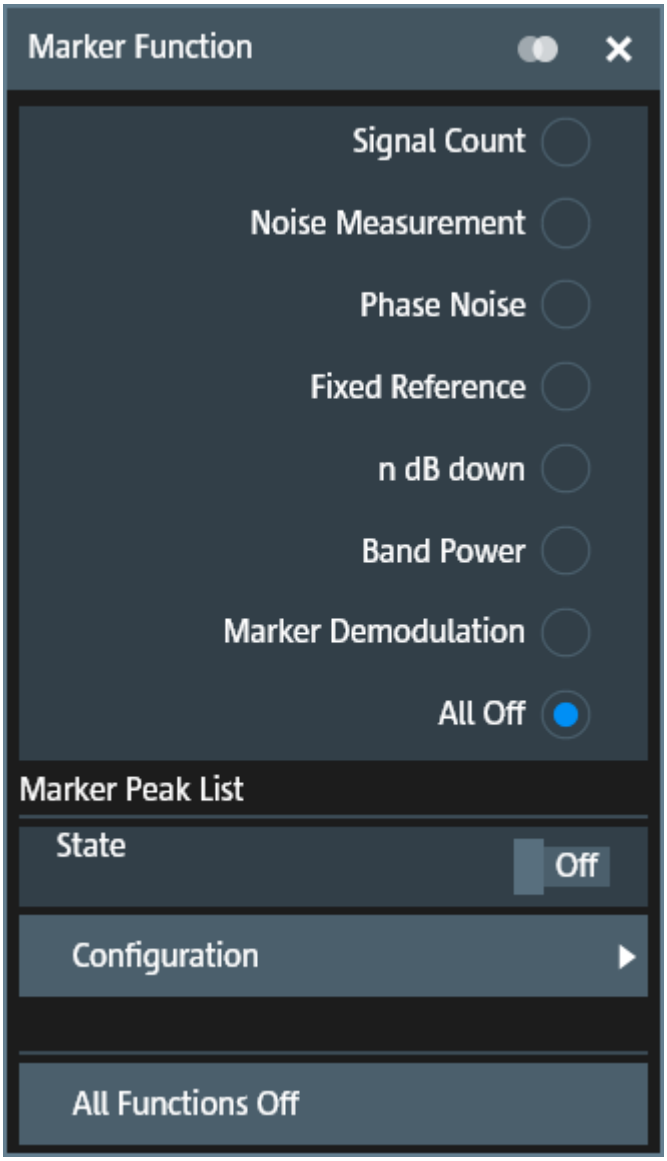
Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:CENTer on page 1413

Set Ref Level to Marker Level
Sets the reference level to the level of the selected marker.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:REFerence on page 613

5.4.3 Marker (measurement) functions

Access: Marker Function (> "Select Marker Function")



The remote commands required to define these settings are described in Section 5.4.3, "Marker (measurement) functions", on page 1193.

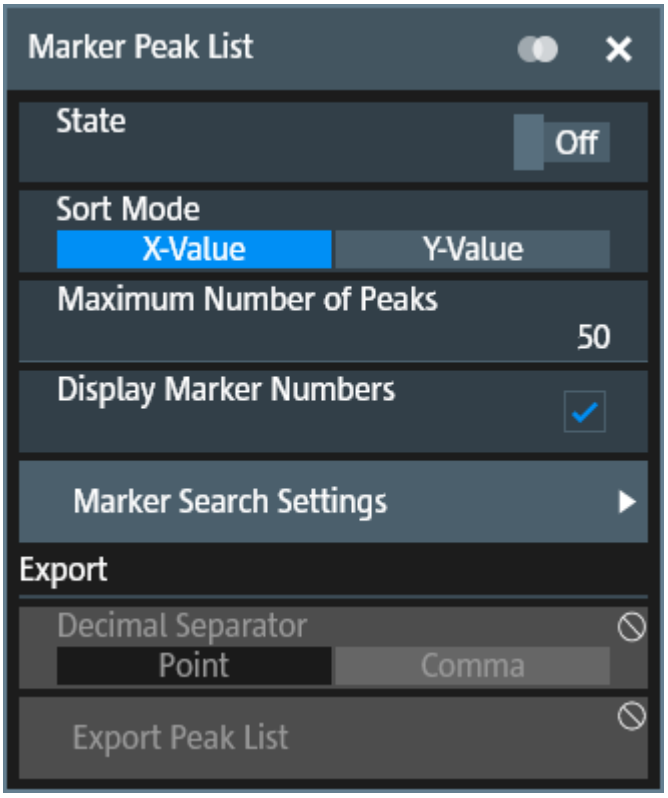
- Marker peak list 1195
- Measuring a precise frequency (signal count marker) 1196
- Measuring noise density (Noise Measurement marker) 1198
- Phase Noise measurement marker 1201
- Defining a fixed reference 1204
- Measuring characteristic bandwidths (n dB down marker) 1206
- Measuring the power in a channel (Band Power marker) 1208
- Demodulating marker values and providing audio output (Marker Demodulation) 1212
- Disabling all marker functions 1215

5.4.3.1 Marker peak list

Access: Marker Function > "Marker Peak List"

A common measurement task is to determine peak values, i.e. maximum or minimum signal levels. The FSWX provides various peak search functions and applications. The marker peak list shows details for a specified number of detected peaks in the measured signal.

For details on limit lines for searches, see "Peak search limits" on page 313.



Remote commands:

`TRAC? LIST,`

See `TRACe<n>[:DATA]` on page 688

Marker Peak List State 1195
Sort Mode 1196
Maximum Number of Peaks 1196
Display Marker Numbers 1196
Marker Search Settings 1196
Export Peak List 1196
Decimal Separator 1196

Marker Peak List State
Enables/disables the marker peak list. If enabled, the "Marker Table" is displayed and the peaks are indicated in the diagram.

For each detected peak, the "Marker Table" indicates the frequency/time ("X-Value") and measurement result ("Y-Value").

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe on page 733

Sort Mode
Defines whether the peak list is sorted according to the x-values or y-values. In both cases, the values are sorted in ascending order.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT on page 732

Maximum Number of Peaks
Defines the maximum number of peaks to be determined and displayed.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE on page 732

Display Marker Numbers
By default, the marker numbers are indicated in the diagram so you can find the peaks from the list. However, for large numbers of peaks, the marker numbers can decrease readability. In this case, disable the marker number display.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe] on page 731

Marker Search Settings
For the marker peak list, you can configure the common marker search settings.

See Section 5.4.2.2, "Marker search settings", on page 1188.

Export Peak List
You can export the peak list to an ASCII file (.DAT) for analysis in an external application.

For more information, see Section 4.10.4, "Exporting and importing measurement results for evaluation", on page 366.

Remote command:
MMEMory:STORe<n>:PEAK on page 803

Decimal Separator
Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:
FORMat:DEXPort:DSEParator

5.4.3.2 Measuring a precise frequency (signal count marker)

A normal marker determines the position of the trace point and indicates the signal frequency at this position. The trace, however, contains only a limited number of points.

Depending on the selected measurement span, each trace point can represent many measurement values. Thus, the frequency resolution of each trace point is limited.

For details, see Section 4.3.3.8, "How much data is measured: sweep points and sweep count", on page 246.

The RBW and sweep time settings restrict the frequency resolution further.

To determine the frequency of a signal point accurately without changing the sweep settings, the FSWX is equipped with a signal counter. The signal counter sets the RF to the current marker position. Then it counts the zero crossings of the IF (thus the term signal *counter*) and derives the precise frequency value.

The FSWX can only determine the frequency accurately using the signal counter function if the marker is sufficiently close to the actual signal. For a 3-dB Gaussian filter, the delta must be less than 2*RBW. Usually, the marker peak function detects a trace point that is close enough. However, for a large span or a small number of sweep points, the result can be inaccurate.

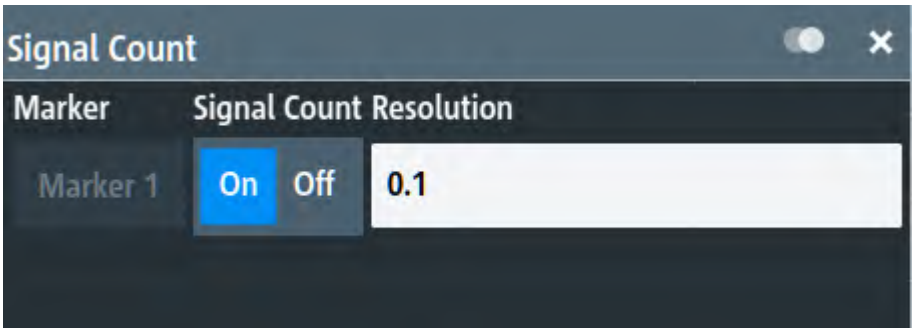
You can perform signal counting explicitly at the current marker position using the "Signal Count" marker function. For certain functions, the FSWX uses the signal counter implicitly.

The FSWX can only use the signal counter while it is not sweeping. Thus, to perform a signal count for a marker, the FSWX stops the sweep at the marker position. It determines the frequency with the desired resolution and then continues the sweep.

Signal counters are not available for measurements on I/Q-based data.

Signal count settings

Access: Marker Function > "Select Marker Function" > "Signal Count" > "Signal Count Configuration"



Programming example

"Example: performing a highly accurate frequency measurement using the signal count marker" on page 758

Signal Count marker state 1198
Resolution 1198

Signal Count marker state
Enables or disables the special signal count marker function.

When activated, the sweep stops at the reference marker until the signal counter has delivered a result.

Remote command:
`CALCulate<n>:MARKer<m>:COUNt` on page 746

Resolution
Defines the resolution with which the signal is analyzed around the reference marker 1.

Remote command:
`CALCulate<n>:MARKer<m>:COUNt:RESolution` on page 747

5.4.3.3 Measuring noise density (Noise Measurement marker)

The "Noise Measurement" marker function measures the noise power density at the position of the marker. In the time domain mode, the FSWX considers all trace points to determine the noise power density. In the frequency domain, the FSWX considers eight points to the right and left of the marker (if available) to obtain a stable result.

- Noise measurement marker basics.....1198
- Noise measurement marker settings.....1199

Noise measurement marker basics

Result display

Noise density is the noise referred to a bandwidth of 1 Hz.

Depending on the amplitude unit, it is expressed as follows:

- For power-related units (dBm, dBpW, W), the result is expressed in unit/Hz (e.g., dBm/Hz).
- For voltage- and current-related units (dBmV, dBµV, V, dBµA, A), the result is expressed in unit/√Hz (e.g., µV/√Hz).

The "Marker Table" indicates the noise density as the "Function Result".

Prerequisite settings

The following settings are required to obtain correct values:

- Detector: "Sample" or "RMS"
- Video bandwidth:
  ≤ 0.1 resolution bandwidth with "Sample" detector
  ≥ 3 x resolution bandwidth with "RMS" detector
- Trace averaging:
  In the default setting, the FSWX uses the "Sample" detector for the noise marker function. Using the "Sample" detector, you can set the trace to "Average" mode to stabilize the measured values. Using the "RMS" detector, trace averaging produces noise levels that are too low and cannot be corrected. Instead, increase the sweep time to obtain stable measurement results.

Correction factors

The FSWX uses the following correction factors to determine the noise density from the marker level.

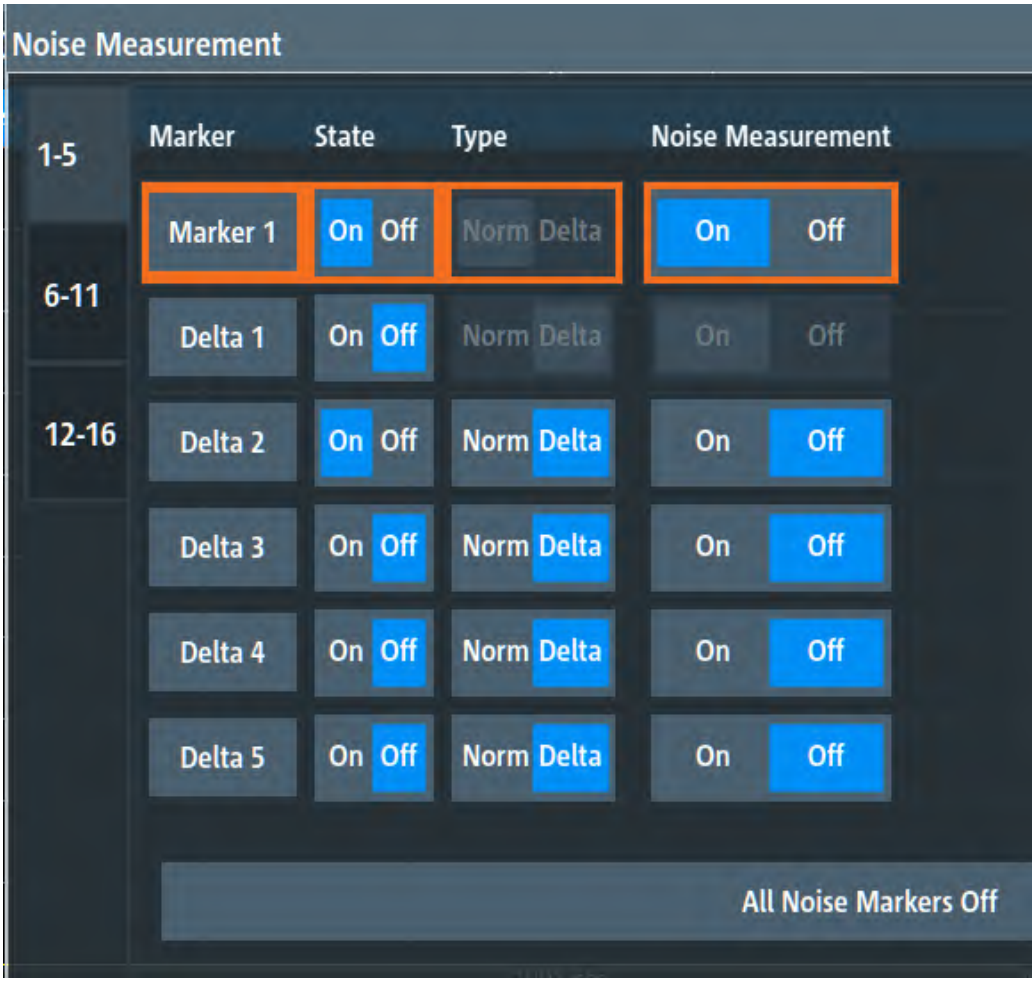
- Since the noise power is indicated regarding 1 Hz bandwidth, the bandwidth correction value is deducted from the marker level. The correction value is calculated as:
  10 x lg (1 Hz/<BW_noise>)
  Where <BW_noise> is the noise or power bandwidth of the specified resolution filter (RBW)
- RMS detector: Except for bandwidth correction, no further corrections are required since this detector already indicates the power for each point of the trace.
- Sample detector: As a result of video filter averaging and trace averaging, 1.05 dB are added to the marker level. This is the difference between the average value and the RMS value of white noise. With a logarithmic level axis, the FSWX adds another 1.45 dB. Logarithmic averaging is thus fully taken into account. The resulting value is 1.45 dB lower than the result using linear averaging.
- To allow for a more stable noise display, eight trace points on each side of the measurement frequency are averaged.
- For span > 0, the measured values are averaged over time (after a sweep).



You can calculate the noise figure of the FSWX from the measured power density level. Deduct the specified RF attenuation from the displayed noise level and add 174 to the result.

Noise measurement marker settings

Access: Marker Function >"Select Marker Function" > "Noise Measurement" > "Noise Measurement Configuration"



The individual marker settings correspond to those defined in the "Marker Settings" dialog box. Any changes to the marker state or type in the "Marker Function" dialog box are also changed in the "Marker Settings" dialog box and vice versa.

Programming example

"Example: performing a highly accurate frequency measurement using the signal count marker" on page 758

Marker State....1200
Marker Type....1201
Noise Measurement State....1201
All Noise Markers Off....1201

Marker State
Enables or disables the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 702
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 699

Marker Type
Toggles the marker type.

The type for normal marker 1 is always "Normal". The type for delta marker 1 is always "Delta". You cannot change those types.

If normal marker 1 is the active marker and you select "Marker Type", an additional delta marker 1 is enabled. For any other marker, toggling the marker type does not enable an additional marker, it only toggles the type of the selected marker.

- "Normal"
  A normal marker indicates the absolute value at the defined position in the diagram.
- "Delta"
  A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 702
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 699

Noise Measurement State
Enables or disables the noise measurement for the selected marker in the diagram.

This function is only available for normal markers.

If enabled, the marker displays the noise power density measured at the position of the marker.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe]` on page 735
`CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult?` on page 734

All Noise Markers Off
Disables noise measurement for all markers.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:NOISe:AOFF` on page 734

5.4.3.4 Phase Noise measurement marker

Phase noise is unintentional modulation of a carrier. It creates frequencies next to the carrier frequency.

Phase noise marker basics

A phase noise measurement consists of noise density measurements at defined offsets from the carrier. The results are provided in relation to the carrier level (dBc).
The "Phase Noise" marker function measures the noise power at the delta markers, referred to 1 Hz bandwidth. The reference point for the phase noise measurement is fixed. By default, the FSWX uses the current frequency and level of marker 1 as the fixed reference marker. However, you can start a peak search to use the current signal peak as the reference point, or you can define a reference point manually.

After phase noise measurement is started, you can change the reference level or the center frequency so that the carrier is outside the displayed frequency range. You can also enable a notch filter to suppress the carrier.

Using the "Auto Peak" function in the marker "Search Configuration", the FSWX determines the reference point automatically after each sweep. Use this function to track a drifting source during a phase noise measurement. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Thus, the phase noise measurement leads to reliable results in a certain offset although the source is drifting. Only if the marker 2 reaches the border of the span, the delta marker value is adjusted to be within the span. In these cases, select a larger span.

The phase noise is calculated as the difference in level at the reference point and the noise power density. The "Marker Table" indicates the phase noise as the "Function Result".

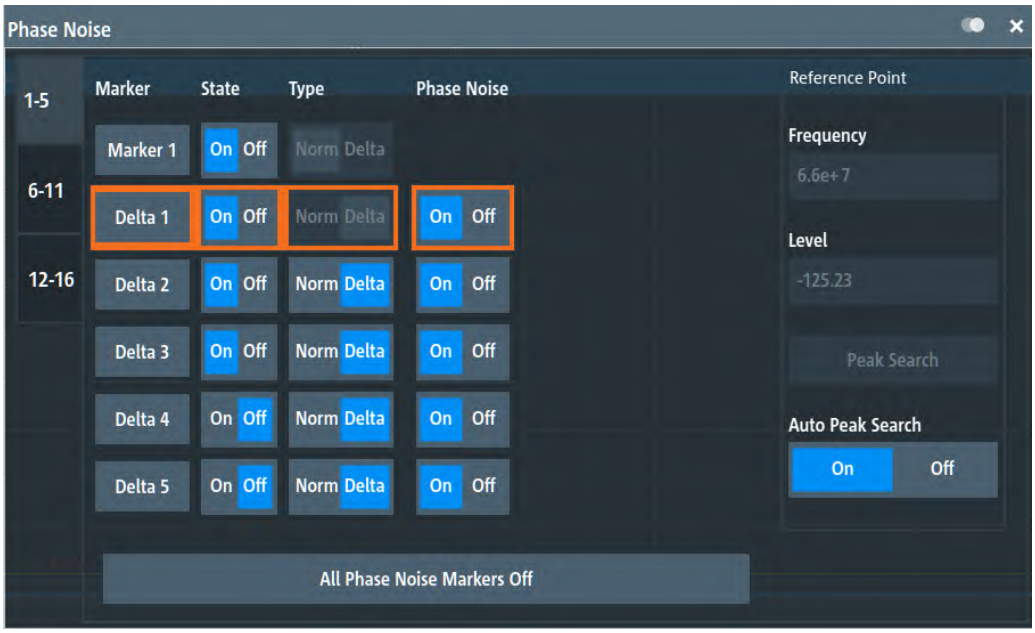
The FSWX automatically uses the "Sample" detector. It sets the video bandwidth to 0.1 times the resolution bandwidth (RBW). The FSWX determines the required correction values for the noise power measurement due to these settings. To obtain stable results, two trace points on each side of the delta marker position are averaged.

The procedure to determine the noise power is identical to the "Noise Measurement" marker function.

See Section 5.4.3.3, "Measuring noise density (Noise Measurement marker)", on page 1198.

Phase noise marker settings

Access: Marker Function > "Select Marker Function" > "Phase Noise" > "Phase Noise Configuration"



The individual marker settings correspond to those defined in the "Marker Settings" dialog box. Any changes to the marker state or type in the "Marker Function" dialog box are also changed in the "Marker Settings" dialog box and vice versa.

Programming example

"Example: performing a highly accurate frequency measurement using the signal count marker" on page 758

Marker State....1203
Marker Type....1203
Phase Noise measurement state....1203
Reference Point....1204
All Phase Noise Markers Off....1204

Marker State
Enables or disables the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 702
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 699

Marker Type
Toggles the marker type.

The type for normal marker 1 is always "Normal". The type for delta marker 1 is always "Delta". You cannot change those types.

If normal marker 1 is the active marker and you select "Marker Type", an additional delta marker 1 is enabled. For any other marker, toggling the marker type does not enable an additional marker, it only toggles the type of the selected marker.

- "Normal"
  A normal marker indicates the absolute value at the defined position in the diagram.
- "Delta"
  A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 702
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 699

Phase Noise measurement state
Enables or disables phase noise measurement for the reference point in the diagram.

This function is only available for delta markers.

If enabled, the delta markers display the phase noise measured at defined offsets from the reference position.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe]` on page 738
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe]` on page 737
`CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult?` on page 737
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?` on page 736

Reference Point
Instead of using marker 1 as the reference marker, the phase noise measurement can use a fixed reference marker. The "Level" and "Frequency" or "Time" settings define the position and value of the reference point.

As an alternative, you can perform a peak search to use the maximum value of the selected trace as the reference point.

To repeat the peak search automatically after each sweep and update the reference point, enable "Auto Peak Search".

For details, see Section 5.4.3.5, "Defining a fixed reference", on page 1204.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed[:STATe]` on page 730
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X` on page 728
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y` on page 729
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO` on page 736

All Phase Noise Markers Off
Disables phase noise measurement for all markers.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe]` on page 738
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe]` on page 737

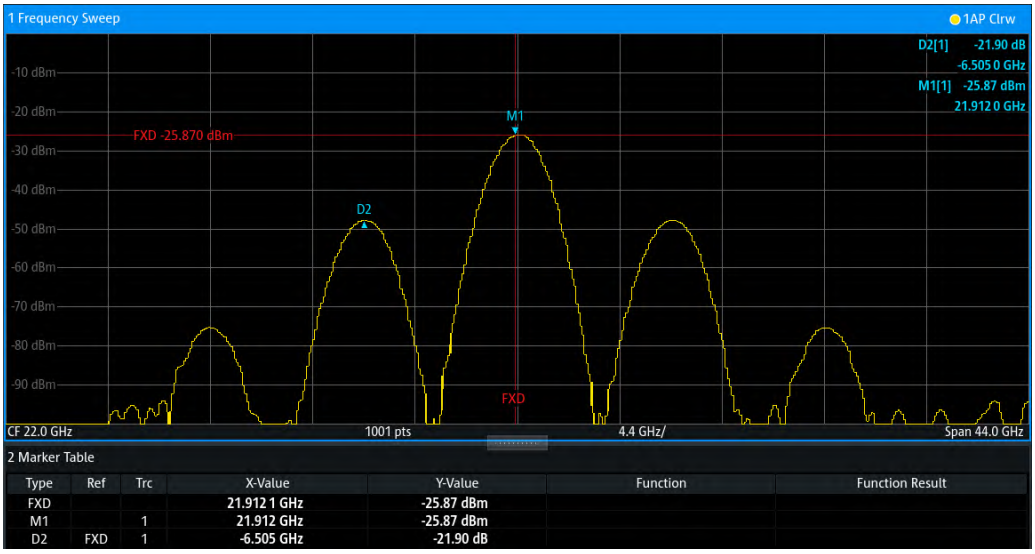
5.4.3.5 Defining a fixed reference

If you use a common marker as a reference marker, it can vary its position depending on the measurement results. However, you can define a fixed reference marker for trace analysis. Once positioned, the reference marker does not move during subsequent sweeps unless you explicitly move it manually.

This function is not available in all result displays.

Fixed Reference basics

When you enable the "Reference Fixed" marker function, a vertical and a horizontal red display line are displayed, marked as "FXD". A normal marker is enabled and set to the peak value. A delta marker is enabled and set to the next peak. The fixed reference marker is set to the position of the normal marker at the peak value. The delta marker refers to the fixed reference marker.

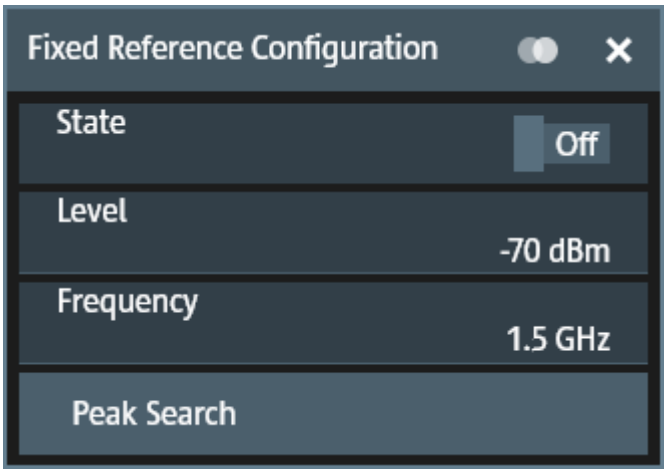


You can move the position of the fixed reference marker graphically by dragging the display lines, or numerically by entering values for the marker position and level.

Once defined, you can use the fixed reference marker ("FXD") as a reference for a delta marker.

Fixed Reference configuration

Access: Marker Function > "Select Marker Function" > "Reference Fixed" > "Reference Fixed Configuration"



Programming example

"Example: performing a highly accurate frequency measurement using the signal count marker" on page 758

Fixed Reference State..... 1206
Level.....1206
Frequency / Time..... 1206
Peak Search.....1206

Fixed Reference State
Enables or disables the use of a fixed reference point for delta markers.

If enabled, a vertical and a horizontal red display line are displayed, marked as "FXD". The crossing point defines the fixed reference point.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed[:STATe]` on page 730

Level
Defines the (y-axis) value of the reference point.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y` on page 729

Frequency / Time
Defines the x-axis value of the reference point.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X` on page 728

Peak Search
Performs a peak search for the selected marker and uses the result as the fixed reference point.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]` on page 728

5.4.3.6 Measuring characteristic bandwidths (n dB down marker)

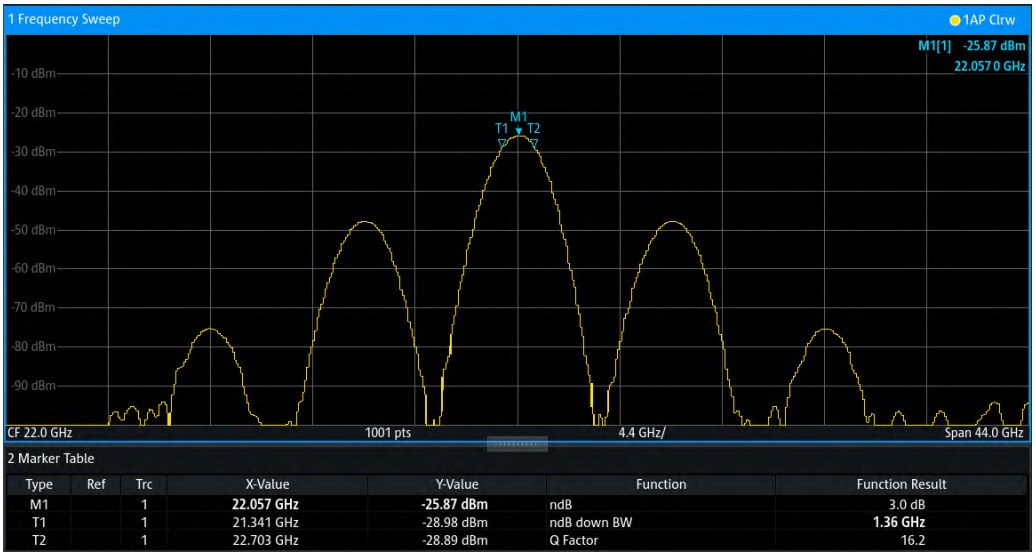
When characterizing the shape of a signal, the bandwidth at a specified offset from its peak level is often of interest. The offset is specified as a relative decrease in amplitude of n dB. To measure this bandwidth, you can use several markers and delta markers and determine the bandwidth manually. However, using the "n dB down" marker function makes the task simple and quick.

n dB down basics.....1206
n dB down settings.....1207

n dB down basics

The "n dB down" marker function uses the current value of marker 1 as the reference point. It enables two temporary markers T1 and T2 on trace 1. Their level is n dB below the level of the reference point. Marker T1 is placed to the left and marker T2 to the right of the reference marker. The default setting for n is 3 dB, but you can define other values.

If you define a positive offset, the markers T1 and T2 are placed below the reference point. If you define a negative value, for example, for notch filter measurements, the markers T1 and T2 are placed above the reference point.



The "Marker Table" displays the following marker function results:

Table 5-20: n dB down marker function results

Label	Description
"M1"	Current position and level of marker 1
"ndB"	Offset value (n dB down)
"T1", "T2"	Current position and level of the temporary markers
"ndB down Bw" / "PWid"	Determined bandwidth (frequency) or pulse width (time) at the offset
"Q-factor"	Center frequency / n-dB-down-bandwidth Quality factor of the determined bandwidth (characteristic of damping or resonance)

If the measurement cannot determine the required position for the temporary markers uniquely, for example due to noise, dashes are displayed as a result.

n dB down settings

Access: Marker Function > "Select Marker Function" > "n dB down" > "n dB Down Configuration"



Programming example

"Example: performing a highly accurate frequency measurement using the signal count marker" on page 758

n dB down State....1208
n dB down value....1208

n dB down State
Enables or disables the n dB down measurement for Marker 1 in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe` on page 744
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult?` on page 744

n dB down value
Defines the delta level from the reference marker 1 used to determine the bandwidth or pulse width.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency?` on page 743
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME?` on page 745

5.4.3.7 Measuring the power in a channel (Band Power marker)

To determine the noise power in a transmission channel, you can use a noise marker and multiply the result with the channel bandwidth. However, the results are only accurate for flat noise.

The "Band Power" marker function measures the integrated power for a defined span (band) around a marker, similar to ACP measurements.

- Band power marker basics....1208
- Band power marker settings....1210

Band power marker basics

By default, the function integrates over 5 % of the current span. The span is indicated by limit lines in the diagram. You can easily change the span by moving the limit lines in the diagram. The lines are automatically aligned symmetrically to the marker frequency. If you move the marker on the screen, the limit lines also automatically move.

The function provides the results either as a power (dBm) or density (dBm/Hz) value in the "Marker Table".

Relative band power markers

Delta markers have a reference value. The results for band power markers which are defined as *delta* markers can also be calculated as reference power values (in dB).

In this case, the result of the band power delta marker is the difference between the absolute power in the band around the delta marker and the absolute power for the

reference marker. The powers are subtracted logarithmically, so the result is a dB value.

[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]

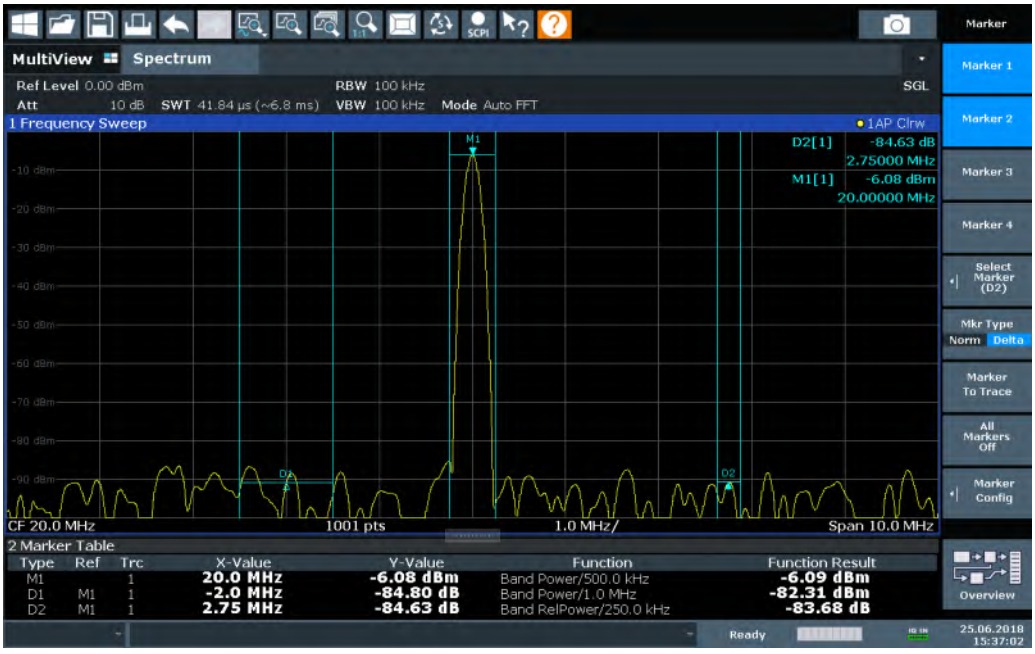
The measured power for the reference marker can be:

- An absolute power at a single point, if the reference marker is not a band power marker
- The power in a band, if the reference marker is a band power marker itself

If the reference marker for the band power marker is also a delta marker, the absolute power level for the reference marker is used for calculation.

Band power markers are only available for standard frequency measurements (not zero span) in the "Spectrum" application.

The entire band must lie within the display. If you move it outside of the display, the result cannot be calculated (indicated by "- - -" as the "Function Result"). However, the width of the band is maintained so that the band power can be calculated again when the band returns to the display.

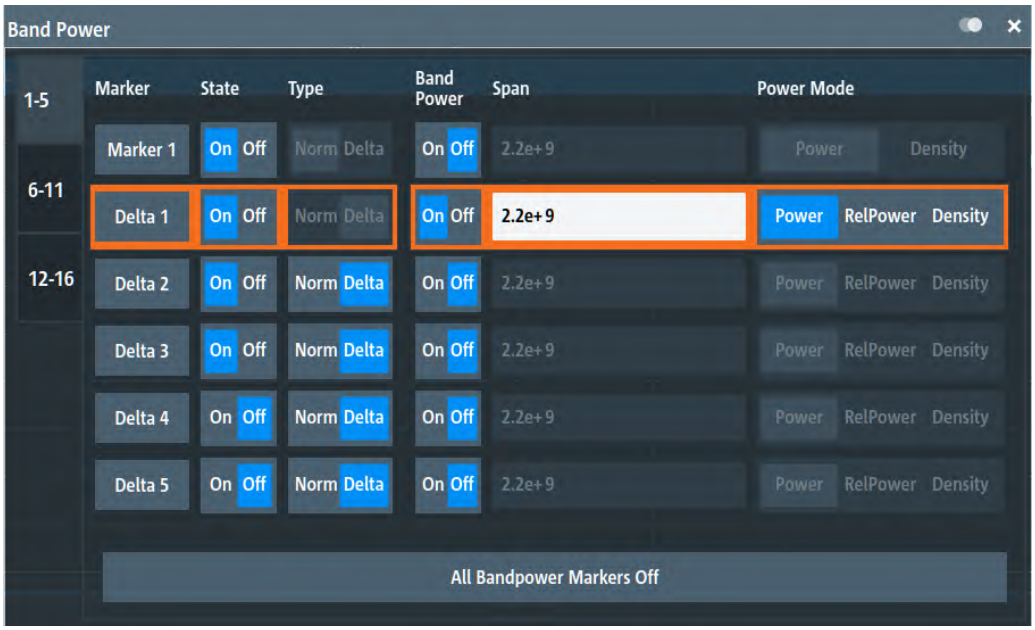


All markers can be defined as band power markers, each with a different span. When a band power marker is enabled, if no marker is enabled yet, marker 1 is enabled. Otherwise, the currently active marker is used as a band power marker (all other marker functions for this marker are disabled).

If the detector mode for the marker trace is set to "Auto", the RMS detector is used.

Band power marker settings

Access: Marker Function > "Select Marker Function" > "Band Power" > "Band Power Configuration"



Programming example

"Example: performing a highly accurate frequency measurement using the signal count marker" on page 758

Marker State....1210
Marker Type....1210
Band Power State....1211
Span....1211
Power Mode....1211
All Bandpower Markers Off....1212

Marker State

Enables or disables the marker in the diagram.

Remote command:

`CALCulate<n>:MARKer<m>[:STATe]` on page 702

`CALCulate<n>:DELTamarker<m>[:STATe]` on page 699

Marker Type

Toggles the marker type.

The type for normal marker 1 is always "Normal". The type for delta marker 1 is always "Delta". You cannot change those types.

If normal marker 1 is the active marker and you select "Marker Type", an additional delta marker 1 is enabled. For any other marker, toggling the marker type does not enable an additional marker, it only toggles the type of the selected marker.

- "Normal"

A normal marker indicates the absolute value at the defined position in the diagram.

- "Delta"
  A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 702
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 699

Band Power State
Enables or disables the band power measurement for the selected marker in the diagram.

Band power markers are only available for standard frequency measurements (not zero span) in the "Spectrum" application.

If enabled, the markers display the power or density measured in the band around the current marker position.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 740
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult?` on page 739

Span
Defines the span (band) around the marker for which the power is measured.

The span is indicated by lines in the diagram. You can easily change the span by moving the limit lines in the diagram. They are automatically aligned symmetrically to the marker frequency. They are also moved automatically if you move the marker on the screen.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN` on page 740
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN` on page 741

Power Mode
Defines the mode of the power measurement result.

"Power"	The result is an absolute power level. Configure the power unit in the amplitude settings. See "Power Level Unit" on page 184.
"Relative Power"	This setting is only available for a delta band power marker. The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker (see "Ref Marker" on page 1184). The powers are subtracted logarithmically, so the result is a dB value. *[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]* For details, see "Relative band power markers" on page 1208.

"Density" The result is a power level in relation to the bandwidth, displayed in dBm/Hz.

Note:
For the following amplitude units the band power marker result in the power density mode is not dBm/Hz.

- Amplitude units W, dBpW: band power density in amplitude unit/Hz.
- Amplitude units dBmV, dBµV, V, dBµA, A: band power density in amplitude unit/sqrt(Hz).

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE` on page 739
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE` on page 740

All Bandpower Markers Off
Disables band power measurement for all markers.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:AOFF` on page 738

5.4.3.8 Demodulating marker values and providing audio output (Marker Demodulation)

The FSWX provides demodulators for AM and FM signals. The "Marker Demodulation" function sends the demodulated data at the current marker frequency to the audio output. Thus, you can identify a displayed signal acoustically with the help of the internal loudspeaker or with headphones.

This function is not available for "Spectrum Emission Mask" measurements or measurements on I/Q-based data.

Marker demodulation basics..... 1212
Marker demodulation settings..... 1213

Marker demodulation basics

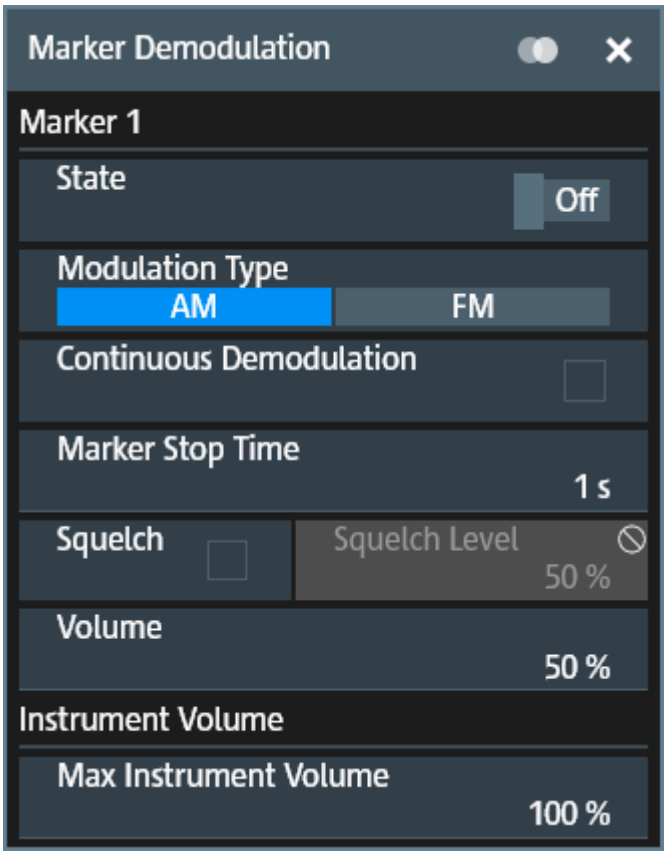
For marker demodulation, the sweep stops at the frequency determined by marker 1 for the specified time. The function demodulates the RF signal in a bandwidth that corresponds to the RBW. The function can also demodulate the signal continuously. In this case, the audio signal is output regardless of the marker position and the marker stop time. For measurements in the time domain (zero span), marker demodulation is always continuous.

Optionally, you can define a minimum level ("Squelch Level") for output. Thus, the signal is only demodulated when it exceeds the set level. Squelching is useful during continuous demodulation to avoid listening to noise.

The squelch function enables the video trigger function and disables any other trigger or gating settings. The squelch level and trigger level are set to the same value. In the application info panel, the trigger source is indicated as "SQL" for squelch. The squelch level is indicated by a red line in the diagram.

Marker demodulation settings

Access: Marker Function > "Select Marker Function" > "Marker Demodulation" > "Marker Demodulation Configuration"



Programming example

"Example: performing a highly accurate frequency measurement using the signal count marker" on page 758

Marker Demodulation State 1213
Modulation Type 1214
Continuous Demodulation 1214
Marker Stop Time 1214
Squelch 1214
Squelch Level 1214
Volume 1214
Max Instrument Volume 1214

Marker Demodulation State
Enables or disables demodulation output. If enabled, the signal is demodulated and sent to the audio output.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation[:STATe]` on page 749

Modulation Type
Defines the demodulation type for output. The default setting is AM.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:SELect` on page 748

Continuous Demodulation
If enabled, the signal is demodulated continuously and sent to the audio output, regardless of the marker position and the marker stop time. Thus, you can monitor the frequency range acoustically, if the sweep time is long enough.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:CONTinuous` on page 747

Marker Stop Time
Defines how long the sweep stops at the marker position to output the demodulated signal.

For zero span measurements, demodulation is always active continuously, regardless of the marker stop time.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:HOLDoff` on page 748

Squelch
Enables or disables the squelch function. If enabled, the audio output is cut off below a defined threshold level. Thus, you avoid hearing noise at the audio output when no signal is available.

The squelch function enables the video trigger function and disables any other trigger or gating settings. The squelch level and trigger level are set to the same value. In the application info panel, the trigger source is indicated as "SQL" for squelch. The squelch level is indicated by a red line in the diagram.

Remote command:
`[SENSe:]DEMod:SQUelch[:STATe]` on page 749

Squelch Level
Defines the level threshold below which the audio output is cut off if squelching is enabled. The video trigger level is set to the same value.

The squelch level is indicated by a red line in the diagram.

Remote command:
`[SENSe:]DEMod:SQUelch:LEVel` on page 749

Volume
Define the output volume using the slider.

Remote command:
`SYSTem:SPEaker:VOLume` on page 626

Max Instrument Volume
To protect users from damage, you can restrict the maximum instrument volume in percent.

Remote command:
SYSTem:SPEaker:MAXVolume on page 625

5.4.3.9 Disabling all marker functions

Access: Marker Function >"Select Marker Function" > "All Functions Off"

You can disable all special marker functions in one step.

Remote command:

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:AOFF on page 738

CALCulate<n>:MARKer<m>:FUNCtion:NOISe:AOFF on page 734

CALCulate<n>:MARKer<m>:FUNCtion:PNOise:AOFF on page 737

5.4.4 Trace evaluation

A trace is a collection of measured data points. The trace settings determine how the measured data is analyzed and displayed on the screen.

- Trace configuration 1215
- Trace Math 1221
- Spectrogram settings 1223

5.4.4.1 Trace configuration

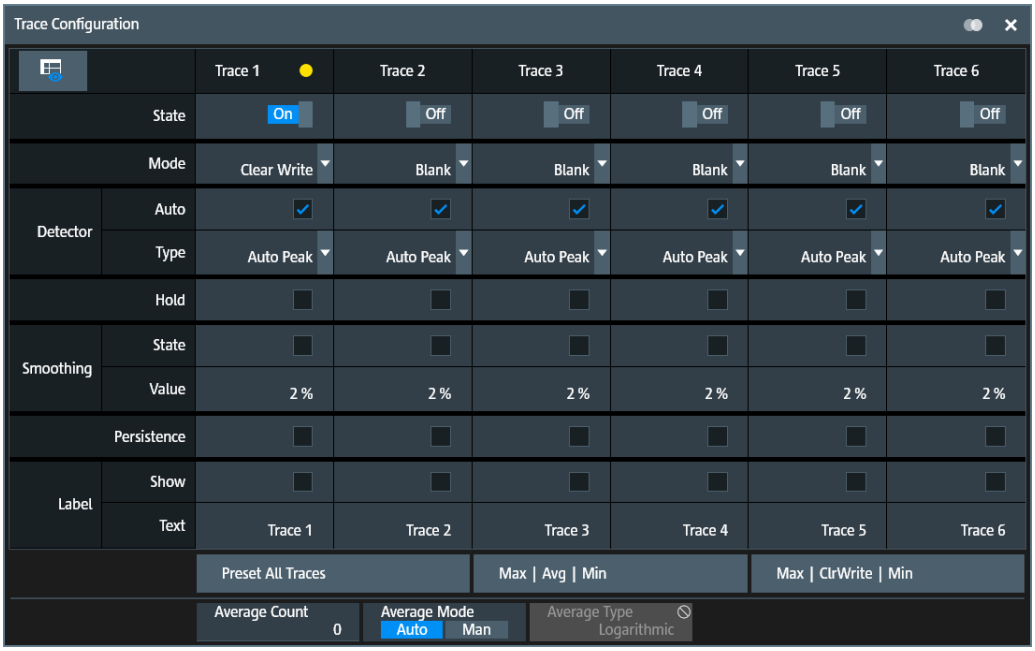
Access: [Trace] > "Trace Configuration"

You can configure up to 6 individual traces in the same result display. Each trace is displayed in a different color, indicated in the window title bar and the trace settings.



You can also export trace data to an ASCII file for further analysis.

For more information, see Section 4.10.4, "Exporting and importing measurement results for evaluation", on page 366.



For more information, see Section 4.8.1.1, "Impact of the trace settings", on page 278.

Add Trace / Trace<x>....1216
Settings selection....1216
Trace State....1217
Trace Mode....1217
Detector....1217
Type....1218
Hold....1218
Smoothing....1218
Persistence....1218
Label....1219
Predefined Trace Settings - Quick Config....1219
Average Count....1220
Average Mode....1220
Average Type....1220
X-Corr Factor....1221
Copy Trace....1221

Add Trace / Trace<x>
Displays the "Trace Configuration" dialog to enable another trace in the selected result display.

For more information, see Section 4.8.1.2, "How to configure a standard trace", on page 299.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 669

Settings selection
Opens a list of available settings for the dialog. Enable the settings you want to display in the dialog. "Set to Default" restores the default display with all settings.

This function is useful for basic configurations for which only specific settings are relevant to you.

Trace State
Enables or disables a trace. Only enabled traces are shown in the result display.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 669

Trace Mode
Defines the update mode for subsequent traces.

"Clear Write" Overwrite mode (default): the trace is overwritten by each sweep.
All available detectors are supported.
In the "Spectrum" application, the "Detector" is automatically set to "Auto Peak".

"Max Hold" The FSWX determines and displays the maximum value over several measurements. The FSWX saves the sweep result in the trace memory only if the new value is greater than the previous one.
This mode is not available for statistic measurements.

"Min Hold" The FSWX determines and displays the minimum value over several measurements. The FSWX saves the sweep result in the trace memory only if the new value is lower than the previous one.
This mode is not available for statistic measurements.

"Average" The FSWX determines and displays the average value over several measurements.
The Average Count determines the number of averaging procedures.
This mode is not available for statistic measurements.

"View" The FSWX freezes and displays the current contents of the trace memory.

"Blank" The FSWX removes the selected trace from the display.

"Density" Provides a color-coded trace of how often a particular (clear/write) trace point occurs in multiple sweeps.
The Average Count determines the number of sweeps.

For more information, see "Detecting changes over time - persistence and density" on page 289.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE` on page 671

Detector
Determines how the detector type is defined.

"Auto" (Default:) The FSWX selects the optimum detector for the selected trace and filter mode.

"Manual" You define the required detector Type.

Remote command:
`[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO` on page 677

Type
Defines the trace detector to be used for trace analysis.

For more information, see "Mapping samples to sweep points with the trace detector" on page 278.

The trace detector combines multiple FFT window results to create the final spectrum. If necessary, the trace detector also reduces the number of calculated frequency points (defined by the FFT length) to the defined number of sweep points. By default, the "Auto Peak" trace detector is used.

Remote command:
`[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]` on page 676

Hold
If enabled, traces in "Min Hold", "Max Hold" and "Average" mode are not reset after you change specific parameters.

Normally, the FSWX starts the measurement again after you change parameters and before it analyzes the measurement results (e.g. using a marker). If necessary, the FSWX resets the trace automatically to avoid false results (e.g. after span changes). For applications that do not require a reset after parameter changes, you can disable the automatic reset.

By default, "Hold" is disabled.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous`
on page 672

Smoothing
If enabled, the trace is smoothed by the specified value. Define the smoothing value as a percentage of the display width. The larger the smoothing value, the greater the smoothing effect. Values between 1 % and 50 % are supported.

Note: Effects of smoothing on postprocessing functions. Note that in the "Spectrum" application, the FSWX applies all functions that are performed after the sweep, such as limit checks, markers, or channel power measurements, to the smoothed trace data. Thus, the results differ from results based on the original trace.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]`
on page 674
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture`
on page 673

Persistence
If enabled, past traces remain visible in the display, and slowly fade away. The persistency duration depends on the sweep count.

For a sweep count = 0, the persistence duration is infinite, that is: each trace remains visible until you start a new sweep.

This option is automatically enabled for Trace Mode "Density".

For details, see "Detecting changes over time - persistence and density" on page 289

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:PERSistence[:STATe] on page 673

Label
You can define a descriptive label for active traces instead of the default "Trace <x>" label.

Note: This function is not available in all applications.

If the "Show" property is enabled, the user-defined label is displayed in the diagram area. The font color corresponds to the color of the particular trace (for example, yellow trace: yellow font).

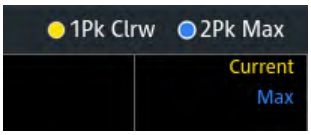


Figure 5-57: Example: the yellow and blue traces have a label

You can move the trace label to any position on the display by dragging it to the new position.

You can only configure labels for active traces, that is: traces whose "Mode" is not "Blank".

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe] on page 670
DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT on page 670

Predefined Trace Settings - Quick Config
The FSWX provides quick access to commonly required trace settings.

Function	Trace Settings	
"Preset All Traces"	Trace 1:	"Clear Write" Auto Detector ("Auto Peak")
	Traces 2-6:	"Blank" Auto Detector
"Max | Avg | Min"	Trace 1:	"Max Hold" Auto Detector ("Positive Peak")
	Trace 2:	"Average" Auto Detector ("Sample")
	Trace 3:	"Min Hold" Auto Detector ("Negative Peak")
	Traces 4-6:	"Blank" Auto Detector
"Max | ClrWrite | Min"	Trace 1:	"Max Hold" Auto Detector ("Positive Peak")

Function	Trace Settings	
	Trace 2:	"Clear Write" Auto Detector ("Auto Peak")
	Trace 3:	"Min Hold" Auto Detector ("Negative Peak")
	Traces 4-6:	"Blank" Auto Detector

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:PRESet` on page 672

Average Count
Determines the number of averaging or search operations for the trace modes "Average", "Max Hold" or "Min Hold".

In continuous sweep mode, if sweep count = 0 (default), averaging is performed over 10 sweeps. For sweep count =1, no averaging or search operations are performed.

This value is identical to the Sweep Count setting in the "Sweep Configuration".

Remote command:
`[SENSe<ip>:]AVERage<n>:COUNt` on page 675

Average Mode
Defines whether the trace mode is defined automatically or manually.

"Auto" (Default:) The FSWX determines the optimal averaging mode automatically according to the selected trace detector.

"Manual" You define the trade mode manually. See "Average Type" on page 1220.

Remote command:
`[SENSe<ip>:]AVERage<n>:AUTO` on page 674

Average Type
Defines the mode with which the trace is averaged over several sweeps.

This setting applies to all traces with trace mode "Average".

"Logarithmic" (Default:) For logarithmic scaling, the values are averaged in dBm. For linear scaling, the behavior is the same as with linear averaging.

"Linear" The power level values are converted into a linear unit (V) before averaging. After the averaging, the data is converted back into its original unit.

"Power" The power level values are converted into unit Watt before averaging. After the averaging, the data is converted back into its original unit. Use this mode to average power values in volts or amperes correctly. In particular, for small VBW values (smaller than the RBW), use power averaging mode for correct power measurements in FFT sweep mode.

Remote command:
[SENSe<ip>:]AVERage<n>:TYPE on page 676

X-Corr Factor
Indicates the number of sweep samples that are cross-correlated to determine a single sweep point if the "RMS X-Corr" detector is used.

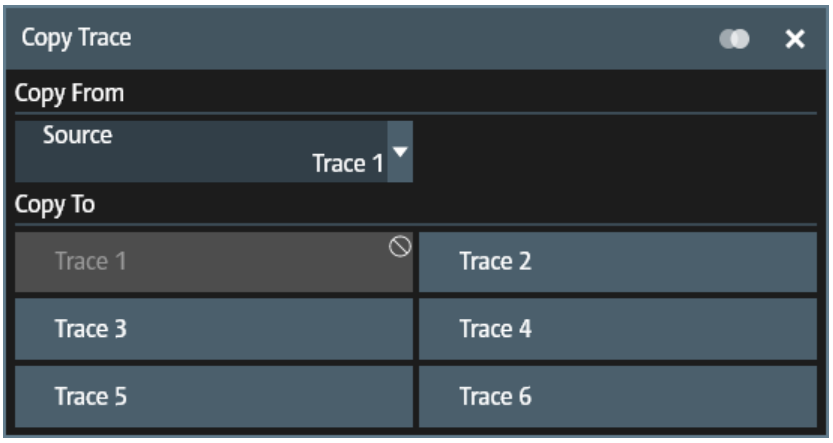
See also Section 4.1.5.2, "RMS X-Corr detector", on page 161.

Remote command:
[SENSe<ip>:]SWEep:XFACtor on page 1428

Copy Trace
Access: "Overview" > "Analysis" > "Traces" > "Copy Trace"

Or: [Trace] > "Copy Trace"

Copies trace settings from an active trace to another trace.



"Copy From" selects the source trace. You can only select active traces as the source.

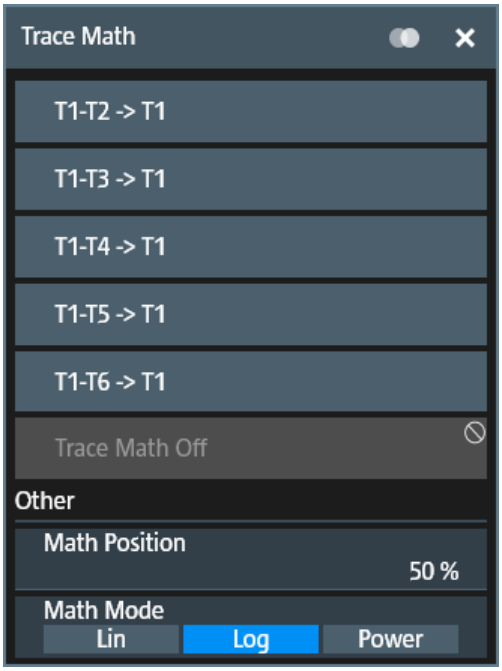
"Copy To" selects the destination. The source and destination traces cannot be identical.

Remote command:
TRACe<n>:COPY on page 677

5.4.4.2 Trace Math

Access: [Trace] > "Trace Math"

You can combine the results from multiple traces for the same measurement using mathematical functions. For example, if you have a result display with an average trace and a maximum trace, you can analyze the maximum difference between the average and maximum values. To analyze the span of result values, you can subtract the minimum trace from the maximum trace.



Trace math function....1222
Math Position....1222
Math Mode....1222

Trace math function
Defines which trace is subtracted from trace 1. Trace 1 displays the result.

The result refers to the zero point defined with the Math Position setting.

To disable the trace math function, select "Trace Math Off".

Remote command:
`CALCulate<n>:MATH<t>[:EXPRession][:DEFine]` on page 686
`CALCulate<n>:MATH<t>:STATe` on page 687

Math Position
Defines the zero point on the y-axis of the resulting trace in percent of the diagram height. Values from -100 % to +200 % are supported.

Remote command:
`CALCulate<n>:MATH<t>:POSition` on page 687

Math Mode
Defines the mode for the trace math calculations.

"Lin" Enables linear subtraction. The power level values are converted into linear units before subtraction. After the subtraction, the data is converted back into its original unit. This setting takes effect if the grid is set to a linear scale. In this case, the data is converted into V before subtraction, i.e. subtraction is done in V.

"Log" Enables logarithmic subtraction.
This subtraction method only takes effect if the grid is set to a logarithmic scale, i.e. the unit of the data is dBm. In this case, the values are subtracted in dBm. Otherwise (i.e. with linear scaling), the behavior is the same as with linear subtraction.
The 0-dB point of the logarithmic scale is set to the "Math Position" on page 1222.

"Power" Enables linear power subtraction.
The power level values are converted into unit Watt before subtraction. After the subtraction, the data is converted back into its original unit.
Unlike the linear mode, the subtraction is always done in W.

Remote command:
`CALCulate<n>:MATH<t>:MODE` on page 686

5.4.4.3 Spectrogram settings

Access: [Trace] > "Spectrogram Configuration"

Spectrograms support additional trace settings. They are only available if a "Spectrogram" result display is active.

Search functions for spectrogram markers are described in Section 5.4.2.3, "Marker search settings for spectrograms", on page 1190.

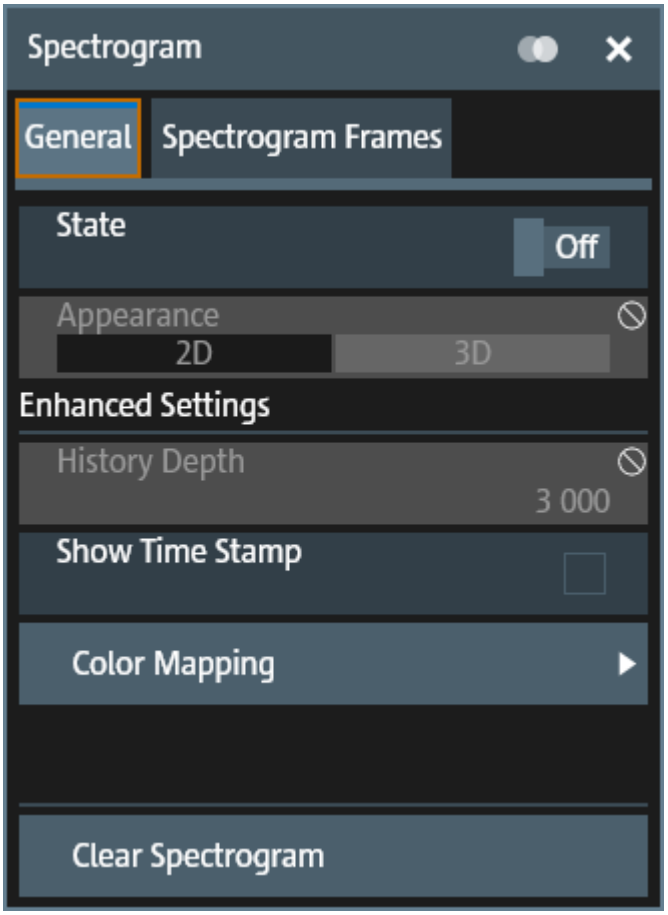
For background information, see also "Working with spectrograms" on page 290.

- General spectrogram settings....1223
- Spectrogram frames....1225
- Color map settings....1227

General spectrogram settings

Access: "Overview" > "Trace Configuration" > "Spectrogram Configuration" > "General"

This section describes general settings for spectrogram display.



Spectrogram State 1224
Appearance 1224
History Depth 1225
3-D Display Depth 1225
Trace 1225
Show Time Stamp 1225
Color Mapping 1225
Clear Spectrogram 1225

Spectrogram State
Enables and disables a "Spectrogram" result display.

Remote command:
`CALCulate<n>:SPECtrogram:LAYout` on page 681

Appearance
Toggles between a 2-dimensional and 3-dimensional spectrogram. In the common 2-dimensional spectrogram, the power is indicated by a color mapping. In a 3-dimensional spectrogram, the power is also displayed in a third dimension, the z-axis.

For background information, see also "Working with spectrograms" on page 290.

Remote command:
`CALCulate<n>:SPECtrogram:THReedim[:STATe]` on page 682

History Depth
Sets the number of frames that the FSWX stores in its memory.

The maximum number of frames depends on the number of sweep points.

See "Sweep Points" on page 969.

For an overview of the maximum number of frames depending on the number of sweep points, see Table 4-24.

If the memory is full, the FSWX deletes the oldest frames stored in the memory and replaces them with the new data.

Remote command:
`CALCulate<n>:SPECtrogram:HDEPth` on page 680

3-D Display Depth
Defines the number of frames displayed in a 3-dimensional spectrogram.

For background information, see also "Working with spectrograms" on page 290.

Trace
Defines which trace the spectrogram is based on.

Remote command:
`CALCulate<n>:SPECtrogram:TRACe` on page 682

Show Time Stamp
Hides or shows the timestamp in the spectrogram footer. The timestamp shows the system time while the measurement is running. In single sweep mode or if you stop the sweep, the timestamp shows the time and date of the end of the sweep.

When enabled, the timestamp replaces the display of the frame number.

Remote command:
`CALCulate<n>:SPECtrogram:TSTamp[:STATe]` on page 683
`CALCulate<n>:SPECtrogram:TSTamp:DATA?` on page 682

Color Mapping
Opens the "Color Mapping" dialog.

For details, see "Color map settings" on page 1227.

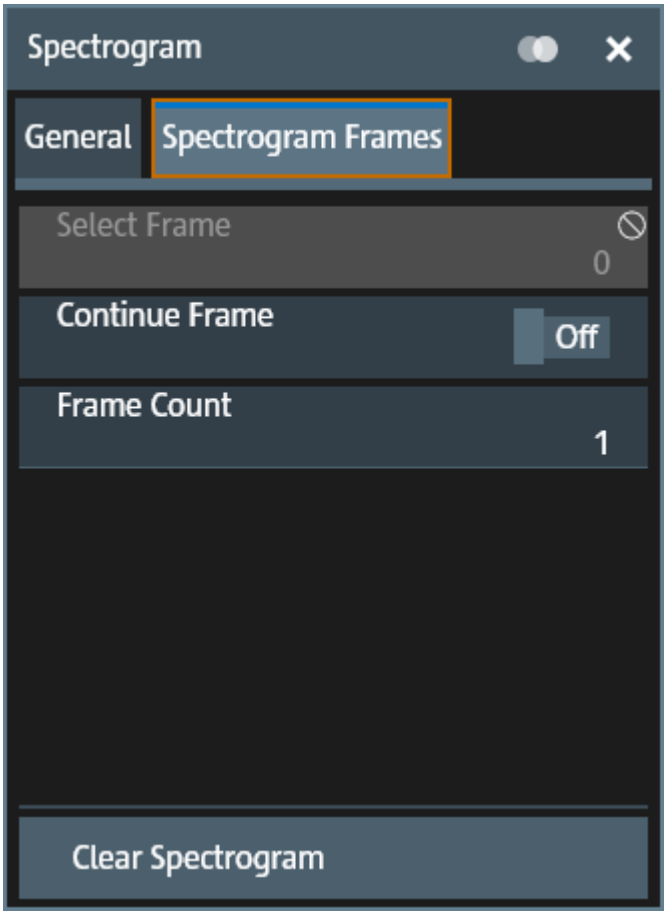
Clear Spectrogram
Resets the "Spectrogram" result display and clears the history buffer.

Remote command:
`CALCulate<n>:SPECtrogram:CLEar[:IMMediate]` on page 679

Spectrogram frames

Access: "Overview" > "Trace Configuration" > "Spectrogram Configuration" > "Spectrogram Frames"

Settings concerning the frames and how they are handled during a sweep.



Select Frame....1226
Continue Frame....1226
Frame Count....1227
Clear Spectrogram....1227

Select Frame
Selects a specific frame, loads the corresponding trace from the memory, and displays it in a separate "Spectrogram" diagram.

Note that when you enable a marker or change the position of the active marker, the frame that belongs to that marker is automatically selected.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For background information, see also "Working with spectrograms" on page 290.

Remote command:
`CALCulate<n>:SPECtrogram:FRAMe:SELect` on page 680

Continue Frame
Determines whether the results of the previous sweeps are included in the analysis of the next sweeps for trace modes "Max Hold", "Min Hold", and "Average".

This function is available in single sweep mode only.

If enabled, when the average or peak values are determined for the new sweep, the results of the previous sweeps in the spectrogram are also considered.

If disabled, the average or peak values are determined from the results of the newly swept frames only.

Remote command:
`CALCulate<n>:SPECtrogram:CONTinuous` on page 679

Frame Count
Determines how many frames are plotted during a single sweep (as opposed to a continuous sweep). The maximum number of possible frames depends on the history depth (see "History Depth" on page 1225).

For background information, see also "Working with spectrograms" on page 290.

Remote command:
`CALCulate<n>:SPECtrogram:FRAMe:COUNt` on page 679

Clear Spectrogram
Resets the "Spectrogram" result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:
`CALCulate<n>:SPECtrogram:CLEar[:IMMediate]` on page 679

Color map settings

Access: "Overview" > "Analysis" > "Traces" > "Spectrogram" > "Color Mapping"

Or: [Trace] > "Spectrogram Configuration" > "Color Mapping"

For more information, see "Color maps" on page 296.

For details on changing color-mapping settings, see Section 4.8.1.5, "How to configure the color mapping", on page 302.

In addition to the available color settings, the dialog displays the current color map and provides a preview of the display with the current settings.

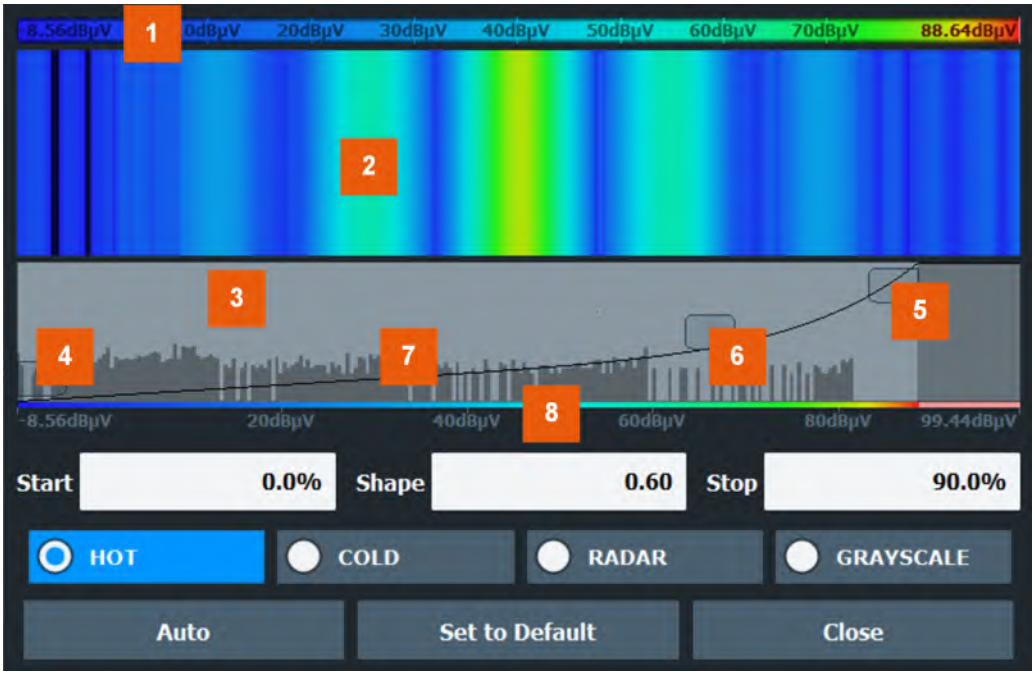


Figure 5-58: Color Mapping dialog

1 = Color map: shows the current color distribution
2 = Preview pane: shows a preview of the spectrogram with any changes that you make to the color scheme
3 = Color curve pane: graphical representation of all settings available to customize the color scheme
4/5 = Color range start and stop sliders: define the range of the color map or amplitudes for the spectrogram
6 = Color curve slider: adjusts the focus of the color curve
7 = Histogram: shows the distribution of measured values
8 = Scale of the horizontal axis (value range)

Start / Stop 1228
Shape 1228
Hot/Cold/Radar/Grayscale 1229
Auto 1229
Set to default 1229
Close 1229

Start / Stop
Defines the lower and upper boundaries of the value range of the spectrogram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer` on page 684
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer` on page 685

Shape
Defines the shape and focus of the color curve for the spectrogram result display.

-1 to 0	More colors are distributed among the lower values.
0	Colors are distributed linearly among the values.
0 to 1	More colors are distributed among the higher values.

Remote command:
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe on page 684

Hot/Cold/Radar/Grayscale
Selects the color scheme for the spectrogram.

Remote command:
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe] on page 685

Auto
Defines the color range automatically according to the measured values for optimized display.

Set to default
Sets the color mapping to the default settings.

Remote command:
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault on page 684

Close
Saves the changes and closes the dialog.

5.5 Remote commands

The commands required to perform measurements in the "Spectrum" application in a remote environment are described here.

It is assumed that the FSWX has already been set up for remote operation in a network as described in Section 4.13.6, "How to set up a network and remote control", on page 526.

- Configuring and performing measurements....1229
- Spectrum analysis commands....1413
- Programming examples....1431

5.5.1 Configuring and performing measurements

The following commands are required to configure measurements in a remote environment. The tasks for manual operation are described in Section 5.3, "RF measurements", on page 985.

- Performing RF measurements....1230
- Configuring power measurements....1231
- Measuring the channel power and ACLR....1236
- Measuring the carrier-to-noise ratio....1301
- Measuring the occupied bandwidth....1302
- Remote commands for noise power ratio (NPR) measurements....1304
- Measuring the spectrum emission mask....1320
- Measuring spurious emissions....1359
- Analyzing statistics (APD, CCDF)....1374

- Measuring the time domain power....1384
- Measuring the harmonic distortion....1394
- Measuring the third order intercept point....1398
- Measuring the AM modulation depth....1401
- List evaluations....1404
- Measuring the pulse power....1408

5.5.1.1 Performing RF measurements

Useful commands for performing RF measurements described elsewhere

- Section 4.14.9, "Performing measurements", on page 645
- `INITiate<n>:ESPectrum` on page 1322
- `INITiate<n>:SPURious` on page 1359

Remote commands exclusive for performing RF measurements:

[SENSe<ip>:]FREQuency:MODE....1230
[SENSe:]SWEep:COUNt:CURRent?....1230

[SENSe<ip>:]FREQuency:MODE <Mode>

Selects a basic frequency measurement.

Suffix:
<ip> Input

Parameters:
<Mode> CW | FIXed | SWEep

FIXed | CW
Selects a fixed frequency measurement (zero span).
Define the frequency with `[SENSe<ip>:]FREQuency:CENTer` on page 612.

SCAN | SWEep
Selects a frequency sweep over a defined range.
Define the frequency range with:
`[SENSe<ip>:]FREQuency:STARt` on page 1417
`[SENSe<ip>:]FREQuency:STOP` on page 1418

Example: `SENS:FREQ:MODE FIX`

Manual operation: See "Frequency Sweep" on page 987

[SENSe:]SWEep:COUNt:CURRent?

Prerequisite:A sweep count value is defined and the instrument is in single sweep mode.

This query returns the current number of started sweeps or measurements.

Return values:
<CurrentCount>

Example:
//Set sweep count to 64
```
SWE:COUNt 64
```
//Switch to single sweep mode
```
INIT:CONT OFF
```
//Start a sweep (without waiting for the sweep end!)
```
INIT
```
//Query the number of started sweeps
```
SWE:COUN:CURR?
```

Usage: Query only

5.5.1.2 Configuring power measurements

The following commands work for several power measurements.

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:MODE 1231
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult 1231
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SELect 1233
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>[:STATe] 1234
[SENSe:]POWer:ACHannel:PRESet 1235
[SENSe:]POWer:ACHannel:PRESet:RLEVel 1235
[SENSe:]POWer:TRACe 1235

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:MODE <Mode>

Selects the trace display mode for power measurements.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

<sb> irrelevant

Parameters:
<Mode> WRITe | MAXHold

WRITe
The power is calculated from the current trace.

MAXHold
The power is calculated from the current trace and compared with the previous power value using a maximum algorithm.

Example:
//Display the currently measured power values.
```
CALC:MARK:FUNC:POW:MODE WRIT
```

Manual operation: See "Power Mode" on page 1103

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult <Measurement>

Queries the results of power measurements.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also INITiate<n>:CONTinuous on page 646.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

<sb> Sub block in a Multi-standard radio measurement;
MSR ACLR: 1 to 8
Multi-SEM: 1 to 8
for all other measurements: irrelevant

Parameters:

<Measurement> ACPower | AOBandwidth | AOBWidth | CPOWer | MCACpower | OBANdwidth | OBWidth | COBandwidth | COBWidth | CN | CN0 | PPOWer | GACLr | MACM | TPOWer

ACPower | MCACpower
ACLR measurements (also known as adjacent channel power or multicarrier adjacent channel measurements).
Returns the power for every active transmission and adjacent channel. The order is:
• power of the transmission channels
• power of adjacent channel (lower,upper)
• power of alternate channels (lower,upper)
MSR ACLR results:
For MSR ACLR measurements, the order of the returned results is slightly different:
• power of the transmission channels
• total power of the transmission channels for each sub block
• power of adjacent channels (lower, upper)
• power of alternate channels (lower, upper)
• power of gap channels (lower1, upper1, lower2, upper2)
The unit of the return values depends on the scaling of the y-axis:
• logarithmic scaling returns the power in the current unit
• linear scaling returns the power in W

GACLr
For MSR ACLR measurements only: returns a list of ACLR values for each gap channel (lower1, upper1, lower2, upper2)

MACM
For MSR ACLR measurements only: returns a list of CACLR values for each gap channel (lower1, upper1, lower2, upper2)

CN
Carrier-to-noise measurements.
Returns the C/N ratio in dB.

CN0
Carrier-to-noise measurements.
Returns the C/N ratio referenced to a 1 Hz bandwidth in dBm/Hz.

CPOWer
Channel power measurements.
Returns the channel power. The unit of the return values depends on the scaling of the y-axis:
• logarithmic scaling returns the power in the current unit
• linear scaling returns the power in W
For SEM measurements, the return value is the channel power of the reference range (in the specified sub block).

PPOWer
Prerequisite: Power reference type is set to peak power (see `[SENSe:]ESPectrum<sb>:RTYPe` on page 1341).
Peak power measurements.
Returns the peak power. The unit of the return values depends on the scaling of the y-axis:
• logarithmic scaling returns the power in the current unit
• linear scaling returns the power in W
For SEM measurements, the return value is the peak power of the reference range (in the specified sub block).

OBANdwidth | OBWidth
Occupied bandwidth.
Returns the occupied bandwidth in Hz.

COBandwidth | COBWidth
<Centroid frequency>,<Frequency offset>
See "Centroid frequency" on page 1137
Note: A frequency offset defined in the "Frequency" settings is not considered for the harmonic frequency results.

Example: //Query the results of the adjacent channel power measurement.
`CALC:MARK:FUNC:POW:RES ACP`

Manual operation: See "Measurement Mode" on page 1133

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SELect <MeasType>

Selects a power measurement and turns the measurement on.

Suffix:
<n> Window 1 to 16
<m> Marker 1 to 16
<sb> irrelevant

Parameters:
<MeasType> ACPower | CPOWer | MCACpower | AOBWidth | OBANdwidth | OBWidth | CN | CN0

ACPower | MCACpower
Adjacent channel leakage ratio (ACLR), also known as adjacent channel power or multicarrier adjacent channel.
The FSWX performs the measurement on the trace selected with `[SENSe:]POWer:TRACe`.

CPOWer
Channel power measurement with a single carrier.
The FSWX performs the measurement on the trace selected with `[SENSe:]POWer:TRACe`.

OBANdwidth | OBWidth
Occupied bandwidth measurement.
The FSWX performs the measurement on the trace that marker 1 is positioned on.

CN
Carrier-to-noise ratio measurement.

CN0
Carrier-to-noise ratio measurement referenced to 1 Hz bandwidth

Example: //Enable an adjacent channel power measurement.
```
CALC:MARK:FUNC:POW:SEL ACP
```

Manual operation: See "Measurement Mode" on page 1133

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>[:STATe] <State>

Enables or disables a power measurement.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

<sb> irrelevant

Parameters:
<State> ON | OFF | 1 | 0

ON | 1
The power measurement selected with `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SELect` is activated.

OFF | 0
A standard frequency sweep is activated.

*RST: 0

Example: //Disable all power measurements and enable a standard frequency sweep.
```
CALC:MARK:FUNC:POW:STAT OFF
```

Manual operation: See "Measurement Mode" on page 1133

[SENSe:]POWer:ACHannel:PRESet <Measurement>

Determines the ideal span, bandwidths and detector for the current power measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also`INITiate<n>:CONTinuous` on page 646 .

Parameters:

<Measurement>

ACPower | MCACpower
ACLR measurement

CPOWer
channel power measurement

OBANdwidth | OBWidth
Occupied bandwidth measurement

CN
Carrier to noise ratio

CN0
Carrier to noise ration referenced to a 1 Hz bandwidth

Example:
```
POW:ACH:PRES
```

Manual operation:
See "Optimize Instrument Settings" on page 1103
See "Optimize Settings" on page 1134
See "Optimize Settings" on page 1139

[SENSe:]POWer:ACHannel:PRESet:RLEVel

Determines the ideal reference level for the current measurement.

This automatic routine makes sure that the signal power level does not overload the FSWX or restrict the dynamic range by an insufficient S/N ratio.

To determine the best reference level, the FSWX aborts current measurements and performs a series of test sweeps. After it has finished the test, it continues with the actual measurement.

Example:
```
SENS:POW:ACH:PRES:RLEV
```

[SENSe:]POWer:TRACe <TraceNumber>

Selects the trace channel power measurements are performed on.

For the measurement to work, the corresponding trace has to be active.

Parameters:

<TraceNumber>

Range: 1 to 6
*RST: 1

Example: //Assign the measurement to trace 2.
```
POW:TRAC 2
```

Manual operation: See "Selected Trace" on page 1102

5.5.1.3 Measuring the channel power and ACLR

All remote control commands specific to channel power or ACLR measurements are described here.

- Managing measurement configurations....1236
- Configuring the channels....1238
- Defining weighting filters....1242
- Selecting the reference channel....1245
- Checking limits....1246
- Checking limits (total limit pass mode)....1253
- General ACLR measurement settings....1257
- Configuring MSR ACLR measurements....1258
- Performing an ACLR measurement....1289
- Retrieving and analyzing measurement results....1289
- Programming examples for channel power measurements....1293

Managing measurement configurations

The following commands control measurement configurations for ACLR measurements.

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet....1236
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:STANdard:CATalog?....1237
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:STANdard:DELete....1237
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:STANdard:SAVE....1237

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet <Standard>

Loads a measurement configuration.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

If the "Multi-Standard Radio" standard is selected (see "Standard" on page 1100), different commands are required to configure ACLR measurements (see "Configuring MSR ACLR measurements" on page 1258).

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

<sb> irrelevant

Parameters:

<Standard> For more information see "Predefined standards" on page 1100. If you want to load a customized configuration, the parameter is a string containing the file name.

Example: `CALC:MARK:FUNC:POW:PRES TETR`

Manual operation: See "Predefined standards" on page 1100
See "Managing user standards" on page 1100

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:STANdard:CATalog?

Queries all files containing ACLR standards.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

<sb> Sub block in a Multi-standard radio measurement;
MSR ACLR: 1 to 8
Multi-SEM: 1 to 8
for all other measurements: irrelevant

Return values:

<Standards> List of standard files.

Example: `CALC:MARK:FUNC:POW:STAN:CAT?`

Usage: Query only

Manual operation: See "Managing user standards" on page 1100

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:STANdard:DELete
<Standard>

Deletes a file containing an ACLR standard.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

<sb> irrelevant

Parameters:

<Standard> String containing the file name of the standard.

Example: `CALC:MARK:FUNC:POW:STAN:DEL`

Manual operation: See "Managing user standards" on page 1100

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:STANdard:SAVE <Standard>

Saves the current ACLR measurement configuration as a new ACLR standard.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

<sb> irrelevant

Parameters:
<Standard> String containing the file name. The file format is xml.

Example: `CALC:MARK:FUNC:POW:STAN:SAVE`

Manual operation: See "Managing user standards" on page 1100

Configuring the channels

The following commands configure channels for channel power and ACLR measurements.

[SENSe:]POWer:ACHannel:ACPairs....1238
[SENSe:]POWer:ACHannel:BWIDth:ACHannel....1239
[SENSe:]POWer:ACHannel:BANDwidth:ACHannel....1239
[SENSe:]POWer:ACHannel:BWIDth:ALTernate<ch>....1239
[SENSe:]POWer:ACHannel:BANDwidth:ALTernate<ch>....1239
[SENSe:]POWer:ACHannel:BWIDth[:CHANnel<ch>]....1239
[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>]....1239
[SENSe:]POWer:ACHannel:NAME:ACHannel....1240
[SENSe:]POWer:ACHannel:NAME:ALTernate<ch>....1240
[SENSe:]POWer:ACHannel:NAME:CHANnel<ch>....1240
[SENSe:]POWer:ACHannel:SPACing[:ACHannel]....1241
[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>....1241
[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch>....1242
[SENSe:]POWer:ACHannel:TXCHannel:COUNt....1242

[SENSe:]POWer:ACHannel:ACPairs <ChannelPairs>

Defines the number of pairs of adjacent and alternate channels.

Parameters:
<ChannelPairs> Range: 0 to 12
*RST: 1

Example: `SENS:POW:ACH:ACP`

Manual operation: See "Channel count: TX Channels, Adjacent Channels" on page 1101
See "Number of adjacent channels (Adj Count)" on page 1116

[SENSe:]POWer:ACHannel:BWIDth:ACHannel <Bandwidth>
[SENSe:]POWer:ACHannel:BANDwidth:ACHannel <Bandwidth>

Defines the channel bandwidth of the adjacent channels.

The adjacent channels are the first channels to the left and right of the transmission channels. If you set the channel bandwidth for these channels, the FSWX sets the bandwidth of the alternate channels to the same value (not for MSR signals).

For asymmetrical MSR signals, this command defines the bandwidth of the lower adjacent channel. To configure the bandwidth for the upper adjacent channel, use the `[SENSe:]POWer:ACHannel:BANDwidth:UACHannel` command.

Parameters:

<Bandwidth>
Range: 100 Hz to 1000 MHz
*RST: 14 kHz
Default unit: Hz

Example:
```
SENS:POW:ACH:BAND:ACH 1KHZ
```

Manual operation: See "Adjacent channel Bandwidth" on page 1116

[SENSe:]POWer:ACHannel:BWIDth:ALTernate<ch> <Bandwidth>
[SENSe:]POWer:ACHannel:BANDwidth:ALTernate<ch> <Bandwidth>

Defines the channel bandwidth of the alternate channels.

For MSR signals, this command defines the bandwidth of the lower alternate channels in asymmetrical configurations. To configure the bandwidth for the upper alternate channel, use the `[SENSe:]POWer:ACHannel:BANDwidth:UALTernate<ch>` on page 1265 command.

If you set the channel bandwidth for the first alternate channel, the FSWX sets the bandwidth of the other alternate channels to the same value, but not the other way round (not for MSR signals). The command works hierarchically: to set a bandwidth of the 3rd and 4th channel, you have to set the bandwidth of the 3rd channel first.

Suffix:

<ch>
1 to 11
Alternate channel number

Parameters:

<Bandwidth>
Range: 100 Hz to 1000 MHz
*RST: 14 kHz
Default unit: Hz

Example:
```
SENS:POW:ACH:BAND:ALT 100
```

Manual operation: See "Adjacent channel Bandwidth" on page 1116

[SENSe:]POWer:ACHannel:BWIDth[:CHANnel<ch>] <Bandwidth>
[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>] <Bandwidth>

Defines the channel bandwidth of the transmission channels.

Suffix:
<ch> TX channel number

Parameters:
<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz
Default unit: Hz

Example: //Set the channel bandwidth for the second transmission channel to 500 Hz.
`SENS:POW:ACH:BAND:CHAN2 500`

Manual operation: See "Channel Bandwidth" on page 1134
See "Channel Bandwidth" on page 1138

[SENSe:]POWer:ACHannel:NAME:ACHannel <Name>

Defines a name for the adjacent channel.

For MSR ACLR measurements, this command defines the name for the lower adjacent channel in asymmetric channel definitions. To define the name for the upper adjacent channel use the `[SENSe:]POWer:ACHannel:NAME:UACHannel` command.

Parameters:
<Name> String containing the name of the channel
*RST: ADJ

Example: `SENS:POW:ACH:NAME:ACH 'ADJ1'`

Manual operation: See "Name" on page 1115

[SENSe:]POWer:ACHannel:NAME:ALTernate<ch> <Name>

Defines a name for an alternate channel.

For MSR ACLR measurements, this command defines the name for the lower alternate channel in asymmetric channel definitions. To define the name for the upper alternate channels use the `[SENSe:]POWer:ACHannel:NAME:UALTernate<ch>` command.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<Name> String containing the name of the channel
*RST: ALT<1...11>

Example: `SENS:POW:ACH:NAME:ALT 'ALT1'`

Manual operation: See "Name" on page 1117

[SENSe:]POWer:ACHannel:NAME:CHANnel<ch> <Name>

Defines a name for a transmission channel.

Suffix:
<ch> 1 to 18
TX channel number

Parameters:
<Name> String containing the name of the channel
*RST: TX<1...18>

Example: `SENS:POW:ACH:NAME:CHAN 'TX1'`

[SENSe:]POWer:ACHannel:SPACing[:ACHannel] <Spacing>

Defines the distance from transmission channel to adjacent channel.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first sub block to the lower adjacent channel. To configure the spacing for the upper adjacent channel in asymmetrical configurations, use the `[SENSe:]POWer:ACHannel:SPACing:UACHannel` command.

A change of the adjacent channel spacing causes a change in the spacing of all alternate channels below the adjacent channel (not for MSR signals).

Parameters:
<Spacing> Range: 100 Hz to 2000 MHz
*RST: 14 kHz
Default unit: Hz

Example: `SENS:POW:ACH:SPAC:ACH 1000`

Manual operation: See "Adjacent channel Spacing" on page 1116

[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch> <Spacing>

Defines the distance from transmission channel to alternate channels.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first sub block to the lower alternate channel. To configure the spacing for the upper alternate channel in asymmetrical configurations, use the `[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch>` command.

If you set the channel spacing for the first alternate channel, the FSWX adjusts the spacing of alternate channels of a lower order, but not the other way round (not for MSR signals). The command works hierarchically: to set a distance from the transmission channel to the 2nd and 3rd alternate channel, you have to define a spacing for the 2nd alternate channel first.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<Spacing> Range: 100 Hz to 2000 MHz
*RST: 40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...
Default unit: Hz

Example: //Set a distance of the alternate channel 2 to 1000 Hz from the transmission channel.
`SENS:POW:ACH:SPAC:ALT2 1000`

Manual operation: See "Adjacent channel Spacing" on page 1116

[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch> <Spacing>

Defines the distance between transmission channels.

If you set the channel spacing for a transmission channel, the FSWX sets the spacing of the lower transmission channels to the same value, but not the other way round. The command works hierarchically: to set a distance between the 2nd and 3rd and 3rd and 4th channel, you have to set the spacing between the 2nd and 3rd channel first.

Suffix:
<ch> 1 to 18
TX channel number

Parameters:
<Spacing> Range: 14 kHz to 2000 MHz
*RST: 20 kHz
Default unit: Hz

Example: //Define the transmission channel 2 at 1000 Hz away from TX channel 1.
`SENS:POW:ACH:SPAC:CHAN2 1000`

[SENSe:]POWer:ACHannel:TXCHannel:COUNt <Number>

Defines the number of transmission channels.

The command works for measurements in the frequency domain.

Parameters:
<Number> Range: 1 to 18
*RST: 1

Example: //Define 10 transmission channels.
`SENS:POW:ACH:TXCH:COUN 10`

Manual operation: See "Channel count: TX Channels, Adjacent Channels" on page 1101

Defining weighting filters

The following commands define weighting filters for ACLR measurements.

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel 1243
[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL] 1243
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch> 1243
[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch> 1243
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel 1244

[SENSe:]POWer:ACHannel:FILTer[:STATe][:ALL] 1244
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch> 1244
[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch> 1245

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel <Alpha>

Defines the roll-off factor for the adjacent channel weighting filter.

For asymmetrical MSR signals, this command defines the roll-off factor for the lower adjacent channel. To configure the factor for the upper adjacent channel, use the `[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel` command.

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Example: `SENS:POW:ACH:FILT:ALPH:ACH 0`

Manual operation: See "Adjacent channel Weighting Filters" on page 1116

[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL] <Value>

Defines the alpha value for the weighting filter for all channels.

Parameters:

<Value> *RST: 0.22

Example: `POW:ACH:FILT:ALPH:ALL 0.35`

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch> <Alpha>

Defines the roll-off factor for the alternate channel weighting filter.

For asymmetrical MSR signals, this command defines the roll-off factor for the lower alternate channels. To configure the factor for the upper alterante channels, use the `[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch>` command.

Suffix:

<ch> Alternate channel number

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Example: `SENS:POW:ACH:FILT:ALPH:ALT2 0`

Manual operation: See "Adjacent channel Weighting Filters" on page 1116

[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch> <Alpha>

Defines the roll-off factor for the transmission channel weighting filter.

Suffix:
<ch> TX channel number

Parameters:
<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Example: `SENS:POW:ACH:FILT:ALPH:CHAN2 0`

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel <State>

Enables or disables the weighting filter for the adjacent channel.

For asymmetrical MSR signals, this command enables or disables the weighting filter for the lower adjacent channel. To configure the filter state for the upper adjacent channel, use the `[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel` command.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `SENS:POW:ACH:FILT:STAT:ACH OFF`

Manual operation: See "Adjacent channel Weighting Filters" on page 1116

[SENSe:]POWer:ACHannel:FILTer[:STATe][:ALL] <State>

Enables or disables the weighting filters for all channels.

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `SENS:POW:ACH:FILT:STAT:ALL OFF`

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch> <State>

Enables or disables the weighting filter for an alternate channel.

For asymmetrical MSR signals, this command enables or disables the weighting filter for the lower alternate channels. To configure the filter state for the upper alternate channels, use the `[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch>` command.

Suffix:
<ch> Alternate channel number

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: SENS:POW:ACH:FILT:STAT:ALT OFF

Manual operation: See "Adjacent channel Weighting Filters" on page 1116

[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch> <State>

Enables or disables the weighting filter for a transmission channel.

Suffix:
<ch> TX channel number

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: SENS:POW:ACH:FILT:STAT:CHAN2 OFF

Selecting the reference channel

The following commands define the reference channel for relative ACLR measurements.

[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE 1245
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO 1245
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual 1246

[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE

Sets the channel power as the reference for relative ACLR measurements.

Example: POW:ACH:REF:AUTO ONCE

Usage: Event

Manual operation: See "Set Channel Power Reference" on page 1102

[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO <RefChannel>

Selects the reference channel for relative measurements.

You need at least one channel for the command to work.

Parameters:
<RefChannel> MINimum | MAXimum | LHIGhest

MINimum
Transmission channel with the lowest power

MAXimum
Transmission channel with the highest power

LHIGhest
Lowest transmission channel for lower adjacent channels and highest transmission channel for upper adjacent channels

Example: //Select the channel with the peak power as reference channel.
POW:ACH:REF:TXCH:AUTO MAX

Manual operation: See "Reference Channel" on page 1102

[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual <ChannelNumber>

Defines a reference channel for relative ACLR measurements.

You need at least one channel for the command to work.

Note that this command is not available for MSR ACLR measurements (see CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet on page 1236).

Parameters:
<ChannelNumber> Range: 1 to 18
*RST: 1

Example: //Set the reference channel for the relative results to transmission channel 2.
SENS:POW:ACH:FILT:REF:TXCH:MAN 2

Manual operation: See "Reference Channel" on page 1102

Checking limits

The following commands configure and query limit checks for channel power and ACLR measurements.

The results of the power limit checks are also indicated in the STAT:QUES:ACPL status registry (see "STATus:QUEStionable:ACPLimit register" on page 497).

CALCulate<n>:LIMit<li>:ACPower:ACHannel:ABSolute 1246
CALCulate<n>:LIMit<li>:ACPower:ACHannel:ABSolute:STATe 1247
CALCulate<n>:LIMit<li>:ACPower:ACHannel[:RELative] 1247
CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult? 1248
CALCulate<n>:LIMit<li>:ACPower:ACHannel[:RELative]:STATe 1249
CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:ABSolute 1249
CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:ABSolute:STATe 1250
CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>[:RELative] 1250
CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:RESult? 1251
CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>[:RELative]:STATe 1252
CALCulate<n>:LIMit<li>:ACPower:PMODe 1252
CALCulate<n>:LIMit<li>:ACPower[:STATe] 1252

CALCulate<n>:LIMit<li>:ACPower:ACHannel:ABSolute <LowerLimit>[,
<UpperLimit>]

Defines the absolute limit of the adjacent channels.

If you have defined an absolute limit as well as a relative limit, the FSWX uses the lower value for the limit check.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<LowerLimit> The limit of the lower adjacent channel.

Range: -200 dBm to 200 dBm
*RST: -200 dBm
Default unit: dBm

<UpperLimit> The limit of the upper adjacent channel.

Range: -200 dBm to 200 dBm
*RST: -200 dBm
Default unit: dBm

Example: //Set the adjacent channel power to be between -100 dBm and +100 dBm.

```
CALC:LIM:ACP:ACH:ABS -100,100
```

CALCulate<n>:LIMit<li>:ACPower:ACHannel:ABSolute:STATe <State>[, <State>]

Prerequisite: Activate the general ACLR limit check with `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.

Turns the absolute limit check for the adjacent channels on and off.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<State> ON | OFF | 1 | 0

Absolute limit check for lower adjacent channel

*RST: 0

<State> ON | OFF | 1 | 0

Absolute limit check for upper adjacent channel

*RST: 0

Example: //Disable both absolute limit checks.

```
CALC:LIM:ACP:ACH:ABS:STAT OFF, OFF
```

CALCulate<n>:LIMit<li>:ACPower:ACHannel[:RELative] <LowerLimit>[, <UpperLimit>]

Defines the relative limit of the adjacent channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the FSWX uses the lower value for the limit check.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<LowerLimit> The limit of the lower adjacent channel.

Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

<UpperLimit> The limit of the upper adjacent channel.

Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

Example: //Set the limits for both the upper and lower adjacent channels to 3 dB, relative to the TX channel power.

```
CALC:LIM:ACP:ACH:REL 3,3
```

CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult?

Queries the state of the limit check for the adjacent channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Return values:

<LowerACH> text value

Thestate of the limit check for the lower adjacent channels.

PASSED
Limit check has passed.

FAIL
Limit check has failed.

<UpperACH> text value

The state of the limit check for the upper adjacent channels.

PASSED
Limit check has passed.

FAIL
Limit check has failed.

Example:
```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED,PASSED
```

Usage: Query only

Manual operation: See "Relative Limit/Absolute Limit" on page 1112
See "Limit Checking" on page 1121

CALCulate<n>:LIMit<li>:ACPower:ACHannel[:RELative]:STATe <State>[, <State>]

Turns the relative limit check for the adjacent channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<State> ON | OFF | 1 | 0
Relative limit check for lower adjacent channel
*RST: 0

<State> ON | OFF | 1 | 0
Relative limit check for upper adjacent channel
*RST: 0

Example: //Disable the limit checks for both adjacent channels.
```
CALC:LIM:ACP:ACH:REL:STAT OFF, OFF
```

CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:ABSolute <LowerLimit>[, <UpperLimit>]

Defines the absolute limit of the alternate channels.

If you have defined an absolute limit as well as a relative limit, the FSWX uses the lower value for the limit check.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<ch> 1 to 11
Alternate channel number

Parameters:
<LowerLimit> The limit of the lower adjacent channel.
Range: -200 dBm to 200 dBm
*RST: -200 dBm
Default unit: dBm

<UpperLimit> The limit of the upper adjacent channel.

Range: -200 dBm to 200 dBm
*RST: -200 dBm
Default unit: dBm

Example: //Require both the upper and the lower adjacent channels to be under 100 dBm.
```
CALC:LIM:ACP:ALT:ABS 100,100
```

CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:ABSolute:STATe <State>[, <State>]

Turns the absolute limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<ch> 1 to 11
Alternate channel number

Parameters:
<State> ON | OFF | 1 | 0
Absolute limit check for lower alternate channel
*RST: 0

<State> ON | OFF | 1 | 0
Absolute limit check for upper alternate channel
*RST: 0

Example: //Disable the limit checks for both adjacent channels.
```
CALC:LIM:ACP:ALT:ABS:STAT OFF, OFF
```

CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>[:RELative] <LowerLimit>[, <UpperLimit>]

Defines the relative limit of the alternate channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the FSWX uses the lower value for the limit check.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<ch> 1 to 11
Alternate channel number

Parameters:

<LowerLimit> The limit of the lower alternate channel.

Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

<UpperLimit> The limit of the upper alternate channel.

Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

Example: //Set the limits for both the upper and lower adjacent channels to 3 dB, relative to the TX channel power.

```
CALC:LIM:ACP:ALT:REL 3,3
```

CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:RESult?

Queries the state of the limit check for the adjacent or alternate channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<ch> Alternate channel number

Return values:

<LowerChan> text value

The state of the limit check for the lower alternate or adjacent channels.

PASSED
Limit check has passed.

FAIL
Limit check has failed.

<UpperChan> text value

The state of the limit check for the upper alternate or adjacent channels.

PASSED
Limit check has passed.

FAIL
Limit check has failed.

Example:
```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED,PASSED
```

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>[:RELative]:STATe <State>[, <State>]

Turns the relative limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<ch> 1 to 11
Alternate channel number

Parameters:

<State> ON | OFF | 1 | 0
Relative limit check for lower alternate channel
*RST: 0

<State> ON | OFF | 1 | 0
Relative limit check for upper alternate channel
*RST: 0

Example: //Disable the limit checks for the second upper and lower alternate channels.
```
CALC:LIM:ACP:ALT2:REL:STAT OFF,OFF
```

CALCulate<n>:LIMit<li>:ACPower:PMODe <Mode>

Supported only by the LTE and 5G application.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

Parameters:

<Mode> AND | OR

Example:
```
CALC:LIM:ACP:PMOD AND
```

CALCulate<n>:LIMit<li>:ACPower[:STATe] <State>

Enables or disables the limit check for ACLR measurements.

In addition, limits must be defined and activated individually for each channel (see CALCulate<n>:LIMit<li>:ACPower:ACHannel[:RELative]:STATe, CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>[:RELative]:STATe, CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ABSolute:STATe, CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ACLR[:RELative]:STATe and CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO][:CACLr][:RELative]:STATe).

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: CALC:LIM:ACP:STAT OFF

Manual operation: See "Relative Limit/Absolute Limit" on page 1112
See "Limit Checking" on page 1121

Checking limits (total limit pass mode)

The following commands are only available in the ACLR measurements of the LTE and 5G applications.

Depending on the syntax, the commands return the limit check results for:

- adjacent channels
- alternate channels
- gap channels in multi carrier ACLR measurements (LTE and 5G downlink only)
- gap channels in cumulative ACLR measurement (LTE downlink and 5G downlink only)

CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult:ABSolute 1253
CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult:RELative 1254
CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:RESult:ABSolute 1254
CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:RESult:RELative 1254
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult:ABSolute? 1255
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult:RELative? 1255
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLr]:RESult:ABSolute? 1256
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLr]:RESult:RELative? 1257

CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult:ABSolute

During an ACLR measurement, the power values can be checked whether they exceed user-defined or standard-defined limits.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Example: //Query results of the adjacent channel limit check
CALC:LIM:ACP:ACH:RES:ABS?

CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult:RELative

Prerequisite: Select relative limit check mode using CALCulate<n>:LIMit<li>:ACPower:PMODe on page 1252

Queries the relative limit check results for the adjacent channels (ACLR measurements).

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

Example: //Query results of the adjacent channel limit check
CALC:LIM:ACP:ACH:RES:REL?

CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:RESult:ABSolute

Queries the absolute limit check results for the alternate channels (MC ACLR measurements).

Prerequisites for this command

- Select absolute limit check mode
  ACLR: CALCulate<n>:LIMit<li>:ACPower:PMODe on page 1252.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<ch> 1 to 11

Example: //Query results of the alternate channel limit check
CALC:LIM:ACP:ALT:RES:ABS?

CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:RESult:RELative

Queries the relative limit check results for the alternate channels (MC ACLR measurements).

Prerequisites for this command

- Select relative limit check mode
  ACLR: CALCulate<n>:LIMit<li>:ACPower:PMODe on page 1252.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<ch> 1 to 11

Example: //Query results of the alternate channel limit check
CALC:LIM:ACP:ALT:RES:REL?

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult:ABSolute?

Queries the absolute power limit check results for the gap channels (MC ACLR measurements).

Prerequisites for this command

- Select absolute limit check mode
  evaluation mode
  ACLR: CALCulate<n>:LIMit<li>:ACPower:PMODe.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 to 6

Return values:

<LowerGap_AB>

<UpperGap_AB>

<LowerGap_BC>

<UpperGap_BC>

<LowerGap_CD>

<UpperGap_CD>

<LowerGap_DE>

<UpperGap_DE>

Example: //Query results of the gap channel limit check
CALC:LIM:ACP:GAP:ACLR:RES:ABS?

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult:RELative?

Queries the relative power limit check results for the gap channels (MC ACLR measurements).

Prerequisites for this command

- Select relative limit check mode
  evaluation mode
  ACLR: CALCulate<n>:LIMit<li>:ACPower:PMODe.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 to 6

Return values:
<LowerGap_AB>

<UpperGap_AB>

<LowerGap_BC>

<UpperGap_BC>

<LowerGap_CD>

<UpperGap_CD>

<LowerGap_DE>

<UpperGap_DE>

Example: //Query results of the gap channel limit check
`CALC:LIM:ACP:GAP:ACLR:RES:REL?`

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLr]:RESult:ABSolute?

Queries the absolute limit check results for the gap channels (MC ACLR measurements).

Prerequisites for this command

- Select absolute limit check mode
  evaluation mode
  ACLR: `CALCulate<n>:LIMit<li>:ACPower:PMODe`.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 to 6

Return values:
<LowerGap_AB>

<UpperGap_AB>

<LowerGap_BC>

<UpperGap_BC>

<LowerGap_CD>

<UpperGap_CD>

<LowerGap_DE>

<UpperGap_DE>

Example: //Query results of the gap channel limit check
`CALC:LIM:ACP:GAP:RES:ABS?`

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLr]:RESult:RELative?

Queries the relative limit check results for the gap channels (MC ACLR measurements).

Prerequisites for this command

- Select relative limit check mode
  evaluation mode
  ACLR:`CALCulate<n>:LIMit<li>:ACPower:PMODe` .

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 to 6

Return values:

<LowerGap_AB>

<UpperGap_AB>

<LowerGap_BC>

<UpperGap_BC>

<LowerGap_CD>

<UpperGap_CD>

<LowerGap_DE>

<UpperGap_DE>

Example: //Query results of the gap channel limit check
`CALC:LIM:ACP:GAP:RES:REL?`

Usage: Query only

General ACLR measurement settings

The following commands control the measurement algorithm.

Useful commands for the ACLR measurement described elsewhere:

- `[SENSe:]POWer:NCORrection` on page 614
- `[SENSe:]POWer:ACHannel:PRESet` on page 1235
- `[SENSe:]POWer:ACHannel:PRESet:RLEVel` on page 1235
- `[SENSe:]POWer:TRACe` on page 1235
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:MODE` on page 1231

Remote commands exclusive to ACLR measurement

[SENSe:]POWer:HSPeed 1258

[SENSe:]POWer:HSPeed <State>

Enables or disables high speed ACLR and channel power measurements.

If on, the FSWX performs a measurement on each channel in the time domain. It returns to the frequency domain when the measurement is done.

In some telecommunications standards, high speed measurements use weighting filters with characteristic or steep-edged channel filters for band limitation.

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

Example: `POW:HSP ON`

Configuring MSR ACLR measurements

If the "Multi-Standard Radio" standard is selected (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236), the channels for the ACLR measurement are configured differently. (For more information see "Multi-standard radio (MSR) signals" on page 1093.)

In this case, use the following commands.

- General MSR ACLR measurement settings 1258
- MSR sub block and Tx channel setup 1259
- MSR adjacent channel setup 1261
- General gap channel setup 1266
- Automatic (symmetrical) configuration 1267
- Manual (asymmetrical) configuration 1273
- MSR channel names 1287

General MSR ACLR measurement settings

Useful commands for configuring general MSR ACLR settings described elsewhere:

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult` on page 1231
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult:PHZ` on page 1291
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:MODE` on page 1231
- `CALCulate<n>:LIMit<li>:ACPower[:STATe]` on page 1252
- `[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO` on page 1245
- `[SENSe:]POWer:NCORrection` on page 614
- `[SENSe:]POWer:TRACe` on page 1235
- `[SENSe:]POWer:ACHannel:MODE` on page 1293
- `[SENSe:]POWer:ACHannel:PRESet` on page 1235
- `[SENSe:]POWer:ACHannel:SSETup` on page 1264

MSR sub block and Tx channel setup

The functions for manual operation are described in "MSR subblock and TX channel settings" on page 1112.

Useful commands for configuring Tx channels described elsewhere:

- `[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>]` on page 1288

Remote commands exclusive to configuring sub blocks and Tx channels

[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch> 1259
[SENSe:]POWer:ACHannel:FILTer[:STATe]:SBLock<sb>:CHANnel<ch> 1259
[SENSe:]POWer:ACHannel:SBCount 1260
[SENSe:]POWer:ACHannel:SBLock<sb>:BWIDth[:CHANnel<ch>] 1260
[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth[:CHANnel<ch>] 1260
[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>] 1260
[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer 1261

[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch> <Alpha>

Defines the roll-off factor for the specified transmission channel's weighting filter.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ch> TX channel number

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Manual operation: See "TX Weighting Filters" on page 1114

[SENSe:]POWer:ACHannel:FILTer[:STATe]:SBLock<sb>:CHANnel<ch> <State>

Enables or disables the weighting filter for the specified transmission channel.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ch> TX channel number

Parameters:

<State> ON | OFF | 1 | 0

*RST: W-CDMA: 1, other technologies: 0

Manual operation: See "TX Weighting Filters" on page 1114

[SENSe:]POWer:ACHannel:SBCount <Number>

Defines the number of sub blocks, i.e. groups of transmission channels in an MSR signal.

For more information see "Multi-standard radio (MSR) signals" on page 1093.

Parameters:

<Number> Range: 1 to 8
*RST: 1

Manual operation: See "Number of subblocks (Sub Block Count)" on page 1111

[SENSe:]POWer:ACHannel:SBLock<sb>:BWIDth[:CHANnel<ch>] <Bandwidth>
[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth[:CHANnel<ch>]
<Bandwidth>

Defines the bandwidth of the specified MSR Tx channel.

Is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236).

Suffix:

<sb> 1 to 8
sub block number

<ch> 1 to 11
Tx channel number

Parameters:

<Bandwidth> Bandwidth in Hz
Default unit: Hz

Example: `SENS:POW:ACH:SBL:BAND:CHAN`

Manual operation: See "TX Bandwidth" on page 1114

[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>] <Frequency>

Defines the (absolute) center frequency of the specified MSR Tx channel.

Note that the position of the first Tx channel in the first sub block and the last Tx channel in the last sub block also affect the position of the adjacent channels.

Is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236).

Suffix:

<sb> 1 to 8
sub block number

<ch> 1 to 11
Tx channel number

Parameters:
<Frequency> absolute frequency in Hz
Default unit: Hz

Example: SENS:POW:ACH:SBL:CENT:CHAN

Manual operation: See "TX Center frequency" on page 1114

[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer <Frequency>

Defines the center of the specified MSR sub block. Note that the position of the sub block also affects the position of the adjacent gap (CACLR) channels.

Is for MSR signals only (see CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet on page 1236).

Suffix:
<sb> 1 to 8
sub block number

Parameters:
<Frequency> absolute frequency in Hz
Default unit: Hz

Example: SENS:POW:ACH:SBL:FREQ:CENT

Manual operation: See "Subblock Center frequency" on page 1113

MSR adjacent channel setup

The functions for manual operation are described in Section 5.3.5.5, "MSR ACLR configuration", on page 1110.

Useful commands for MSR adjacent channel setup described elsewhere:

- "Checking limits" on page 1246
- "MSR channel names" on page 1287

Remote commands exclusive to MSR adjacent channel setup:

[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth....1262
[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>]....1262
[SENSe:]POWer:ACHannel:SBLock<sb>:TXCHannel:COUNt....1263
[SENSe:]POWer:ACHannel:SPACing:UACHannel....1263
[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch>....1263
[SENSe:]POWer:ACHannel:SSETup....1264
[SENSe:]POWer:ACHannel:BWIDth:UACHannel....1264
[SENSe:]POWer:ACHannel:BANDwidth:UACHannel....1264
[SENSe:]POWer:ACHannel:BWIDth:UALTernate<ch>....1265
[SENSe:]POWer:ACHannel:BANDwidth:UALTernate<ch>....1265
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel....1265
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch>....1265
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel....1266
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch>....1266

[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth <Bandwidth>

Defines the bandwidth of the individual MSR sub block. Note that sub block ranges also affect the position of the adjacent gap channels (CACLR).

Is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236).

Suffix:
<sb> 1 to 8
sub block number

Parameters:
<Bandwidth> Bandwidth in Hz
Default unit: Hz

Example: `SENS:POW:ACH:SBL:RFBW`

Manual operation: See "RF Bandwidth" on page 1113

[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>] <Standard>

Defines the technology used for transmission by the specified MSR Tx channel.

Is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236).

Suffix:
<sb> 1 to 8
sub block number

<ch> 1 to 11
Tx channel number

Parameters:
<Standard> Technology used for transmission

GSM
Transmission according to GSM standard

WCDMa
Transmission according to W-CDMA standard

LTE_1_40 | LTE_3_00 | LTE_5_00 | LTE_10_00 | LTE_15_00 | LTE_20_00
Transmission according to LTE standard for different channel bandwidths

NR5G_fr1_5 | NR5G_fr1_10 | NR5G_fr1_15 | NR5G_fr1_20 | NR5G_fr1_25 | NR5G_fr1_30 | NR5G_fr1_40 | NR5G_fr1_50 | NR5G_fr1_60 | NR5G_fr1_70 | NR5G_fr1_80 | NR5G_fr1_90 | NR5G_fr1_100 | NR5G_fr2_50 | NR5G_fr2_100 | NR5G_fr2_200 | NR5G_fr2_400
Transmission according to new radio 5G standard

USER
User-defined transmission; no automatic preconfiguration possible

Example: `SENS:POW:ACH:SBL:TECH:CHAN NR5G_fr1_5`

Manual operation: See "Technology used for transmission" on page 1114

[SENSe:]POWer:ACHannel:SBLock<sb>:TXCHannel:COUNt <Number>

Defines the number of transmission channels the specific sub block contains.

Is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236).

Suffix:
<sb> 1 to 8
sub block number

Parameters:
<Number> Range: 1 to 18
*RST: 1

Example: //Set subblock 2 to contain 3 TX channels
`SENS:POW:ACH:SBL2:TXCH:COUN 3`

Manual operation: See "Number of TX channels (TX Channels Count)" on page 1113

[SENSe:]POWer:ACHannel:SPACing:UACHannel <Spacing>

Defines the distance from the transmission channel to the upper adjacent channel.

For MSR signals, this command defines the distance from the CF of the last Tx channel in the last sub block to the upper adjacent channel in asymmetrical configurations. To configure the spacing for the lower adjacent channel use the `[SENSe:]POWer:ACHannel:SPACing[:ACHannel]` command.

Parameters:
<Spacing> Range: 100 Hz to 2000 MHz
*RST: 14 kHz
Default unit: Hz

Example: `SENS:POW:ACH:SPAC:UACH 1000`

Manual operation: See "Adjacent channel Spacing" on page 1116

[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch> <Spacing>

Defines the distance from transmission channel to the upper alternate channels.

For MSR signals, this command defines the distance from the CF of the last Tx channel in the last sub block to the upper alternate channel in asymmetrical configurations. To configure the spacing for the lower alternate channel, use the `[SENSe:]POWer:ACHannel:SPACing:ALTernate<ch>` command.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<Spacing> Range: 100 Hz to 2000 MHz
*RST: 40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...
Default unit: Hz

Example: `SENS:POW:ACH:SPAC:UALT 1000`

Manual operation: See "Adjacent channel Spacing" on page 1116

[SENSe:]POWer:ACHannel:SSETup <State>

Defines whether adjacent channels are defined symmetrically or not.

For more information see "Multi-standard radio (MSR) signals" on page 1093.

Parameters:
<State> ON | OFF | 1 | 0

ON | 1
The upper and lower adjacent and alternate channels are defined symmetrically. This is the default behaviour and corresponds to the behavior in firmware versions before 2.10.

OFF | 0
The upper and lower channels can be configured differently.

*RST: 1

Example: `SENS:POW:ACH:SSET`

Manual operation: See "Symmetrical Adjacent Setup" on page 1111

[SENSe:]POWer:ACHannel:BWIDth:UACHannel <Bandwidth>
[SENSe:]POWer:ACHannel:BANDwidth:UACHannel <Bandwidth>

Defines the channel bandwidth of the upper adjacent channel in asymmetrical configurations.

The adjacent channel is the first pair of channels next to the transmission channels. To configure the bandwidth for the lower adjacent channel, use the `[SENSe:]POWer:ACHannel:BANDwidth:ALTernate<ch>` command.

Parameters:
<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz
Default unit: Hz

Example: `SENS:POW:ACH:BAND:UACH 100`

Manual operation: See "Adjacent channel Bandwidth" on page 1116

[SENSe:]POWer:ACHannel:BWIDth:UALTernate<ch> <Bandwidth>
[SENSe:]POWer:ACHannel:BANDwidth:UALTernate<ch> <Bandwidth>

Defines the channel bandwidth of the upper alternate channels in asymmetrical configurations. To configure the bandwidth for the lower alternate channel, use the `[SENSe:]POWer:ACHannel:BANDwidth:ALTernate<ch>` command.

Suffix:
<ch> Alternate channel number

Parameters:
<Bandwidth>
Range: 100 Hz to 1000 MHz
*RST: 14 kHz
Default unit: Hz

Example:
```
SENS:POW:ACH:BAND:UALT2 100
```

Manual operation: See "Adjacent channel Bandwidth" on page 1116

[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel <Alpha>

Defines the roll-off factor for the upper adjacent channel weighting filter for asymmetrical MSR signals. To configure the factor for the upper adjacent channel, use the `[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel` command.

Parameters:
<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Example:
```
SENS:POW:ACH:FILT:ALPH:UACH 0.35
```

Manual operation: See "Adjacent channel Weighting Filters" on page 1116

[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch> <Alpha>

Defines the roll-off factor for the upper alternate channels' weighting filter for asymmetrical MSR signals. To configure the factor for the upper alternate channels, use the `[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch>` command.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Example:
```
SENS:POW:ACH:FILT:ALPH:UALT2 0.35
```

Manual operation: See "Adjacent channel Weighting Filters" on page 1116

[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel <State>

Enables or disables the weighting filter for the upper adjacent channel for asymmetrical MSR signals. To configure the factor for the lower adjacent channel, use the `[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel` command.

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

Example: `SENS:POW:ACH:FILT:STAT:UACH ON`

Manual operation: See "Adjacent channel Weighting Filters" on page 1116

[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch> <State>

Enables or disables the weighting filter for the upper alternate channels for asymmetrical MSR signals. To configure the factor for the lower alternate channels, use the `[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTernate<ch>` on page 1244 command.

Suffix:

<ch> 1 to 11
Alternate channel number

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

Example: `SENS:POW:ACH:FILT:STAT:UALT2 ON`

Manual operation: See "Adjacent channel Weighting Filters" on page 1116

General gap channel setup

[SENSe:]POWer:ACHannel:AGCHannels 1266
[SENSe:]POWer:ACHannel:GAP<gap>:MODE 1267

[SENSe:]POWer:ACHannel:AGCHannels <State>

Activates or deactivates gap channels in an MSR signal.

For more information see "Multi-standard radio (MSR) signals" on page 1093.

Parameters:

<State> ON | OFF | 1 | 0

ON | 1
The gap channels are displayed and channel power results are calculated and displayed in the Result Summary.

OFF | 0
The gap channels are not displayed in the diagram and channel power results are not calculated nor displayed in the Result Summary.

*RST: 1

Example: `SENS:POW:ACH:AGCH OFF`

Manual operation: See "Activate Gaps" on page 1118

[SENSe:]POWer:ACHannel:GAP<gap>:MODE <Mode>

Defines how gap channels are configured.

Suffix:
<gap> Gap (CACLR) channel number 1 or 2

Parameters:
<Mode> AUTO | MANual

AUTO
In "Auto" mode, upper and lower gap channels are configured identically, so only two channels need to be configured (gap 1, gap 2). Gap channels are configured identically for all gaps, if more than two sub blocks are defined. Depending on the defined minimum gap size, the actual number of evaluated gap channels is determined automatically.
See also `[SENSe:]POWer:ACHannel:GAP<gap>[:AUTO]:MSIZe` on page 1272.

MANual
In "Manual" mode, up to four channels can be configured individually for each gap. Active gap channels are always evaluated, regardless of the gap size.
See also `[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:LOWer` on page 1285 and `[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:UPPer` on page 1286.

*RST: AUTO

Example: `SENS:POW:ACH:GAP:MODE MAN`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap Mode" on page 1118

Automatic (symmetrical) configuration

The following commands are only available for symmetrical (automatic) configuration of gap channels (see `[SENSe:]POWer:ACHannel:GAP<gap>:MODE` on page 1267).

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ABSolute 1268
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ABSolute:STATe 1268
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ACLR[:RELative] 1269
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ACLR[:RELative]:STATe 1269
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO][:CACLr][:RELative] 1270
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO][:CACLr][:RELative]:STATe 1270
[SENSe:]POWer:ACHannel:BWIDth:GAP<gap>[:AUTO] 1271
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>[:AUTO] 1271
[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>[:AUTO] 1271
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>[:AUTO] 1271
[SENSe:]POWer:ACHannel:GAP<gap>[:AUTO]:MSIZe 1272
[SENSe:]POWer:ACHannel:SPACing:GAP<gap>[:AUTO] 1272

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ABSolute <Limit>[, <Reserved>]

Defines the absolute limit of the specified gap (CACLR) channel.

If you define both an absolute limit and a relative limit, the FSWX uses the lower value for the limit check.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Limit> Defines the absolute limit of the specified gap channel.
Default unit: dBm

<Reserved> Ignored.

Example: `CALC:LIM:ACP:GAP2:ABS 44.2dBm`

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ABSolute:STATe <State>

Enables or disables the absolute limit check for the specified gap (CACLR) channel.

Prerequisite: Activate the general ACLR limit check using `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<State> ON | OFF | 1 | 0
*RST: 0

Example: CALC:LIM:ACP:GAP1:ABS:STAT ON

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ACLR[:RELative] <Limit>[, <UpperLimit>]

Defines the relative limit for the ACLR power in the specified gap channel. The reference value for the relative limit is the measured channel power.

If you define both an absolute limit and a relative limit, the FSWX uses the lower value for the limit check.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Limit> Defines the relative limit for the ACLR power in the specified gap channel in dB.
Default unit: dB

<UpperLimit> Ignored.
Default unit: dB

Example: CALC:LIM:ACP:GAP1:ACLR:REL 3dB

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ACLR[:RELative]:STATe <State>

Enables or disables the relative limit check for the specified gap (CACLR) channel.

Prerequisite: Activate the general ACLR limit check using CALCulate<n>:LIMit<li>:ACPower[:STATe].

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<State> ON | OFF | 1 | 0
*RST: 0

Example: CALC:LIM:ACP:GAP1:ACLR:REL:STAT ON

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO][:CACLr][:RELative]
<Limit>[, <UpperLimit>]

Defines the relative limit of the specified gap (CACLR) channel. The reference value for the relative limit is the measured channel power.

If you define both an absolute limit and a relative limit, the FSWX uses the lower value for the limit check.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:
<Limit> Defines the relative limit of the specified gap channel in dB.
Default unit: dB

<UpperLimit> Optional: Defines the relative upper limit of the specified gap channel.
Default unit: dB

Example: `CALC:LIM:ACP:GAP1:REL 3dB,0`

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO][:CACLr][:RELative]:STATe
<State>

Enables or disables the relative limit check for the specified gap (CACLR) channel.

Prerequisite: Activate the general ACLR limit check using `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example: `CALC:LIM:ACP:GAP1:REL:STAT ON`

[SENSe:]POWer:ACHannel:BWIDth:GAP<gap>[:AUTO] <Bandwidth>
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>[:AUTO] <Bandwidth>

Defines the bandwidth of the MSR gap (CACLR) channel in all sub block gaps.

This command is for MSR signals only (see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` on page 1236).

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:
<Bandwidth> numeric value in Hz
*RST: 3.84 MHz
Default unit: Hz

Example: `SENS:POW:ACH:BAND:GAP2 5MHZ`

[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>[:AUTO] <State>

Enables or disables the weighting filter for the specified gap (CACLR) channel in all sub block gaps.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `SENS:POW:ACH:FILT:GAP2 ON`

Manual operation: See "Gap channel Weighting Filters" on page 1121

[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>[:AUTO] <Alpha>

Defines the roll-off factor for the specified gap (CACLR) channel's weighting filter in all sub block gaps.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:
<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Example: `SENS:POW:ACH:FILT:ALPH:GAP2 0.2`

Manual operation: See "Gap channel Weighting Filters" on page 1121

[SENSe:]POWer:ACHannel:GAP<gap>[:AUTO]:MSIZe <Bandwidth>

Prerequisite: Symmetrical gap channels in "Auto" gap mode (see `[SENSe:]POWer:ACHannel:GAP<gap>:MODE` on page 1267)

If the gap between the sub blocks does not exceed the specified bandwidth, the gap channels are not displayed in the diagram, and the gap channel results are not calculated in the result summary.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:
<Bandwidth> numeric value in Hz

*RST: gap1: 5 MHz; gap2: 10 MHz
Default unit: Hz

Example: //Evaluate gap channel 2 only if the gap is wider than 5 MHz.
`POW:ACH:GAP2:MSIZ 5 MHz`

Manual operation: See "Minimum Gap Size to Show Gap" on page 1119

[SENSe:]POWer:ACHannel:SPACing:GAP<gap>[:AUTO] <Spacing>

Defines the distance from sub block to the specified gap channel.

In "Auto" gap mode, channels in the upper gap are identical to those in the lower gap. Thus, only 2 gap channels are configured.

The spacing for gap channels is defined in relation to the outer edges of the surrounding sub blocks, i.e.

Spacing = [CF of the gap channel] - [left sub block center] + ([RF bandwidth of left sub block] /2)

(See also Figure 5-36 and Figure 5-37.)

Suffix:
<gap> 1 | 2
Gap channel number

Parameters:
<Spacing> numeric value in Hz

*RST: 2.5 MHz
Default unit: Hz

Example: `SENS:POW:ACH:SPAC:GAP2 5MHZ`

Manual operation: See "Gap channel Spacing" on page 1120
See "Gap channel Bandwidth" on page 1120

Manual (asymmetrical) configuration

The following commands are only available for asymmetrical (manual) configuration of gap channels (see [SENSe:]POWer:ACHannel:GAP<gap>:MODE on page 1267).

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ABSolute 1273
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ABSolute:STATe 1274
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ACLR[:RELative] 1275
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ACLR[:RELative]:STATe 1275
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer[:CACLr][:RELative] 1276
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer[:CACLr][:RELative]:STATe .. 1277
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ABSolute 1277
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ABSolute:STATe 1278
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ACLR[:RELative] 1279
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ACLR[:RELative]:STATe 1279
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer[:CACLr][:RELative] 1280
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer[:CACLr][:RELative]:STATe ... 1281
[SENSe:]POWer:ACHannel:BWIDth:GAP<gap>:MANual:LOWer 1281
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>:MANual:LOWer 1281
[SENSe:]POWer:ACHannel:BWIDth:GAP<gap>:MANual:UPPer 1282
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>:MANual:UPPer 1282
[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>:MANual:LOWer 1283
[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>:MANual:UPPer 1283
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>:MANual:LOWer 1284
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>:MANual:UPPer 1284
[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:LOWer 1285
[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:UPPer 1286
[SENSe:]POWer:ACHannel:SPACing:GAP<gap>:MANual:LOWer 1286
[SENSe:]POWer:ACHannel:SPACing:GAP<gap>:MANual:UPPer 1287

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ABSolute
<SBGaps>, <Limit>
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ABSolute?
<SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the absolute limit of the specified lower gap (CACLR) channel.

If you define both an absolute limit and a relative limit, the FSWX uses the lower value for the limit check.

Suffix:

<n>	Window 1 to 16
	Limit line 1 to 8
<gap>	1 | 2 Gap (CACLR) channel number

Parameters:

<Limit>	Defines the absolute limit of the specified gap channel. Default unit: dBm

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACP:GAP2:MAN:LOW:ABS AB,44.2dBm`

Example: `CALC:LIM:ACP:GAP:MAN:LOW:ABS? BC,DEF`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ABSolute:STATe <SBGaps>, <State>

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ABSolute:STATe? <SBGaps>

Prerequisites:

- Activate the general ACLR limit check using `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.
- Configure the gap channels asymmetrically (manually).

Enables or disables the absolute limit check for the specified lower gap (CACLR) channel.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACP:GAP2:MAN:LOW:ABS:STAT BC,ON`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ACLR[:RELative] <SBGaps>, <Limit>
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ACLR[:RELative]? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the relative limit for the ACLR power in the specified lower gap channel. The reference value for the relative limit is the measured channel power.

If you define both an absolute limit and a relative limit, the FSWX uses the lower value for the limit check.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap channel number

Parameters:
<Limit> Defines the relative limit for the ACLR power in the specified gap channel.
Default unit: dB

Parameters for setting and query:
<SBGaps> AB | BC | CD | DE | EF | FG | GH
Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACP:GAP1:MAN:LOW:ACLR:REL AB,3dB`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ACLR[:RELative]:STATe <SBGaps>, <State>
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer:ACLR[:RELative]:STATe? <SBGaps>

Prerequisites:

- Activate the general ACLR limit check using `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.
- Configure the gap channels asymmetrically (manually).

Enables or disables the relative limit check for the specified lower gap (CACLR) channel.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:
<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACP:GAP2:MAN:LOW:ACLR:STAT BC,ON`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer[:CACLr][:RELative] <SBGaps>, <Limit>
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer[:CACLr][:RELative]? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the relative limit of the specified lower gap (CACLR) channel. The reference value for the relative limit is the measured channel power.

If you define both an absolute limit and a relative limit, the FSWX uses the lower value for the limit check.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:
<Limit> Defines the relative limit of the specified gap channel in dB.

Default unit: dB

Parameters for setting and query:
<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACPower:GAP2:MANual:LOWer BC, 5`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer[:CACLr][:RELative]:STATe <SBGaps>, <State>
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:LOWer[:CACLr][:RELative]:STATe? <SBGaps>

Prerequisites:

- Activate the general ACLR limit check using `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.
- Configure the gap channels asymmetrically (manually).

Enables or disables the relative limit check for the specified lower gap (CACLR) channel.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example:
```
CAL:LIMit:ACPower:GAP2:MAN:LOW:STAT BC,ON
```

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ABSolute <SBGaps>, <Limit>
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ABSolute? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the absolute limit of the specified upper gap (CACLR) channel.

If you define both an absolute limit and a relative limit, the FSWX uses the lower value for the limit check.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:
<Limit> Defines the absolute limit of the specified gap channel.
Default unit: dBm

Parameters for setting and query:
<SBGaps> AB | BC | CD | DE | EF | FG | GH
Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACP:GAP2:MAN:UPP:ABS AB,44.2dBm`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ABSolute:STATe <SBGaps>, <State>
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ABSolute:STATe? <SBGaps>

Prerequisites:

- Activate the general ACLR limit check using `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.
- Configure the gap channels asymmetrically (manually).

Enables or disables the absolute limit check for the specified upper gap (CACLR) channel.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACP:GAP2:MAN:UPP:ABS:STAT BC,ON`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ACLR[:RELative] <SBGaps>, <Limit>

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ACLR[:RELative]? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the relative limit for the ACLR power in the specified upper gap channel. The reference value for the relative limit is the measured channel power.

If you define both an absolute limit and a relative limit, the FSWX uses the lower value for the limit check.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap channel number

Parameters:

<Limit> Defines the relative limit for the ACLR power in the specified gap channel in dB.

Default unit: dB

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACP:GAP1:MAN:UPP:ACLR:REL AB,3dB`

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ACLR[:RELative]:STATe <SBGaps>, <State>

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer:ACLR[:RELative]:STATe? <SBGaps>

Prerequisites:

- Activate the general ACLR limit check using `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.
- Configure the gap channels asymmetrically (manually).

Enables or disables the relative limit check for the specified upper gap (CACLR) channel.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACP:GAP2:MAN:UPP:ACLR:STAT BC,ON`

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer[:CACLr][:RELative] <SBGaps>, <Limit>
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer[:CACLr][:RELative]? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the relative limit of the specified upper gap (CACLR) channel. The reference value for the relative limit is the measured channel power.

If you define both an absolute limit and a relative limit, the FSWX uses the lower value for the limit check.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Limit> Defines the relative limit of the specified gap channel in dB.

Default unit: dB

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CALC:LIM:ACPower:GAP2:MANual:UPPer BC, 5`

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer[:CACLr][:RELative]:STATe <SBGaps>, <State>
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:MANual:UPPer[:CACLr][:RELative]:STATe? <SBGaps>

Prerequisites:

- Activate the general ACLR limit check using `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.
- Configure the gap channels asymmetrically (manually).

Enables or disables the relative limit check for the specified upper gap (CACLR) channel.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `CAL:LIMit:ACPower:GAP2:MAN:UPP:STATe BC,ON`

[SENSe:]POWer:ACHannel:BWIDth:GAP<gap>:MANual:LOWer <SBGaps>, <Bandwidth>
[SENSe:]POWer:ACHannel:BWIDth:GAP<gap>:MANual:LOWer? <SBGaps>
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>:MANual:LOWer <SBGaps>, <Bandwidth>
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>:MANual:LOWer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the bandwidth of the lower gap channel in the specified gap.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:
<Bandwidth> *RST: 3.84 MHz
Default unit: Hz

Parameters for setting and query:
<SBGaps> AB | BC | CD | DE | EF | FG | GH
Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `POW:ACH:BAND:GAP:MAN:LOW BC,5MHz`

Example: `POW:ACH:BWIDth:GAP:MAN:LOW? AB,MIN`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap channel Bandwidth" on page 1120

[SENSe:]POWer:ACHannel:BWIDth:GAP<gap>:MANual:UPPer <SBGaps>, <Bandwidth>
[SENSe:]POWer:ACHannel:BWIDth:GAP<gap>:MANual:UPPer? <SBGaps>
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>:MANual:UPPer <SBGaps>, <Bandwidth>
[SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>:MANual:UPPer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the bandwidth of the upper gap channel in the specified gap.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:
<Bandwidth> *RST: 3.84 MHz
Default unit: Hz

Parameters for setting and query:
<SBGaps> AB | BC | CD | DE | EF | FG | GH
Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `POW:ACH:BAND:GAP:MAN:UPP BC,5MHz`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap channel Bandwidth" on page 1120

[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>:MANual:LOWer <SBGaps>, <State>
[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>:MANual:LOWer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Enables or disables the weighting filter for the specified lower gap channel.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:
<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `SENS:POW:ACH:FILT:GAB:MAN:LOW BC,ON`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap channel Weighting Filters" on page 1121

[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>:MANual:UPPer <SBGaps>, <State>
[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>:MANual:UPPer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Enables or disables the weighting filter for the specified upper gap channel.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `SENS:POW:ACH:FILT:GAP:MAN:UPP BC,ON`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap channel Weighting Filters" on page 1121

[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>:MANual:LOWer <SBGaps>, <Alpha>
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>:MANual:LOWer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the roll-off factor for the specified lower gap channel's weighting filter.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `SENS:POW:ACH:FILT-ALPH:GAP:MAN:LOW BC,0.25`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap channel Weighting Filters" on page 1121

[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>:MANual:UPPer <SBGaps>, <Alpha>
[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>:MANual:UPPer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the roll-off factor for the specified upper gap channel's weighting filter.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:

<Alpha> Roll-off factor

Range: 0 to 1
*RST: 0.22

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `SENS:POW:ACH:FILT:ALPH:GAP2:MAN:UPP BC,0.25`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap channel Weighting Filters" on page 1121

[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:LOWer <SBGaps>, <State>
[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:LOWer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines which lower gap channels are active in the specified gap.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: //Enable the second lower gap channel in the gap between sub blocks B and C.
`SENS:POW:ACH:GCH:GAP2:MAN:LOW BC, ON`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap Channel Active" on page 1119

[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:UPPer <SBGaps>, <State>
[SENSe:]POWer:ACHannel:GCHannel[:STATe]:GAP<gap>:MANual:UPPer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines which upper gap channels are active in the specified gap.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number 1 or 2

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Parameters for setting and query:
<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: //Enable the second upper gap channel in the gap between sub blocks B and C.
```
SENS:POW:ACH:GCH:GAP2:MAN:UPP BC, ON
```

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap Channel Active" on page 1119

[SENSe:]POWer:ACHannel:SPACing:GAP<gap>:MANual:LOWer <SBGaps>, <Spacing>
[SENSe:]POWer:ACHannel:SPACing:GAP<gap>:MANual:LOWer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the distance from sub block to the specified lower gap channel.

The required spacing can be determined according to the following formula:

Spacing = [CF of the gap channel] - [left sub block center] + ([RF bandwidth of left sub block] /2)

Suffix:
<gap> 1 | 2
Gap channel number

Parameters:
<Spacing> Default unit: Hz

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `POW:ACH:SPAC:GAP:MAN:LOW AB, 5MHz`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap channel Spacing" on page 1120

[SENSe:]POWer:ACHannel:SPACing:GAP<gap>:MANual:UPPer <SBGaps>, <Spacing>
[SENSe:]POWer:ACHannel:SPACing:GAP<gap>:MANual:UPPer? <SBGaps>

Prerequisite: asymmetrical (manual) configuration of gap channels

Defines the distance from the sub block to the specified upper gap channel.

The required spacing can be determined according to the following formula:

Spacing = [right sub block CF] - [CF of gap channel] - ([RF bandwidth of right sub block] /2)

Suffix:

<gap> 1 | 2
irrelevant

Parameters:

<Spacing> Default unit: Hz

Parameters for setting and query:

<SBGaps> AB | BC | CD | DE | EF | FG | GH

Name of the gap, defined by the letters of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B).

Example: `POW:ACH:SPAC:GAP:MAN:UPP AB,5MHz`

Example: See "Example: configuring and performing an asymmetrical MSR ACLR measurement" on page 1297

Manual operation: See "Gap channel Spacing" on page 1120

MSR channel names

The functions for manual operation are described in "Name" on page 1117.

[SENSe:]POWer:ACHannel:NAME:GAP<gap>....1288
[SENSe:]POWer:ACHannel:NAME:UACHannel....1288
[SENSe:]POWer:ACHannel:NAME:UALTernate<ch>....1288
[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>]....1288

[SENSe:]POWer:ACHannel:NAME:GAP<gap> <Name>

Queries the name of the GAP channel.

Suffix:
<gap> 1 | 2
Gap (CACLR) channel number

Parameters:
<Name> String containing the name of the channel
*RST: 'Gap1', 'Gap2'

Example: `SENS:POW:ACH:NAME:GAP1 'FirstGap'`

[SENSe:]POWer:ACHannel:NAME:UACHannel <Name>

Defines the name for the upper adjacent channel in asymmetrical MSR channel definitions. To define the name for the lower adjacent channel use the `[SENSe:]POWer:ACHannel:NAME:ACHannel` command.

Parameters:
<Name> String containing the name of the channel
*RST: ADJ

Example: `SENS:POW:ACH:NAME:UACH 'UpAdj'`

Manual operation: See "Name" on page 1117

[SENSe:]POWer:ACHannel:NAME:UALTernate<ch> <Name>

Defines the name for the specified upper alternate channel in asymmetrical MSR channel definitions. To define the name for the lower adjacent channels use the `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet` command.

Suffix:
<ch> 1 to 11
Alternate channel number

Parameters:
<Name> String containing the name of the channel
*RST: ALT<1...11>

Example: `SENS:POW:ACH:NAME:UALT2 'alt2'`

Manual operation: See "Name" on page 1117

[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>] <Name>

Queries the name of the specified MSR Tx channel.

In MSR ACLR measurements, TX channel names correspond to the specified technology, followed by a consecutive number. The assigned sub block (A,B,C,D,E) is indicated as a prefix (e.g. A: WCDMA1). Channel names cannot be defined manually.

Is for MSR signals only (see CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:PRESet on page 1236).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<Name> String containing the name of the channel

Example: //Query the name of the MSR Tx channel 2.
POW:ACH:SBL2:NAME:CHAN2?

Manual operation: See "Name" on page 1115
See "Name" on page 1117

Performing an ACLR measurement

The following commands are required to perform an ACLR measurement:

- CALC:MARK:FUNC:POW:SEL ACP, seeCALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SELect on page 1233
- CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>[:STATe] on page 1234
- INITiate<n>[:IMMediate] on page 647

Retrieving and analyzing measurement results

The following commands retrieve and analyze measurement results for ACLR measurements.

Useful commands for channel power measurements described elsewhere

- CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult on page 1231
- TRACe<n>[:DATA] on page 688
- CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult? on page 1248
- CALCulate<n>:LIMit<li>:ACPower:ALTernate<ch>:RESult? on page 1251

Remote commands exclusive to channel power measurements

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult? 1290
CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLr]:RESult? 1290
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult:PHZ 1291
CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult:UNIT 1292
[SENSe:]POWer:ACHannel:MODE 1293

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult?

The command returns the ACLR power limit check results for the selected gap channel in an MSR ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

The results of the power limit checks are also indicated in the `STAT:QUES:ACPL` status registry (see "STATus:QUEStionable:ACPLimit register" on page 497).

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 | 2
Gap (CACLR) channel number

Return values:

<LowerGap_AB>

<UpperGap_AB>

<LowerGap_BC>

<UpperGap_BC>

<LowerGap_CD>

<UpperGap_CD>

<LowerGap_DE>

<UpperGap_DE>

Example:

```
INIT:IMM;*WAI;
CALC:LIM:ACP:GAP2:ACLR:RES?
PASSED,PASSED
```

Usage: Query only

CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLr]:RESult?

The command returns the limit check results for the upper and lower gap (CACLR) channels for the selected gap in an MSR ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

For details on MSR signals see "Multi-standard radio (MSR) signals" on page 1093.

The results of the power limit checks are also indicated in the STAT:QUES:ACPL status registry (see "STATus:QUEStionable:ACPLimit register" on page 497).

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<gap> 1 to 6
Gap (CACLR) channel number

Return values:

<LowerGap_AB>, <UpperGap_AB> [,<LowerGap_BC>, <UpperGap_BC>, <LowerGap_CD>, <UpperGap_CD>, <LowerGap_DE>, <UpperGap_DE>, <LowerGap_EF>, <UpperGap_EF>, <LowerGap_FG>, <UpperGap_FG>, <LowerGap_GH>, <UpperGap_GH>]

Limit check results for the CACLR power in the upper and lower gap channels for the selected gap. Results are only returned for the available sub blocks.

PASSED
Limit check has passed.

FAIL
Limit check has failed.

NONE
No results available, e.g. because limit checking was deactivated

<UpperGap_AB>

<LowerGap_BC>

<UpperGap_BC>

<LowerGap_CD>

<UpperGap_CD>

<LowerGap_DE>

<UpperGap_DE>

Example:

```
INIT:IMM;*WAI;
CALC:LIM:ACP:GAP2:RES?
PASSED,PASSED
```

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult:PHZ <State>

Selects the unit the FSWX returns results for power measurements.

You can query results with CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult.

For LTE and 5G applications, use the command CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult:UNIT.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

<sb> irrelevant

Parameters:
<State> ON | OFF | 1 | 0

ON | 1
Channel power density in dBm/Hz

OFF | 0
Channel power in dBm

*RST: 0

Example: //Query the output of results referred to the channel bandwidth.
`CALC:MARK:FUNC:POW:RES:PHZ ON`

Manual operation: See "Channel power level and density (Power Unit)" on page 1103

CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult:UNIT <Measurement>

LTE and 5G applications only.

Selects the unit the FSWX returns results for power measurements.

You can query results with `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult`.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

<sb> irrelevant

Parameters:
<Measurement>

ABS
Channel power in dBm

PHZ
Channel power density in dBm/Hz

MPHZ
Channel power density in dBm/MHz

*RST: ABS

Example: //Select unit for power measurements
`CALC:MARK:FUNC:POW:RES:UNIT PHZ`

Manual operation: See "Channel power level and density (Power Unit)" on page 1103

[SENSe:]POWer:ACHannel:MODE <Mode>

Selects the way the FSWX displays the power of adjacent channels.

You need at least one adjacent channel for the command to work.

Parameters:

<Mode> ABSolute | RELative

ABSolute
Shows the absolute power of all channels

RELative
Shows the power of adjacent and alternate channels in relation to the transmission channel

*RST: RELative

Manual operation: See "Absolute and relative values (ACLR Mode)" on page 1103

Programming examples for channel power measurements

The following programming examples are meant to demonstrate the most important commands to perform channel power measurements in a remote environment.

- Example: configuring and performing an ACLR measurement.....1293
- Example: configuring and performing an MSR ACLR measurement.....1295
- Example: configuring and performing an asymmetrical MSR ACLR measurement 1297

Example: configuring and performing an ACLR measurement

In this example we will configure and perform an adjacent-channel power measurement. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task. For most common measurement standards, the FSWX performs the measurement optimally with the predefined settings, without further configuration.

```
//-----------Preparing the measurement ------------
//Reset the instrument
*RST

//-------------Preparing the measurement---------------------

//Activate adjacent-channel power measurement.
CALC:MARK:FUNC:POW:SEL ACP
//Select the user standard "GSM"
CALC:MARK:FUNC:POW:PRES GSM

//---------------Setting Up Channels------------
//Create one transmission channel.
POW:ACH:TXCH:COUN 1
//Name the first transmission channel 'TX Channel'.
POW:ACH:NAME:CHAN1 'TX Channel'
//Create two adjacent channels - one adjacent channel and one alternate channel.
POW:ACH:ACP 2
```

```
//Name the adjacent channel 'ABC'
POW:ACH:NAME:ACH 'ABC'
//Name the first alternate channel 'XYZ'.
POW:ACH:NAME:ALT1 'XYZ'
//Define a bandwidth of 30 kHz for the transmission channel.
POW:ACH:BWID:CHAN1 30kHz
//Define a bandwidth of 30 kHz for the adjacent channel.
POW:ACH:BWID:ACH 30kHz
//Define a bandwidth of 30 kHz for the first alternate channel.
POW:ACH:BWID:ALT1 30kHz
//Define a distance of 33 kHz from the center of the transmission channel to the
//center of the adjacent channel.
//Also adjust the distance to the alternate channels (66 kHz).
POW:ACH:SPAC 33kHz
//Define a distance of 100 kHz from the center of the transmission channel to the
//center of the first alternate channel.
POW:ACH:SPAC:ALT1 100kHz

//---------------Selecting a Reference Channel--
//Select relative display of the channel power.
POW:ACH:MODE REL
//Define transmission channel 1 as the reference channel.
POW:ACH:REF:TXCH:MAN 1

//-----------Saving the settings as a user standard--------------
//Save the user standard with the name "my_aclr_standard".
//Weighting filters can only be defined for user-defined standards.
CALC:MARK:FUNC:POW:STAN:SAVE 'my_aclr_standard'

//---------------Defining Weighting Filters-----
//Define a roll-off factor of 0.35 for the weighting filter of the first
//transmission channel.
POW:ACH:FILT:ALPH:CHAN1 0.35
//Turn the weighting filter for the first transmission channel on.
POW:ACH:FILT:CHAN1 ON
//Define a roll-off factor of 0.35 for the weighting filter of the adjacent
//channel.
POW:ACH:FILT:ALPH:ACH 0.35
//Turn the weighting filter for the adjacent channel on.
POW:ACH:FILT:ACH ON
//Define a roll-off factor of 0.35 for the weighting filter of the first
//alternate channel.
POW:ACH:FILT:ALPH:ALT1 0.35
//Turn the weighting filter for the first alternate channel on.
POW:ACH:FILT:ALT1 ON

//---------------Working with Limits------------
//Define a relative limit of 30 dB below the power of the reference channel
//for both adjacent channels.
CALC:LIM:ACP:ACH 30DB,30DB
```

```
//Define a relative limit of 25 dB below the power of the reference channel
//for the first alternate channels.
CALC:LIM:ACP:ALT1 25DB,25DB
//Define an absolute limit of -35 dBm for both adjacent channels.
CALC:LIM:ACP:ACH:ABS -35DBM,-35DBM
//Turn the ACLR limit check on.
CALC:LIM:ACP ON
//Turn the relative limit check for adjacent channels on.
CALC:LIM:ACP:ACH:STAT ON
//Turn the absolute limit check for adjacent channels on.
CALC:LIM:ACP:ACH:ABS:STAT ON
//Turn the absolute limit check for the first alternate channel on.
CALC:LIM:ACP:ALT1:ABS:STAT ON

//--------------Performing the Measurement-----
//Determine the ideal ACLR measurement configuration.
POW:ACH:PRES ACP;*WAI
//Determine the ideal reference level for the measurement.
POW:ACH:PRES:RLEV;*WAI
//Initiate a new measurement and waits until the sweep has finished.
INIT;*WAI

//---------------Limit Check--------------------
//Query the results of the limit check for the adjacent channels.
CALC:LIM:ACP:ACH:RES?
//Query the results of the limit check for the first alternate channels.
CALC:LIM:ACP:ALT1:RES?

//---------------Retrieving Results-------------
//Query the results for the ACLR measurement.
CALC:MARK:FUNC:POW:RES? ACP
```

Example: configuring and performing an MSR ACLR measurement

This example demonstrates how to configure and perform an ACLR measurement on a multi-standard radio signal in a remote environment.

```
//-----------Preparing the measurement ------------
//Reset the instrument
*RST


// Select ACLR measurement
:CALCulate:MARKer:FUNCtion:POWer:SELect ACPower

// Select MSR Standard :CALCulate:MARKer:FUNCtion:POWer:PRESet MSR

//Configure general measurement settings
:SENSe:FREQuency:CENTer 1.25GHz
:SENSe:FREQuency:SPAN 62.0MHz
:SENSe:POWer:ACHannel:SBCount 3
```

```
//----------------- Configuring Sub block A

:SENSe:POWer:ACHannel:SBLock1:TXCHannel:COUNt 3
:SENSe:POWer:ACHannel:SBLock1:FREQuency:CENTer 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:RFBWidth 12MHZ

:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel1 1.226GHZ
:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel2 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel3 1.234GHZ

:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel1 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel2 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel3 GSM


:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel1 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel2 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel3 2.5MHZ

//----------------- Configuring Sub block B

:SENSe:POWer:ACHannel:SBLock2:TXCHannel:COUNt 1
:SENSe:POWer:ACHannel:SBLock2:FREQuency:CENTer 1.255GHZ
:SENSe:POWer:ACHannel:SBLock2:RFBWidth 4MHZ

:SENSe:POWer:ACHannel:SBLock2:CENTer:CHANnel1 1.255GHZ

:SENSe:POWer:ACHannel:SBLock2:TECHnology:CHANnel1 LTE_1_40

:SENSe:POWer:ACHannel:SBLock2:BANDwidth:CHANnel1 3.25MHZ

//----------------- Configuring Sub block C

:SENSe:POWer:ACHannel:SBLock3:TXCHannel:COUNt 2
:SENSe:POWer:ACHannel:SBLock3:FREQuency:CENTer 1.268GHZ
:SENSe:POWer:ACHannel:SBLock3:RFBWidth 8MHZ

:SENSe:POWer:ACHannel:SBLock3:CENTer:CHANnel1 1.266GHZ
:SENSe:POWer:ACHannel:SBLock3:CENTer:CHANnel2 1.270GHZ


:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel1 2.75MHZ
:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel2 2.75MHZ

//----------------- Configuring ADJ channels

:SENSe:POWer:ACHannel:BANDwidth:ACHannel 1.60MHZ
:SENSe:POWer:ACHannel:BANDwidth:ALTernate1 1.60MHZ
```

```
:SENSe:POWer:ACHannel:SPACing:ACHannel 3MHZ
:SENSe:POWer:ACHannel:SPACing:ALTernate1 5MHZ

//----------------- Configuring gap (CACLR) channels

:SENSe:POWer:ACHannel:SPACing:GAP1 2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP2 5.0MHZ

:SENSe:POWer:ACHannel:BANDwidth:GAP1 2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP2 2.0MHZ

//--------------Performing the Measurement-----

//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//---------------Retrieving Results-------------

//Return the results for the ACLR measurement.
CALC:MARK:FUNC:POW:RES? MCAC
//Results:
//Transmission channels in sub block A
//-13.2346727385,-13.2346723793,-13.2390131759,
//Transmission channels in sub block B
//-17.0863336597,
//Transmission channels in sub block C
//-13.2390127767,-13.2390134744,
//Totals for each sub block
//-8.4649064021,-17.0863336597,-10.2287131689,
//Adjacent channels
//-67.9740721019,-67.9740728014,-0.00434041734,-0.00434041734,
//CACLR channels
//-0.52933512766,-64.9990115835,-64.5012521492,-0.33507330922,
//-64.4924159646,-0.52932552499,-0.52932552495,-64.4934163414
```

Example: configuring and performing an asymmetrical MSR ACLR measurement

This example demonstrates how to configure and perform an ACLR measurement on an asymmetrical multi-standard radio signal in a remote environment.

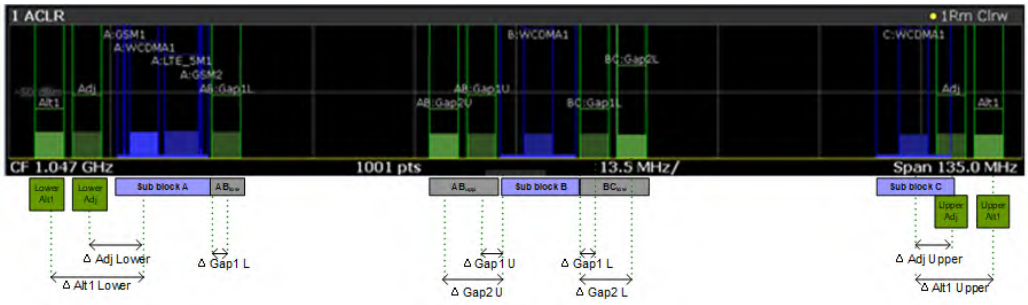


Figure 5-59: Asymmetrical MSR signal structure

```
//-----------Preparing the measurement ------------
//Reset the instrument
*RST


// Select ACLR measurement
:CALCulate:MARKer:FUNCtion:POWer:SELect ACPower

// Select MSR Standard
:CALCulate:MARKer:FUNCtion:POWer:PRESet MSR

//Configure general measurement settings
:SENSe:FREQuency:CENTer 1.25GHz
:SENSe:FREQuency:SPAN 62.0MHz
:SENSe:POWer:ACHannel:SBCount 3

//----------------- Configuring Sub block A

:SENSe:POWer:ACHannel:SBLock1:TXCHannel:COUNt 3
:SENSe:POWer:ACHannel:SBLock1:FREQuency:CENTer 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:RFBWidth 12MHZ

:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel1 1.226GHZ
:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel2 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:CENTer:CHANnel3 1.234GHZ

:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel1 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel2 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel3 GSM


:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel1 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel2 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel3 2.5MHZ

//----------------- Configuring Sub block B

:SENSe:POWer:ACHannel:SBLock2:TXCHannel:COUNt 1
:SENSe:POWer:ACHannel:SBLock2:FREQuency:CENTer 1.255GHZ
```

```
:SENSe:POWer:ACHannel:SBLock2:RFBWidth 4MHZ

:SENSe:POWer:ACHannel:SBLock2:CENTer:CHANnel1 1.255GHZ

:SENSe:POWer:ACHannel:SBLock2:TECHnology:CHANnel1 LTE_1_40

:SENSe:POWer:ACHannel:SBLock2:BANDwidth:CHANnel1 3.25MHZ

//----------------- Configuring Sub block C

:SENSe:POWer:ACHannel:SBLock3:TXCHannel:COUNt 2
:SENSe:POWer:ACHannel:SBLock3:FREQuency:CENTer 1.268GHZ
:SENSe:POWer:ACHannel:SBLock3:RFBWidth 8MHZ

:SENSe:POWer:ACHannel:SBLock3:CENTer:CHANnel1 1.266GHZ
:SENSe:POWer:ACHannel:SBLock3:CENTer:CHANnel2 1.270GHZ


:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel1 2.75MHZ
:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel2 2.75MHZ

//----------------- Configuring ADJ channels

:SENSe:POWer:ACHannel:BANDwidth:ACHannel 1.60MHZ
:SENSe:POWer:ACHannel:BANDwidth:ALTernate1 1.60MHZ

:SENSe:POWer:ACHannel:SPACing:ACHannel 3MHZ
:SENSe:POWer:ACHannel:SPACing:ALTernate1 5MHZ

//----------------- Configuring gap channels manually
:SENSe:POWer:ACHannel:AGCHannels ON
:SENSe:POWer:ACHannel:GAP:MODE MAN

//----------------- Configuring AB gap channels
// 1 lower, 2 upper

:SENSe:POWer:ACHannel:GCH:GAP1:MAN:LOW AB, ON
:SENSe:POWer:ACHannel:GCH:GAP1:MAN:UPP AB, ON
:SENSe:POWer:ACHannel:GCH:GAP2:MAN:UPP AB, ON

:SENSe:POWer:ACHannel:SPACing:GAP1:MAN:LOW AB,2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP1:MAN:UPP AB,2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP2:MAN:UPP AB,4.2MHZ

:SENSe:POWer:ACHannel:BANDwidth:GAP1:MAN:LOW AB,2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP1:MAN:UPP AB,2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP2:MAN:UPP AB,2.0MHZ

:SENSe:POWer:ACHannel:FILTer:STATe:GAP1:MAN:LOW AB,ON
:SENSe:POWer:ACHannel:FILTer:STATe:GAP1:MAN:UPP AB,ON
```

```
:SENSe:POWer:ACHannel:FILTer:STATe:GAP2:MAN:UPP AB,ON

:SENSe:POWer:ACHannel:FILTer:ALPHa:GAP1:MAN:LOW AB,0.25
:SENSe:POWer:ACHannel:FILTer:ALPHa:GAP1:MAN:UPP AB,0.25
:SENSe:POWer:ACHannel:FILTer:ALPHa:GAP2:MAN:UPP AB,0.25

//Limit check
:CALC:LIM:ACP ON
:CALC:LIM:ACP:GAP1:MAN:UPP:ABS:STAT AB,ON
:CALC:LIM:ACP:GAP1:MAN:UPP:ABS AB,3DBM
:CALC:LIM:ACP:GAP2:MAN:UPP:ABS:STAT AB,ON
:CALC:LIM:ACP:GAP2:MAN:UPP:ABS AB,3DBM

//----------------- Configuring BC gap channels
// 2 lower, 0 upper

:SENSe:POWer:ACHannel:GCH:GAP1:MAN:LOW AB, ON
:SENSe:POWer:ACHannel:GCH:GAP2:MAN:LOW AB, ON

:SENSe:POWer:ACHannel:SPACing:GAP1:MAN:LOW BC,2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP2:MAN:LOW BC,4.2MHZ

:SENSe:POWer:ACHannel:BANDwidth:GAP1:MAN:LOW BC,2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP2:MAN:LOW BC,2.0MHZ

//Limit check
:CALC:LIM:ACP ON
:CALC:LIM:ACP:GAP1:MAN:LOW:ABS:STAT BC,ON
:CALC:LIM:ACP:GAP1:MAN:LOW:ABS BC,3DBM
:CALC:LIM:ACP:GAP1:MAN:LOW:CACL:REL:STAT BC,ON
:CALC:LIM:ACP:GAP1:MAN:LOW:CACL:REL BC,-3DB

:CALC:LIM:ACP:GAP2:MAN:LOW:ACLR:REL:STAT BC,ON
:CALC:LIM:ACP:GAP2:MAN:LOW:ACLR:REL BC,-3DB

//--------------Performing the Measurement-----

//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//---------------Retrieving Results-------------

//Return the results for the ACLR measurement.
CALC:MARK:FUNC:POW:RES? MCAC
//Results:
//Transmission channels in sub block A
//-13.2346727385,-13.2346723793,-13.2390131759,
//Transmission channels in sub block B
```

```
//-17.0863336597,
//Transmission channels in sub block C
//-13.2390127767,-13.2390134744,
//Totals for each sub block
//-8.4649064021,-17.0863336597,-10.2287131689,
//Adjacent channels
//-67.9740721019,-67.9740728014,-0.00434041734,-0.00434041734,
//CACLR channels (AB2L, BC1U, BC2U invalid)
//-0.52933512766,-64.9990115835 9.91e37,-0.33507330922,
//-64.4924159646, 9.91e37,-0.52932552495, 9.91e37

//Limit check
CALC:LIM:ACP:GAP1:ACLR:RES?
//Result for gap 1 channels: ABGap1L,ABGap1U,BCGap1L, ( BCGap1U invalid )
//PASSED,PASSED,PASSED,NONE
CALC:LIM:ACP:GAP2:ACLR:RES?
//Result for gap 2 channels: (ABGap2L invalid ),ABGap2U,BCGap2L, ( BCGap2U invalid )
//NONE,PASSED,PASSED,NONE
```

5.5.1.4 Measuring the carrier-to-noise ratio

The following commands are necessary to perform carrier-to-noise measurements.

- `CALC:MARK:FUNC:POW:SEL CN | CN0`, see `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SELect`
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>[:STATe]`
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult`
- `[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>]`
- `[SENSe:]POWer:ACHannel:PRESet`

Programming example: Measuring the carrier-to-noise ratio

This programming example demonstrates how to perform a Carrier-to-noise measurement in a remote environment.

```
//----------Preparing the measurement------------
*RST
//Reset the instrument
FREQ:CENT 800MHz
//Sets the center frequency to the carrier frequency of 800 MHz.
CALC:MARK:FUNC:POW:SEL CN
//Activates carrier-to-noise ratio measurement.
POW:ACH:PRES CN
//Optimizes the instrument settings according to the channel bandwidth.
POW:ACH:PRES:RLEV
//Determines the ideal reference level for the measurement.

//--------------Performing the Measurement-----
INIT:CONT OFF
```

```
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

// Now turn off the carrier signal and repeat the measurement:
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:POW:RES? CN
//Returns the carrier-to-noise ratio.
```

5.5.1.5 Measuring the occupied bandwidth

All remote control commands specific to occupied bandwidth measurements are described here.

- Configuring the measurement....1302
- Programming example: OBW measurement....1303

Configuring the measurement

The following commands configure measurements of the occupied bandwidth.

Useful commands for occupied bandwidth measurements described elsewhere

Configuring the channel:

- `[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>]`
- `[SENSe:]POWer:ACHannel:PRESet`
- `[SENSe:]POWer:ACHannel:PRESet:RLEVel`

Defining search limits:

- `CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 707
- `CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 708
- `CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt` on page 708

Performing the measurement:

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SELect` on page 1233
- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>[:STATe]` on page 1234

Retrieving results:

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult` on page 1231

Remote commands exclusive to occupied bandwidth measurements:

[SENSe:]POWer:BWIDth....1303
[SENSe:]POWer:BANDwidth....1303

[SENSe:]POWer:BWIDth <Percentage>
[SENSe:]POWer:BANDwidth <Percentage>

Selects the percentage of the total power that defines the occupied bandwidth.

Parameters:

<Percentage>
Range: 10 PCT to 99.9 PCT
*RST: 99 PCT
Default unit: percent

Example: `POW:BAND 95PCT`

Manual operation: See "% Power Bandwidth" on page 1138

Programming example: OBW measurement

This programming example demonstrates the measurement example described in Section 5.3.7.5, "Measurement example", on page 1140 in a remote environment.

```
//-----------Preparing the measurement ------------
//Reset the instrument
*RST

//-------------Configuring the Measurement----------------------
//Set the center frequency to 800 MHz.
FREQ:CENT 800MHz
//Set the reference level to -10 dBm.
DISP:TRAC:Y:RLEV -10dBm
//Activate occupied bandwidth measurement.
CALC:MARK:FUNC:POW:SEL OBW
//Set the percentage of power to 99%.
POW:BWID 99PCT
//Set the channel bandwidth to 21 kHz.
POW:ACH:BAND 21kHz
//Optimize the instrument settings according to the channel bandwidth.
POW:ACH:PRES OBW
//Determine the ideal reference level for the measurement.
POW:ACH:PRES:RLEV
//Set the trace detector to positive peak.
DET APE

//--------------Performing the Measurement-----
//Select single sweep mode.INIT:CONT OFF

//Initiate a new measurement and waits until the sweep has finished.
INIT;*WAI

//---------------Retrieving Results-------------
//Return the occupied bandwidth.
CALC:MARK:FUNC:POW:RES? OBW
```

5.5.1.6 Remote commands for noise power ratio (NPR) measurements

- Activating an NPR measurement....1304
- Configuring an NPR measurement....1304
- Configuring signal generator control....1307
- Retrieving results from an NP measurement....1318
- Programming example: measuring the noise power ratio....1319

Activating an NPR measurement

[SENSe:]NPRatio:STATe....1304

[SENSe:]NPRatio:STATe <State>

Activates or deactivates the noise power ratio (NPR) measurement.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Deactivates the NPR measurement (returns to common frequency sweep)

ON | 1
Activates the NPR measurement

*RST: 0

Example:

```
NPR:STAT ON
```

Configuring an NPR measurement

[SENSe:]NPRatio:CHANnel:BWIDth....1304
[SENSe:]NPRatio:CHANnel:INTegration:AUTO....1305
[SENSe:]NPRatio:CHANnel:INTegration:BWIDth....1305
[SENSe:]NPRatio:CHANnel:INTegration:FREQuency:OFFSet....1306
[SENSe:]NPRatio:MODE....1306
[SENSe:]NPRatio:NOTCh<notch>:BWIDth:RELative....1306
[SENSe:]NPRatio:NOTCh<notch>:BWIDth[:ABSolute]....1307
[SENSe:]NPRatio:NOTCh<notch>:COUNt....1307
[SENSe:]NPRatio:NOTCh<notch>:FREQuency:OFFSet....1307

[SENSe:]NPRatio:CHANnel:BWIDth <Frequency>

Defines the channel bandwidth as an absolute value. Bandwidths covered by defined notches are deducted from this value.

Parameters:

<Frequency> *RST: 72 MHz
Default unit: Hz

Example: //Use abandwidth of 100000000 - (2*5000000) = 90000000 Hz as a basis for the total power density.
```
NPR:CHAN:BWID 100000000
NPR:NOTC:COUN 2
NPR:NOTC1:BWID 5000000
```

Manual operation: See "Channel Bandwidth" on page 1170

[SENSe:]NPRatio:CHANnel:INTegration:AUTO <State>

Determines which bandwidth is used for total power density calculation.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
The integration bandwidth and its position is defined manually using `[SENSe:]NPRatio:CHANnel:INTegration:BWIDth` on page 1305 and `[SENSe:]NPRatio:CHANnel:INTegration:FREQuency:OFFSet` on page 1306.
The entire specified bandwidth is used, including any defined notches.

ON | 1
The integration bandwidth is defined automatically as the channel bandwidth, without the notches, centered around the center frequency (see `[SENSe:]NPRatio:CHANnel:BWIDth` on page 1304).

*RST: 1

Example:
```
NPR:CHAN:INT:AUTO ON
```

Manual operation: See "Integration Bandwidth Mode" on page 1170

[SENSe:]NPRatio:CHANnel:INTegration:BWIDth <Frequency>

Defines the bandwidth to be used for total power calculation as an absolute value. This value is only considered for `[SENSe:]NPRatio:CHANnel:INTegration:AUTO`OFF.

The entire specified bandwidth is used, including any defined notches.

Parameters:

<Frequency> *RST: 72 MHz
Default unit: Hz

Example: //Select manual definition of the integration bandwidth.
```
NPR:CHAN:INT:AUTO OFF
```
//Set the integration bandwidth to 100 MHz.
```
NPR:CHAN:INT:BWID 100000000
```

Manual operation: See "Integration Bandwidth" on page 1171

[SENSe:]NPRatio:CHANnel:INTegration:FREQuency:OFFSet <Frequency>

Shifts the bandwidth to be used for total power density calculation away from the currently defined center frequency.

Parameters:

<Frequency> *RST: 0
Default unit: Hz

Example: //Shift the integration bandwidth by 10 MHz from the center frequency.
`NPR:CHAN:INT:FREQ:OFFS 10000000`

Manual operation: See "Channel Frequency Offset" on page 1171

[SENSe:]NPRatio:MODE <Mode>

Determines whether the power measured in a channel or notch is indicated as a power or a density value.

Parameters:

<Mode> POWer | DENSity

DENSity
Power measured in channel or notch divided by the "Channel BW"/"Integration BW" in dBm/Hz

POWer
Absolute power measured in channel or notch in current amplitude unit

*RST: DENSity

Example:
`NPR:MODE DENS`

Manual operation: See "Result Power Mode" on page 1171

[SENSe:]NPRatio:NOTCh<notch>:BWIDth:RELative <Percentage>

Defines the bandwidth of the individual notch as a percentage of the defined channel frequency.

Suffix:

<notch> Notch number 1 to 25

Parameters:

<Percentage> Range: 0 to 100
*RST: 5

Example: //Define a notch bandwidth of 5% of channel bandwidth (100 MHz) = 5 MHz
`NPR:CHAN:BWID 100000000`
`NPR:NOTC2:BWID:REL 5`

Manual operation: See "Notch Bandwidth (absolute / relative to channel bandwidth)" on page 1173

[SENSe:]NPRatio:NOTCh<notch>:BWIDth[:ABSolute] <Frequency>

Defines the bandwidth of the individual notch as an absolute value.

Suffix:
<notch> Notch number 1 to 25

Parameters:
<Frequency> Default unit: Hz

Example: `NPR:NOTC1:BWID 50000000`

Manual operation: See "Notch Bandwidth (absolute / relative to channel bandwidth)" on page 1173

[SENSe:]NPRatio:NOTCh<notch>:COUNt <Amount>

Defines the number of notches for which results are determined. Note that even if bandwidths for further notches are defined, only the number specified here are actually calculated and displayed.

Suffix:
<notch> Notch number 1 to 25

Parameters:
<Amount> integer
Range: 1 to 25
*RST: 1

Example: `NPR:NOTC:COUN 2`

Manual operation: See "Number of Notches" on page 1172

[SENSe:]NPRatio:NOTCh<notch>:FREQuency:OFFSet <Frequency>

Defines the center position of the notch in relation to the currently defined center frequency.

Suffix:
<notch> Notch number 1 to 25

Parameters:
<Frequency> Default unit: Hz

Example: `NPR:NOTC1:FREQ:OFFS -100000000`

Manual operation: See "Frequency Offset per notch" on page 1173

Configuring signal generator control

Useful commands for controlling generators described elsewhere:

- `CONFigure:GENerator:CONNection:CSTate?` on page 863
- `CONFigure:GENerator:IPConnection:ADDRess` on page 864

Remote commands exclusive to controlling generators for NPR measurements

CONFigure:GENerator:EXTernal:ROSCillator ... 1308
CONFigure:GENerator:FREQuency:CENTer ... 1309
CONFigure:GENerator:NPRatio:BB:ARBitrary:WAVeform:SELect? ... 1309
CONFigure:GENerator:NPRatio:BB:STANdard? ... 1309
CONFigure:GENerator:NPRatio:CONNection:CSTate? ... 1309
CONFigure:GENerator:NPRatio:CONTrol[:STATe] ... 1310
CONFigure:GENerator:NPRatio:EXTernal:ROSCillator:CSTate? ... 1310
CONFigure:GENerator:NPRatio:FREQuency:CENTer:CSTate? ... 1310
CONFigure:GENerator:NPRatio:FREQuency:COUPling[:STATe] ... 1311
CONFigure:GENerator:NPRatio:FREQuency:OFFSet ... 1311
CONFigure:GENerator:NPRatio:FREQuency[:FACTor]:DENominator ... 1311
CONFigure:GENerator:NPRatio:FREQuency[:FACTor]:NUMerator ... 1312
CONFigure:GENerator:NPRatio:NOTCh<notch>:BWIDth:ABSolute:CSTate? ... 1312
CONFigure:GENerator:NPRatio:NOTCh<notch>:FREQuency:OFFSet:CSTate? ... 1312
CONFigure:GENerator:NPRatio:NOTCh<notch>:STATe:CSTate? ... 1313
CONFigure:GENerator:NPRatio:NOTCh<notch>[:STATe] ... 1313
CONFigure:GENerator:NPRatio:NOTCh<notch>:CLOCk? ... 1313
CONFigure:GENerator:NPRatio:NOTCh<notch>:COUNt:CSTate? ... 1314
CONFigure:GENerator:NPRatio:POWer:LEVel:CSTate? ... 1314
CONFigure:GENerator:NPRatio:POWer:LEVel:OFFSet:CSTate? ... 1315
CONFigure:GENerator:NPRatio:RFOutput:STATe:CSTate? ... 1315
CONFigure:GENerator:NPRatio:SETTings:NOTCh:UPDate ... 1315
CONFigure:GENerator:NPRatio:SETTings:UPDate ... 1316
CONFigure:GENerator:NPRatio:STATe:CSTate? ... 1316
CONFigure:GENerator:NPRatio[:STATe] ... 1316
CONFigure:GENerator:POWer:LEVel ... 1316
CONFigure:GENerator:POWer:LEVel:OFFSet ... 1317
CONFigure:GENerator:RFOutput[:STATe] ... 1317
CONFigure:GENerator:TARGet:PATH:BB? ... 1317
CONFigure:GENerator:TARGet:PATH:RF ... 1317
CONFigure:SETTings:NPRatio ... 1318
CONFigure:SETTings:NPRatio:NOTCh ... 1318

CONFigure:GENerator:EXTernal:ROSCillator <ReferenceType>

Selects the source of the generator reference frequency.

Parameters:

<ReferenceType> EXTernal | INTernal

EXTernal
An external reference is provided via the EXT connectors on the generator, for example by the FSWX.

INTernal
The internal reference is that of the signal generator itself.

Manual operation: See "Reference Frequency" on page 1177

CONFigure:GENerator:FREQuency:CENTer <Frequency>

Defines the frequency of the signal provided by the signal generator.

Parameters:
<Frequency> Default unit: Hz

Example: `CONF:GEN:FREQ:CENT 1GHZ`

Manual operation: See "Frequency" on page 1176
See "Frequency Generator" on page 1179

CONFigure:GENerator:NPRatio:BB:ARBitrary:WAVeform:SELect?

Queries the ARB waveform file currently used by the signal generator.

Return values:
<ArbWaveform>

Example: `CONF:GEN:NPR:BB:ARB:WAV:SEL?`

Usage: Query only

Manual operation: See "ARB Waveform File" on page 1177

CONFigure:GENerator:NPRatio:BB:STANdard?

Queries the standard currently used by the signal generator.

Return values:
<Standard>

Example: `CONF:GEN:NPR:BB:STAN?`

Usage: Query only

Manual operation: See "Standard" on page 1177

CONFigure:GENerator:NPRatio:CONNection:CSTate?

Queries the state of the connected signal generator and its availability for the "Spectrum" application.

Return values:
<ControlState> OFF | SUCCessful | ERRor

OFF
No signal generator defined

SUCCessful
Connection established to compatible generator

ERRor
Connection error, for example due to an incompatible generator

Usage: Query only

CONFigure:GENerator:NPRatio:CONTrol[:STATe] <State>

Activates or deactivates control of the signal generator by the FSWX.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `CONF:GEN:NPR:CONT:STAT ON`

Manual operation: See "Generator Control state" on page 1175

CONFigure:GENerator:NPRatio:EXTernal:ROSCillator:CSTate?

Queries the state of the generator reference frequency.

Return values:

<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: `CONF:GEN:NPR:EXT:ROSC:CST?`

Usage: Query only

Manual operation: See "Reference Frequency" on page 1177

CONFigure:GENerator:NPRatio:FREQuency:CENTer:CSTate?

Queries the state of the generator center frequency.

Return values:

<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: `CONF:GEN:NPR:FREQ:CENT:CST?`

Usage: Query only

Manual operation: See "Frequency" on page 1176
See "Frequency Generator" on page 1179

CONFigure:GENerator:NPRatio:FREQuency:COUPling[:STATe] <State>

Enables or disables frequency coupling between the FSWX and the connected generator.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off
A fixed frequency is used by the generator.

ON | 1
Switches the function on
The frequency defined on the analyzer is automatically also used by the generator.

*RST: 0

Example:
```
CONF:GEN:NPR:FREQ:COUP:STAT ON
```

Manual operation: See "Generator Frequency Coupling State" on page 1179

CONFigure:GENerator:NPRatio:FREQuency:OFFSet <FrequencyOffset>

Defines a fixed offset to be applied to the generator frequency.

Parameters:

<FrequencyOffset> numeric value

Default unit: Hz

Example:
```
CONF:GEN:NPR:FREQ:OFFS 5
```

Manual operation: See "Frequency Offset" on page 1180

CONFigure:GENerator:NPRatio:FREQuency[:FACTor]:DENominator
<Denominator>

Defines the denominator of the frequency-defining factor for the generator frequency.
See "Frequency Generator" on page 1179.

Parameters:

<Denominator> numeric value

Example:
```
CONF:GEN:NPR:FREQ:FACT:DEN 5
```

Manual operation: See "Denominator" on page 1180

CONFigure:GENerator:NPRatio:FREQuency[:FACTor]:NUMerator <Numerator>

Defines the numerator of the frequency-defining factor for the generator frequency.
See "Frequency Analyzer" on page 1180.

Parameters:
<Numerator> numeric value

Example: `CONF:GEN:NPR:REQ:FACT:NUM 1`

Manual operation: See "Numerator" on page 1180

CONFigure:GENerator:NPRatio:NOTCh<notch>:BWIDth:ABSolute:CSTate?

Queries the state of the absolute notch bandwidth for the specified notch.

Suffix:
<notch> 1 to 25

Return values:
<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: `CONF:GEN:NPR:NOTC1:STAT?`

Usage: Query only

Manual operation: See "Notch Bandwidth (absolute / relative to channel bandwidth)" on page 1173

CONFigure:GENerator:NPRatio:NOTCh<notch>:FREQuency:OFFSet:CSTate?

Queries the state of the frequency offset for the specified notch.

Suffix:
<notch> 1 to 25

Return values:
<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: CONF:GEN:NPR:NOTC1:FREQ:OFFS:CST?

Usage: Query only

Manual operation: See "Frequency Offset per notch" on page 1173

CONFigure:GENerator:NPRatio:NOTCh<notch>:STATe:CSTate?

Queries the state of the generator notch setting for the specified notch.

Suffix:
<notch> 1 to 25

Return values:
<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: CONF:GEN:NPR:NOTC:STAT:CST?

Usage: Query only

CONFigure:GENerator:NPRatio:NOTCh<notch>[:STATe] <State>

Enables or disables the specified notch on the signal generator.

Suffix:
<notch> 1 to 25

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
The notch is not considered for signal generation on the connected signal generator.

ON | 1
The notch is considered for signal generation on the connected signal generator.

*RST: 0

Example: CONF:GEN:NPR:NOTC2:STAT ON

CONFigure:GENerator:NPRatio:NOTCh<notch>:CLOCk?

Queries the generator clock frequency.

Suffix:
<notch> 1 to 25
irrelevant

Return values:
<ClockFrequency>

Example: `CONF:GEN:NPR:NOTC:CLOC?`

Usage: Query only

CONFigure:GENerator:NPRatio:NOTCh<notch>:COUNt:CSTate?

Queries the state of the number of notches.

Suffix:
<notch> 1 to 25
irrelevant

Return values:
<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: `CONF:GEN:NPR:NOTC:COUN:CST?`

Usage: Query only

Manual operation: See "Number of Notches" on page 1172

CONFigure:GENerator:NPRatio:POWer:LEVel:CSTate?

Queries the state of the generator power level.

Return values:
<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: `CONF:GEN:NPR:POW:LEV:CST?`

Usage: Query only

Manual operation: See "Level (RMS)" on page 1177

CONFigure:GENerator:NPRatio:POWer:LEVel:OFFSet:CSTate?

Queries the state of the generator level offset.

Return values:

<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: `CONF:GEN:NPR:POW:LEV:OFFS:CST?`

Usage: Query only

Manual operation: See "Level Offset" on page 1177

CONFigure:GENerator:NPRatio:RFOutput:STATe:CSTate?

Queries the state of the generator RF output.

Return values:

<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: `CONF:GEN:NPR:RFO:STAT:CST?`

Usage: Query only

Manual operation: See "RF Output state" on page 1176

CONFigure:GENerator:NPRatio:SETTings:NOTCh:UPDate

Applies all notch settings to the connected signal generator once.

Example: `CONF:GEN:NPR:SETT:NOTC:UPD`

Usage: Event

CONFigure:GENerator:NPRatio:SETTings:UPDate

Applies all generator setup settings to the connected signal generator once.

Example: `CONF:GEN:NPR:SETT:UPD`

Usage: Event

Manual operation: See "Upload all Notch Settings to Generator" on page 1173
See "Upload all Generator Setup Settings to Generator" on page 1178

CONFigure:GENerator:NPRatio:STATe:CSTate?

Queries the state of the generator notch filter.

Return values:

<ControlState> OFF | SUCCessful | ERRor

OFF
Signal generator control off

SUCCessful
Setting successfully applied on the signal generator

ERRor
Control error, for example because a specified value cannot be applied on the signal generator

Example: `CONF:GEN:NPR:STAT:CST?`

Usage: Query only

Manual operation: See "Generator Notch Filter State" on page 1172

CONFigure:GENerator:NPRatio[:STATe] <State>

Activates or deactivates a notch filter on the signal generator.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: //Enable a notch filter on the connected generator.
`CONF:GEN:NPR:STAT ON`

Manual operation: See "Generator Notch Filter State" on page 1172

CONFigure:GENerator:POWer:LEVel <Level>

Defines the output power level used by the connected signal generator.

Parameters:
<Level> numeric value
Default unit: dBm

Example: `CONF:GEN:POW:LEV 25`

Manual operation: See "Level (RMS)" on page 1177

CONFigure:GENerator:POWer:LEVel:OFFSet <LevelOffset>

Defines a fixed offset in the power level used by the generator, for example due to a gain from the DUT.

Parameters:
<LevelOffset> numeric value
Default unit: dBm

Example: `CONF:GEN:POW:LEV:OFFS 5`

Manual operation: See "Level Offset" on page 1177

CONFigure:GENerator:RFOutput[:STATe] <State>

Enables or disables RF output on the connected generator.

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on
*RST: 0

Example: `CONF:GEN:RFO:STAT ON`

Manual operation: See "RF Output state" on page 1176

CONFigure:GENerator:TARGet:PATH:BB?

Queries the BB signal path of the generator used for signal generation.

Return values:
<Path> A | B

Example: `CONF:GEN:TARG:PATH:BB?`

Usage: Query only

Manual operation: See "Path RF/ Path Baseband" on page 1176

CONFigure:GENerator:TARGet:PATH:RF <Path>

Selects the RF signal path of the generator to be used for signal generation.

Parameters:
<Path> A | B

Example: `CONF:GEN:TARG:PATH:RF B`

Manual operation: See "Path RF/ Path Baseband" on page 1176

CONFigure:SETTings:NPRatio

Usage: Event

Manual operation: See "Query all Generator Setup Settings from Generator" on page 1177

CONFigure:SETTings:NPRatio:NOTCh

Usage: Event

Manual operation: See "Query all Notch Settings from Generator" on page 1174

Retrieving results from an NP measurement

CALCulate<n>:NPRatio:RESult? 1318

CALCulate<n>:NPRatio:RESult? <ResultType>

Queries the power results of the noise power ratio measurement.

Suffix:
<n> Window 1 to 16

Query parameters:
<ResultType> CPOWer | NPOWer | NPRatio | ALL

CPOWer
Returns the total measured power divided by the channel bandwidth (without notches) or integration bandwidth (with notches) in dBm/Hz

NPOWer
Returns the power measured in each notch divided by the notch bandwidth in dBm/Hz

NPRatio
Returns the ratio of the total channel power density divided by the notch power density for each notch in dB

ALL
Returns all power results for the channel and <n> defined notches in the following order:
<ChannelPowerDens>,<NotchPowerDens1>,..,<NotchPowerDens<n>>,<NPR1>,..,<NPR<n>>

Return values:
<ResultTypeResult>

Example: //Return the power ratio in dB for each notch.
CALC:NPR:RES? NPR

Usage: Query only

Programming example: measuring the noise power ratio

This example demonstrates how to determine the noise power ratio for the Section 5.3.12.9, "Measurement example", on page 1181 in a remote environment.

```
//-----------Configuring the measurement ------------
//Reset the instrument
*RST
//Set the center frequency to 500 MHz
FREQ:CENT 500000000
FREQ:SPAN 80000000

//Activate NPR measurement.
NPR:STAT ON

//Specify the channel bandwidth to be used = 72 MHz
NPR:CHAN:BWID 72000000
NPR:CHAN:INT:AUTO ON
//Define the two notches at +/- 12.2 MHz from the CF,
//with a bandwidth of 3.6 MHz
NPR:NOTC:COUN 2
NPR:NOTC1:FREQ:OFFS -12200000
NPR:NOTC1:BWID 3.600000
NPR:NOTC2:FREQ:OFFS 12200000
NPR:NOTC2:BWID:REL 5



//--------------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF

//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//---------------Retrieving Results-------------
//Query the noise power ratio for each notch.
CALC:NPR:RES? ALL
//Result:
//9.38,-51.73,-4685,-61.10,-56.26

//Query the measured power in each trace point
TRAC:DATA? TRACe1
//Returns 1001 power values
```

5.5.1.7 Measuring the spectrum emission mask

All remote control commands specific to spectrum emission mask measurements are described here.



See also Section 5.5.1.2, "Configuring power measurements", on page 1231.

Remote commands exclusive to spectrum emission mask measurements:

- Managing measurement configurations....1320
- Controlling the measurement....1322
- Configuring a multi-sem measurement....1322
- Configuring a sweep list....1323
- Configuring the reference range....1340
- Configuring the power classes....1342
- Configuring MSR SEM measurements....1347
- Configuring the list evaluation....1353
- Performing an SEM measurement....1354
- Retrieving results....1355
- Example: SEM measurement....1355

Managing measurement configurations

The following commands control measurement configurations for SEM measurements.

CALCulate<n>:LIMit<li>:ESPectrum<sb>:RESTore....1320
[SENSe:]ESPectrum<sb>:PRESet[:STANdard]....1320
[SENSe:]ESPectrum<sb>:PRESet:RESTore....1321
[SENSe:]ESPectrum<sb>:PRESet:STORe....1321

CALCulate<n>:LIMit<li>:ESPectrum<sb>:RESTore

Restores the predefined limit lines for the selected Spectrum Emission Mask standard.

All modifications made to the predefined limit lines are lost and the factory-set values are restored.

Suffix:

<n>	Window 1 to 16
	Limit line 1 to 8
<sb>	irrelevant

Example: //Reset the limit lines for the current Spectrum Emission Mask standard to the default setting.

```
CALC:LIM:ESP:REST
```

[SENSe:]ESPectrum<sb>:PRESet[:STANdard] <Standard>

Loads a measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is `home/instrument/.local/share/rohde-schwarz/esmain/fswx/sem_std`.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<Standard> String containing the file name.
If you have stored the file in a subdirectory of the directory mentioned above, you have to include the relative path to the file.

Example: `SENS:ESP:PRES:STAN 'standard1.xml'`

Manual operation: See "Select: Standard" on page 1048
See "Load" on page 1056

[SENSe:]ESPectrum<sb>:PRESet:RESTore

Restores the default configurations of predefined SEM standards.

Note that the command will overwrite customized standards that have the same name as predefined standards.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Example: `SENS:ESP:PRES:REST`

Manual operation: See "Restore Standard Files" on page 1056

[SENSe:]ESPectrum<sb>:PRESet:STORe <Standard>

Saves the current SEM measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is `home/instrument/.local/share/rohde-schwarz/esmain/fswx/sem_std`.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<Standard> String containing the file name.
You can save the file in a subdirectory of the directory mentioned above. In that case, you have to include the relative path to the file.

Example: `SENS:ESP:PRES:STOR 'standard2'`

Manual operation: See "Save" on page 1056

Controlling the measurement

The following commands control the measurement itself.

INITiate<n>:ESPectrum 1322
[SENSe:]SWEep:MODE 1322

INITiate<n>:ESPectrum

Initiates a Spectrum Emission Mask measurement.

Suffix:
<n> Window 1 to 16

Usage: Asynchronous command

[SENSe:]SWEep:MODE <Mode>

Selects the spurious emission and spectrum emission mask measurements.

You can select other measurements with

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>[:STATe]`

Parameters:
<Mode> LIST | AUTO | ESPectrum

AUTO
Turns on basic spectrum measurements.

ESPectrum
Turns on spectrum emission mask measurements.

LIST
Turns on spurious emission measurements.

*RST: AUTO

Example:
```
SWE:MODE ESP
```

Configuring a multi-sem measurement

In the Spectrum application only, spectrum emissions can be measured for multiple sub blocks of channels (see "SEM with multiple subblocks ("Multi-SEM")" on page 1036). Up to 8 sub blocks (with 7 gaps) can be defined. For each sub block, the familiar configuration settings concerning ranges, limit lines etc. can be defined in individual tabs (select the sub block using the <sb> suffix in the corresponding commands). In addition, settings on the sub blocks themselves must be configured.

Useful commands for multi-SEM measurements described elsewhere:

- `[SENSe:]ESPectrum<sb>:RANGe<ri>:MLCalc` on page 1337

Remote commands exclusive to multi-SEM measurements

[SENSe:]ESPectrum<sb>:SCENter 1323
[SENSe:]ESPectrum<sb>:SCOunt 1323

[SENSe:]ESPectrum<sb>:SCENter <Frequency>

Defines the center frequency of the selected sub block in a Multi-SEM measurement.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<Frequency> Frequency within the currently defined global span
(see `[SENSe<ip>:]FREQuency:SPAN` on page 1417 and `[SENSe<ip>:]FREQuency:CENTer` on page 612).

Range: 1 to 3
*RST: 1
Default unit: Hz

Example: `ESP1:SCEN 1GHZ`

Manual operation: See "Center Frequency" on page 1048

[SENSe:]ESPectrum<sb>:SCOunt <Subblocks>

Defines the number of sub blocks in the SEM measurement.

Suffix:
<sb> Subblock 1 to 8

Parameters:
<Subblocks> Number of sub blocks in the SEM measurement.

Range: 1 to 8
*RST: 1

Example: `ESP:SCO 2`

Manual operation: See "Sub Block Count" on page 1048

Configuring a sweep list

The following commands define a sweep list for SEM measurements.

The sweep list cannot be configured using remote commands during an on-going sweep operation.

See also:

- `CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:LIMit[:STATe]` on page 1345

[SENSe:]ESPectrum<sb>:HSPeed 1324
[SENSe:]ESPectrum<sb>:RANGe<ri>:BANDwidth:RESolution 1325
[SENSe:]ESPectrum<sb>:RANGe<ri>:BANDwidth:VIDeo 1325
[SENSe:]ESPectrum<sb>:RANGe<ri>:COUNt? 1325
[SENSe:]ESPectrum<sb>:RANGe<ri>:DELete 1326

[SENSe:]ESPectrum<sb>:RANGe<ri>:FILTer:TYPE ... 1326
[SENSe:]ESPectrum<sb>:RANGe<ri>[:FREQuency]:STARt ... 1327
[SENSe:]ESPectrum<sb>:RANGe<ri>[:FREQuency]:STOP ... 1327
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:ATTenuation ... 1328
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:ATTenuation:AUTO ... 1328
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:GAIN[:VALue] ... 1329
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:GAIN:STATe ... 1329
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:SANalyzer:ATTenuation ... 1329
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:SANalyzer:ATTenuation:AUTO ... 1330
[SENSe:]ESPectrum<sb>:RANGe<ri>:INSert ... 1331
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STARt ... 1331
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STOP ... 1332
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt ... 1332
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:ABS ... 1333
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:FUNCtion ... 1333
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP ... 1334
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:ABS ... 1334
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:FUNCtion ... 1335
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:STATe ... 1336
[SENSe:]ESPectrum<sb>:RANGe<ri>:POINts:MINimum[:VALue] ... 1336
[SENSe:]ESPectrum<sb>:RANGe<ri>:MLCalc ... 1337
[SENSe:]ESPectrum<sb>:RANGe<ri>:RLEVel ... 1337
[SENSe:]ESPectrum<sb>:RANGe<ri>:SWEep:TIME ... 1338
[SENSe:]ESPectrum<sb>:RANGe<ri>:SWEep:TIME:AUTO ... 1338
[SENSe<ip>:]ESPectrum<sb>:RANGe<ri>:SWEep:XFACtor ... 1339
[SENSe:]ESPectrum<sb>:RANGe<ri>:TRANsducer ... 1339
[SENSe:]ESPectrum<sb>:SSETup ... 1339

[SENSe:]ESPectrum<sb>:HSPeed <State>

Enables or disables high speed mode for SEM measurements.

For more information including restrictions see "Fast SEM measurements" on page 1034.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `ESP:HSP ON`

Manual operation: See "Fast SEM" on page 1047

[SENSe:]ESPectrum<sb>:RANGe<ri>:BANDwidth:RESolution <RBW>

Defines the resolution bandwidth for a SEM range.

In case of high speed measurements, the resolution bandwidth has to be identical for all ranges.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:

<RBW> Resolution bandwidth.
Refer to the specifications document for available resolution bandwidths.

*RST: 30.0 kHz
Default unit: Hz

Example: `SENS:ESP2:RANG2:BAND:RES 3KHZ`

Manual operation: See "RBW" on page 1042

[SENSe:]ESPectrum<sb>:RANGe<ri>:BANDwidth:VIDeo <VBW>

Defines the video bandwidth for a SEM range.

In case of high speed measurements, the video bandwidth has to be identical for all ranges.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:

<VBW> Video bandwidth.
Refer to the specifications document for available video bandwidths.

*RST: 10.0 MHz
Default unit: Hz

Example: `SENS:ESP:RANG:BAND:VID 1MHZ`

Manual operation: See "VBW" on page 1042

[SENSe:]ESPectrum<sb>:RANGe<ri>:COUNt?

Queries the number of ranges in the sweep list.

Suffix:
<sb> 1 to 8
Sub block in a Multi-SEM measurement

<ri> irrelevant

Return values:
<Ranges> Number of ranges in the sweep list.

Example: `SENS:ESP:RANG:COUN?`

Usage: Query only

[SENSe:]ESPectrum<sb>:RANGe<ri>:DELete

Removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> Range 1 to 30

Example: `SENS:ESP:RANG3:DEL`

Manual operation: See "Delete Range" on page 1047

[SENSe:]ESPectrum<sb>:RANGe<ri>:FILTer:TYPE <FilterType>

Selects the filter type for an SEM range.

In case of high speed measurements, the filter has to be identical for all ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<FilterType> **NORMal**
Gaussian filters

CFILter
channel filters

RRC
RRC filters

P5
5 Pole filters

*RST: NORM

Refer to the specifications document for available filter bandwidths.

Example: `SENS:ESP2:RANG:FILT:TYPE P5`

[SENSe:]ESPectrum<sb>:RANGe<ri>[:FREQuency]:STARt <Frequency>

Defines the start frequency of a SEM range.

Make sure to set an appropriate span.

- If you set a span that is smaller than the span the SEM sweep list covers, the FSWX will not measure the ranges that are outside the span - results may be invalid.
- If you set a span that is greater than the span the SEM sweep list covers, the FSWX will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see "Ranges and range settings" on page 1030.

Suffix:

<sb> Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:

<Frequency> Numeric value. Note that the minimum frequency range of a SEM range is 20 Hz.

*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)
Default unit: Hz

Example: `SENS:ESP:RANG1:FREQ:STAR -10MHZ`

Manual operation: See "Range Start/ Range Stop" on page 1042

[SENSe:]ESPectrum<sb>:RANGe<ri>[:FREQuency]:STOP <Frequency>

Defines the stop frequency of a SEM range.

Make sure to set an appropriate span.

- If you set a span that is smaller than the span the SEM sweep list covers, the FSWX will not measure the ranges that are outside the span - results may be invalid.
- If you set a span that is greater than the span the SEM sweep list covers, the FSWX will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see "Ranges and range settings" on page 1030.

Suffix:

<sb> Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<Frequency> Numeric value.
*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
Default unit: Hz

Example: `SENS:ESP:RANG2:FREQ:STOP 2MHZ`

Manual operation: See "Range Start/ Range Stop" on page 1042

[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:ATTenuation <Attenuation>

Defines the input attenuation for a SEM range.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<Attenuation> Numeric value.
Refer to the specifications document for the attenuation range.
*RST: 10 dB
Default unit: dB

Example: `SENS:ESP:RANG2:INP:ATT 10`

Manual operation: See "RF Attenuation" on page 1078

[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:ATTenuation:AUTO <State>

Enables or disables automatic selection of the input attenuation for a SEM range.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: //Deactivate the RF attenuation auto mode for range 2.
`ESP:RANG2:INP:ATT:AUTO OFF`

[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:GAIN[:VALue] <Gain>

Selects the gain for a SEM range.

In case of high speed measurements, the level of the preamplifier has to be identical for all ranges.

The command is available with the optional preamplifier.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<Gain> 30 dB
*RST: OFF

Example: `SENS:ESP:RANG2:IMP:GAIN:VAL 30`

[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:GAIN:STATe <State>

Enables or disables the preamplifier for a SEM range.

In case of high speed measurements, the state of the preamplifier has to be identical for all ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `SENS:ESP:RANG2:INP:GAIN:STAT OFF`

Manual operation: See "Preamplifier" on page 1045

[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:SANalyzer:ATTenuation <Attenuation>

Defines the input attenuation for a SEM range.

If an external frontend is active (see INP:SEL EFR, see INPut:SELect on page 558), you can configure attenuation settings for the external frontend and the analyzer separately. This setting defines the attenuation for the analyzer.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<Attenuation> Numeric value.
Refer to the specifications document for the attenuation range.

*RST: 10 dB
Default unit: dB

Example: //Deactivate the RF attenuation auto mode at the analyzer for range 2.
```
ESP:RANG2:INP:SAN:ATT:AUTO OFF
ESP:RANG2:INP:SAN:ATT 5
```

Manual operation: See "RF Attenuation Mechanical" on page 1044

[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:SANalyzer:ATTenuation:AUTO <State>

Enables or disables automatic selection of the input attenuation for a SEM range.

If an external frontend is active (see INP:SEL EFR, see INPut:SELect on page 558), you can configure attenuation settings for the external frontend and the analyzer separately. This setting defines the attenuation for the analyzer.

For high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<State> ON | OFF | 0 | 1

*RST: 1

Example: //Deactivate the RF attenuation auto mode at the analyzer for range 2.
```
ESP:RANG2:INP:SAN:ATT:AUTO OFF
ESP:RANG2:INP:SAN:ATT 5
```

Manual operation: See "RF Attenuation Mechanical" on page 1044

[SENSe:]ESPectrum<sb>:RANGe<ri>:INSert <Mode>

Inserts a new SEM range and updates the range numbers accordingly.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:

<Mode> AFTer | BEFore

AFTer
Inserts a range after the selected range.

BEFore
Inserts a range before the selected range.

Example: //Insert a new range after range 2.
`SENS:ESP:RANG2:INS AFT`

Manual operation: See "Insert before Range/ Insert after Range" on page 1046

[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STARt <Level>

Defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

 Limit line 1 to 8
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range.

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:ABSolute:STARt -10`
For a detailed example see "Example: SEM measurement" on page 1355.

Manual operation: See "Abs Limit Start / Abs Limit Stop <n>" on page 1046

[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STOP <Level>

Defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

 Limit line 1 to 8
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range.

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:ABSolute:STOP -15`
For a detailed example see "Example: SEM measurement" on page 1355.

Manual operation: See "Abs Limit Start / Abs Limit Stop <n>" on page 1046

[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt <Level>

Defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit regardless of the limit check mode.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

 Limit line 1 to 8
Power class for which the limit is defined.

Parameters:

<Level> Relative limit at the start frequency of a SEM range.

Range: -400 to 400
*RST: -50
Default unit: dBc

Example: `SENS:ESP:RANG:LIM:REL:STAR -10`

Manual operation: See "Rel Limit Start / Rel Limit Stop <n>" on page 1046

[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:ABS <Level>

Defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see "Relative limit line functions" on page 1034.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

 Limit line 1 to 8
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the start frequency oFSWX_RC_Configuring and performing measurements, 1, en_USf a SEM range to be used in addition to the relative limit if the MAX function is enabled (see `[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:FUNCtion` on page 1333).

Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STARt:ABSolute -10`
For a detailed example see "Example: SEM measurement" on page 1355.

Manual operation: See "Rel Limit Start / Rel Limit Stop <n>" on page 1046

[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:FUNCtion <Function>

Sets a relative limit value in dBc for the n-th power class at the start or stop frequency of the range.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

 Limit line 1 to 8
Power class for which the limit is defined.

Parameters:

<Function> OFF | MAX

Defines the function to be used to determine the relative limit line start value

MAX
The maximum of the relative *and* the absolute level is used as the limit start value. Use the `[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt` on page 1332 and `[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:ABS` commands to define these values.

OFF
No function is used, the relative limit line is defined by a fixed relative start value. Use the `[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt`command to define this value.

*RST: OFF

Example:
```
SENSe:ESPectrum:RANGe:LIMit:RELative:STARt:FUNCtion MAX
```
For a detailed example see "Example: SEM measurement" on page 1355.

Manual operation: See "Rel Limit Start / Rel Limit Stop <n>" on page 1046

[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP <Level>

Defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit anytime and regardless of the limit check mode.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

 Limit line 1 to 8
Power class for which the limit is defined.

Parameters:
<Level> Relative limit at the stop frequency of a SEM range.

Range: -400 to 400
*RST: -50
Default unit: dBc

Example:
```
SENSe:ESPectrum:RANGe:LIMit:RELative:STOP -15
```
For a detailed example see "Example: SEM measurement" on page 1355.

Manual operation: See "Rel Limit Start / Rel Limit Stop <n>" on page 1046

[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:ABS <Level>

Defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see "Relative limit line functions" on page 1034.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

 Limit line 1 to 8
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see `[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:FUNCtion` on page 1335).

Range: -400 to 400
*RST: -13
Default unit: dBm

Example:

```
SENSe:ESPectrum:RANGe:LIMit:RELative:STOP:ABSolute -15
```

For a detailed example see "Example: SEM measurement" on page 1355.

Manual operation: See "Rel Limit Start / Rel Limit Stop <n>" on page 1046

[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:FUNCtion
<Function>

Enables the use of a function when defining the relative limit for a SEM range.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

 Limit line 1 to 8
Power class for which the limit is defined.

Parameters:

<Function> OFF | MAX

Defines the function to be used to determine the relative limit line stop value

MAX
The maximum of the relative *and* the absolute level is used as the limit stop value. Use the `[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP` and `[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:ABS` commands to define these values.

OFF
No function is used, the relative limit line is defined by a fixed relative stop value. Use the `[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP` on page 1334 command to define this value.

*RST: OFF

Example: `SENSe:ESPectrum:RANGe:LIMit:RELative:STOP:FUNCtion MAX`
For a detailed example see "Example: SEM measurement" on page 1355.

Manual operation: See "Rel Limit Start / Rel Limit Stop <n>" on page 1046

[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:STATe <State>

Selects the limit check mode for *all* SEM ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

 Limit line 1 to 8
Power class for which the limit is defined.

Parameters:
<State> ABSolute | RELative | AND | OR

ABSolute
Checks only the absolute limits defined.

RELative
Checks only the relative limits. Relative limits are defined as relative to the measured power in the reference range.

AND
Combines the absolute and relative limit. The limit check fails when both limits are violated.

OR
Combines the absolute and relative limit. The limit check fails when one of the limits is violated.

*RST: RELative

Example: `SENS:ESP:RANG:LIM:STAT ABS`

Manual operation: See "Limit Check <n>" on page 1045

[SENSe:]ESPectrum<sb>:RANGe<ri>:POINts:MINimum[:VALue] <SweepPoint>

Defines the minimum number of sweep points for the range.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> Range 1 to 30

Parameters:
<SweepPoint> Minimum number of sweep points per range

Range: 1 to 32001
*RST: 1

Example: `SENSe1:ESPectrum:RANGe3:POINts:MIN:VALue 400`

Manual operation: See "Min. Sweep Points" on page 1045

[SENSe:]ESPectrum<sb>:RANGe<ri>:MLCalc <Function>

Defines the function used to calculate the limit line for the n-th power class for overlapping ranges in Multi-SEM measurements. For details see "Limit calculation for individual ranges" on page 1038.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<Function> NONE | MAX | SUM

NONE
(reference ranges only:) the limit of the reference range is used; Reference ranges always use the function "NONE".

SUM
sum of the two limit lines (calculated for linear powers) is used

MAX
maximum of the two limit lines is used

*RST: SUM (reference range: NONE)

Example: `SENS:ESP:RANG2:MLC SUM`

Manual operation: See "Multi Limit Calc." on page 1045

[SENSe:]ESPectrum<sb>:RANGe<ri>:RLEVel <RefLevel>

Defines the reference level for a SEM range.

In case of high speed measurements, the reference level has to be identical for all ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:

<RefLevel> Reference level.
Refer to the specifications document for the reference level range.

*RST: 0 dBm
Default unit: dBm

Example: `SENS:ESP:RANG2:RLEV 10`

Manual operation: See "Ref level" on page 1043

[SENSe:]ESPectrum<sb>:RANGe<ri>:SWEep:TIME <SweepTime>

Defines the sweep time for a SEM range.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:

<SweepTime> Sweep time
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the specifications document for more information.

Default unit: s

Example: `SENS:ESP:RANG2:SWE:TIME 0.0002`

Manual operation: See "Sweep Time" on page 1042

[SENSe:]ESPectrum<sb>:RANGe<ri>:SWEep:TIME:AUTO <State>

Enables or disables automatic selection of the sweep time for a SEM range.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: //Deactivate the sweep time auto mode for range 3.
`ESP:RANG3:SWE:TIME:AUTO OFF`

Manual operation: See "Sweep Time Auto" on page 1042

[SENSe<ip>:]ESPectrum<sb>:RANGe<ri>:SWEep:XFACtor <XCorrFactor>

Defines the number of sweep samples that are cross-correlated to determine a single sweep point if the "RMS X-Corr" detector is used.

Suffix:
<ip> Input

<sb> Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<XCorrFactor> integer

Example: `SENS:ESP:RANG:SWE:XFAC 3`

Manual operation: See "X-Corr Factor" on page 1078

[SENSe:]ESPectrum<sb>:RANGe<ri>:TRANsducer <Transducer>

Selects a transducer factor for a SEM range.

Note that

- the transducer must cover at least the span of the range
- the x-axis has to be linear
- the unit has to be dB

Suffix:
<sb> 1 to 8
Subblock 1 to 8

<ri> 1 to 30
Range 1 to 30

Parameters:
<Transducer> String containing the transducer file name, including the path information.

Example: `SENS:ESP:RANG2:TRAN 'home/instrument/.local/share/rohde-schwarz/esmain/fswx/tr`

Manual operation: See "Transducer" on page 1045

[SENSe:]ESPectrum<sb>:SSETup <State>

Enables or disables symmetrical configuration of the range settings.

See "Ranges and range settings" on page 1030.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `SENS:ESP:SSET ON`

Manual operation: See "Symmetrical Setup" on page 1047

Configuring the reference range

The following commands define the reference range for the SEM sweep list.

[SENSe:]ESPectrum<sb>:BWID 1340
[SENSe:]ESPectrum<sb>:FILTer[:RRC]:ALPHa 1340
[SENSe:]ESPectrum<sb>:FILTer[:RRC][:STATe] 1341
[SENSe:]ESPectrum<sb>:RRANge? 1341
[SENSe:]ESPectrum<sb>:RTYPe 1341

[SENSe:]ESPectrum<sb>:BWID <Bandwidth>

Defines the channel bandwidth of the reference range.

The bandwidth is available if the power reference is the channel power.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<Bandwidth> minimum span ≤ value ≤ span of reference range

*RST: 3.84 MHz
Default unit: Hz

Example: `SENS:ESP:BWID 3MHZ`

Manual operation: See "Tx Bandwidth" on page 1050

[SENSe:]ESPectrum<sb>:FILTer[:RRC]:ALPHa <Alpha>

Prerequisite: The power reference is the channel power.

Defines the roll-off factor for the RRC filter.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<Alpha> Range: 0 to 1
*RST: 0.22

Example: `SENS:ESP:FILT:RRC:ALPH 0.5`

Manual operation: See "Alpha" on page 1050

[SENSe:]ESPectrum<sb>:FILTer[:RRC][:STATe] <State>

Enables or disables the RRC filter in the reference range.

The RRC filter is available if the power reference is the channel power.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `SENS:ESP:FILT:RRC:STAT OFF`

Manual operation: See "RRC Filter State" on page 1050

[SENSe:]ESPectrum<sb>:RRANge?

Queries the reference range.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Return values:
<RefRange> Number of the current reference range.
Range: 1 to 30

Example: `SENS:ESP:RRAN?`

Usage: Query only

[SENSe:]ESPectrum<sb>:RTYPe <Type>

Defines the type of the power reference.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<Type> PEAK | CPOWer

PEAK
Measures the highest peak within the reference range.

CPOWer
Measures the channel power within the reference range (integral bandwidth method).

*RST: CPOWer

Example: `SENS:ESP:RTYP PEAK`

Manual operation: See "Power Reference Type" on page 1049

Configuring the power classes

The following commands define the power classes for SEM measurements.

CALCulate<n>:LIMit<li>:ESPectrum<sb>:LIMits....1342
CALCulate<n>:LIMit<li>:ESPectrum<sb>:MODE....1343
CALCulate<n>:LIMit<li>:ESPectrum<sb>:VALue....1344
CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:COUNt....1344
CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>[:EXCLusive]....1345
CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:LIMit[:STATe]....1345
CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:MAXimum....1346
CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:MINimum....1346

CALCulate<n>:LIMit<li>:ESPectrum<sb>:LIMits <Max1>,<Max2>,<Max3>

Sets or queries up to 4 power classes in one step. You can only define values for the number of power classes defined by `CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:COUNt` on page 1344.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<sb> 1 to 8
Subblock in a multi-SEM measurement

Setting parameters:
<Max1> Defines the value range for power class 1 as `-200 to <Max1>`.
Only available for `CALC:LIM:ESP:PCL:COUNT >=2`
If only 2 power classes are defined, the value range for power class 2 is defined as `<Max1> to 200`.

Range: -199 to + 199
Default unit: DBM

<Max2> Defines the value range for power class 2 as `<Max1> to <Max2>`.
Only available for `CALC:LIM:ESP:PCL:COUNT >=3`
If only 3 power classes are defined, the value range for power class 3 is defined as `<Max2> to 200`.

Range: -199 to + 199, <Max2> must be higher than <Max1>

<Max3> Defines the value range for power class 3 as `<Max2> to <Max3>`.
The value range for power class 4 is defined as `<Max3> to 200`.
Only available for `CALC:LIM:ESP:PCL:COUNT = 4`

Range: -199 to + 199, <Max3> must be higher than <Max2>

Example:
```
CALC:LIM:ESP:LIM -50,50,70
```
Defines the following power classes:
```
<-200, -50>
<-50, 50>
<50, 70>
<70, 200>
```
Query:
```
CALC:LIM:ESP:LIM?
```
Response:
```
-200,-50,50,70,200
```

CALCulate<n>:LIMit<li>:ESPectrum<sb>:MODE <Mode>

Which limit line is to be used for an SEM measurement depends on the power class the input signal power belongs to. This command defines wether the power class is determined automatically or manually.

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<sb> 1 to 8
Sub block in a Multi-SEM measurement

Parameters:

<Mode> **AUTO**
The power class (and thus the limit line) is assigned dynamically according to the currently measured channel power.

MANUAL
One of the specified power classes is selected manually for the entire measurement. The selection is made with the `CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>[:EXCLusive]` command.

*RST: AUTO

Example: //Activate automatic selection of the limit line.
CALC:LIM:ESP:MODE AUTO

CALCulate<n>:LIMit<li>:ESPectrum<sb>:VALue <Power>

Activates the manual limit line selection as and specifies the expected power as a value. Depending on the entered value, the associated predefined limit lines is selected.

Has the same effect as a combination of the CALC:LIM:ESP:MODE MAN and the CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>[:EXCLusive] commands; however, the power class to be used is not defined directly, but via the expected power. As opposed to CALC:LIM:ESP:MODE AUTO, the power class is not re-assigned to the input signal power dynamically, but only once when the command is executed.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<sb> 1 to 8
Sub block in a Multi-SEM measurement

Parameters:
<Power> integer

Range: -200 to 199
*RST: 0

Example: //Activate manual selection of the limit line and selects the limit line for P = 33.
CALC:LIM:ESP:VAL 33

CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:COUNt <NoPowerClasses>

Sets the number of power classes to be defined.

Must be executed before any new power class values can be defined using CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:MAXimum and CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:MINimum.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<sb> 1 to 8
Sub block in a Multi-SEM measurement

<pc> irrelevant

Parameters:
<NoPowerClasses> 1 to 4

*RST: 1

Example: //Define two power classes.
`CALC:LIM:ESP:PCL:COUN 2`

Manual operation: See "Adding or removing a power class" on page 1052

CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>[:EXCLusive] <State>

Selects the power class used by the measurement if `CALCulate<n>:LIMit<li>:ESPectrum<sb>:MODE` is set to manual.

Note that:

- You can only use power classes for which limits are defined.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<sb> 1 to 8
Sub block in a Multi-SEM measurement

<pc> 1 to 3
power class

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: //Activate the first defined power class.
`CALC:LIM:ESP:PCL1 ON`

Manual operation: See "Used Power Classes" on page 1051

CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:LIMit[:STATe] <State>

Selects the limit check mode for each power class.

Suffix:
<n> Window 1 to 16

 Limit line 1 to 8

<sb> 1 to 8
Sub block in a Multi-SEM measurement

<pc> 1 to 3
power class

Parameters:
<State> ABSolute | RELative | AND | OR

ABSolute
Evaluates only limit lines with absolute power values

RELative
Evaluates only limit lines with relative power values

AND
Evaluates limit lines with relative and absolute power values. A negative result is returned if both limits fail.

OR
Evaluates limit lines with relative and absolute power values. A negative result is returned if at least one limit failed.

*RST: REL

Example: `CALC:LIM:ESP:PCL:LIM ABS`

Manual operation: See "Used Power Classes" on page 1051

CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:MAXimum <Level>

Defines the upper limit of a particular power class.

Note:

- The last power class always has an upper limit of 200 dBm.
- The upper limit of a power class must always be the same as the lower limit of the subsequent power class.
- The power class must already exist (see `CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:COUNt` on page 1344).

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<sb> 1 to 8
Sub block in a Multi-SEM measurement

<pc> 1 to 3
power class

Parameters:

<Level> Range: -199.9 dBm to 200 dBm
Default unit: dBm

Example: //Set the maximum power value of the first power class to -40 dBm.
`CALC:LIM:ESP:PCL1:MAX -40 dBm`

Manual operation: See "P_{Min}/ P_{Max}" on page 1051

CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:MINimum <Level>

Defines the lower limit of a particular power class.

Note:

- The first power class always has a lower limit of -200 dBm.
- The lower limit of a power class must always be the same as the upper limit of the previous power class.

- The power class must already exist (see `CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>:COUNt` on page 1344).

Suffix:

<n> Window 1 to 16

 Limit line 1 to 8

<sb> 1 to 8
Sub block in a Multi-SEM measurement

<pc> 1 to 3
power class

Parameters:

<Level> Range: -200 dBm to 199.9 dBm
Default unit: dBm

Example: //Set the minimum power value of the second power class to -40 dBm.
`CALC:LIM:ESP:PCL2:MIN -40 dBm`

Manual operation: See "P_{Min}/ P_{Max}" on page 1051

Configuring MSR SEM measurements

The following commands configure MSR SEM measurements. For details see "Multi-standard radio (MSR) SEM measurements" on page 1036.

For manual operation see "MSR settings" on page 1052.

[SENSe:]ESPectrum<sb>:MSR:APPLy....1347
[SENSe:]ESPectrum<sb>:MSR:BAND....1348
[SENSe:]ESPectrum<sb>:MSR:BCATegory....1348
[SENSe:]ESPectrum<sb>:MSR:CLASs....1349
[SENSe:]ESPectrum<sb>:MSR:GSM:CARRier....1350
[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent....1351
[SENSe:]ESPectrum<sb>:MSR:LTE:CPResent....1351
[SENSe:]ESPectrum<sb>:MSR:MPOWer....1352
[SENSe:]ESPectrum<sb>:MSR:RFBWidth....1352

[SENSe:]ESPectrum<sb>:MSR:APPLy

Configures the SEM sweep list according to the MSR settings defined by previous commands.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

Example:

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Apply to SEM" on page 1054

[SENSe:]ESPectrum<sb>:MSR:BAND <Range>

Defines the frequency range of the bands used by the base station.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

Parameters:

<Range> LOW | HIGH

LOW
≤ 3 GHz

HIGH
> 3 GHz

*RST: LOW

Example:

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Bands" on page 1053

[SENSe:]ESPectrum<sb>:MSR:BCATegory <Category>

Defines the band category for MSR measurements, i.e. the combination of available carriers to measure.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<Category> 1 | 2 | 3

1
2 carriers: LTE FDD and W-CDMA

2
3 carriers: LTE FDD, W-CDMA and GSM/EDGE

3
2 carriers: LTE TDD and TD-SCDMA

*RST: 1

Example:
```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Band Category" on page 1053

[SENSe:]ESPectrum<sb>:MSR:CLASs <Class>

Defines the class of the base station according to its sending range.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<Class> WIDE | MEDium | LOCal

WIDE
Wide Area

MEDium
Medium Range

LOCal
Local Area

*RST: WIDE

Example:

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Base Station Class" on page 1053

[SENSe:]ESPectrum<sb>:MSR:GSM:CARRier <Power>

Prerequisite: band category 2 (see `[SENSe:]ESPectrum<sb>:MSR:BCATegory` on page 1348).

Defines the power of the GSM carrier (if available, see `[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent` on page 1351).

Suffix:

<sb> 1 to 8
Subblock 1 to 8

Parameters:

<Power>
Range: 0 dBm to 100 dBm
*RST: 39.0 dBm
Default unit: dBm

Example:

```
//Select the band category 2
ESP2:MSR:BCAT BC2
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//GSM/Edge present
ESP2:MSR:GSM:CPR ON
//Power of the GSM carrier is 20dBm
ESP2:MSR:GSM:CARR 20
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Power GSM Carrier" on page 1054

[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent <State>

Prerequisite: band category 2 (see [SENSe:]ESPectrum<sb>:MSR:BCATegory on page 1348)

Defines whether a GSM/Edge carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example:
```
//Select the band category 2
ESP2:MSR:BCAT BC2
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//GSM/Edge present
ESP2:MSR:GSM:CPR ON
//Power of the GSM carrier is 20dBm
ESP2:MSR:GSM:CARR 20
```

Manual operation: See "Carrier Adjacent to RF Bandwidth Edge" on page 1053

[SENSe:]ESPectrum<sb>:MSR:LTE:CPResent <State>

Prerequisite: band category 2 (see [SENSe:]ESPectrum<sb>:MSR:BCATegory on page 1348)

Defines whether an LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

Suffix:
<sb> 1 to 8
Subblock 1 to 8

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example:

```
//Select the band category 2
ESP2:MSR:BCAT BC2
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//LTE present
ESP2:MSR:LTE:CPR ON
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Carrier Adjacent to RF Bandwidth Edge" on page 1053

[SENSe:]ESPectrum<sb>:MSR:MPOWer <Power>

PrerequisiteBase stations with a medium range base station class (see `[SENSe:]ESPectrum<sb>:MSR:CLASs` on page 1349)

Defines the maximum output power of the base station.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

Parameters:

<Power> Range: 0 dBm to 100 dBm
Increment: 1 dB
Default unit: dBm

Example:

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
```

Manual operation: See "Base Station Maximum Output Power" on page 1053

[SENSe:]ESPectrum<sb>:MSR:RFBWidth <Bandwidth>

Defines the RF bandwidth of the base station for MSR measurements.

Suffix:

<sb> 1 to 8
Subblock 1 to 8

Parameters:
<Bandwidth> Bandwidth in Hz
*RST: 10.0 MHz
Default unit: Hz

Example:
```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

Manual operation: See "Base Station RF Bandwidth" on page 1053

Configuring the list evaluation

The following commands configure the list evaluation.

Useful commands for SEM measurements described elsewhere

- `MMEMory:STORe<n>:LIST` on page 803

Remote commands exclusive to SEM measurements

CALCulate<n>:ESPectrum:PSEarch:AUTO 1353
CALCulate<n>:ESPectrum:PEAKsearch:AUTO 1353
CALCulate<n>:ESPectrum:PSEarch[:IMMediate] 1354
CALCulate<n>:ESPectrum:PEAKsearch[:IMMediate] 1354
CALCulate<n>:ESPectrum:PSEarch:MARGin 1354
CALCulate<n>:ESPectrum:PEAKsearch:MARGin 1354
CALCulate<n>:ESPectrum:PSEarch:PSHow 1354
CALCulate<n>:ESPectrum:PEAKsearch:PSHow 1354

CALCulate<n>:ESPectrum:PSEarch:AUTO <State>
CALCulate<n>:ESPectrum:PEAKsearch:AUTO <State>

Enables or disables the list evaluation.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: //Deactivate the list evaluation.
```
CALC:ESP:PSE:AUTO OFF
```

Manual operation: See "Result Summary State" on page 1057

CALCulate<n>:ESPectrum:PSEarch[:IMMediate]
CALCulate<n>:ESPectrum:PEAKsearch[:IMMediate]

Initiates a list evaluation.

Suffix:
<n> Window 1 to 16

CALCulate<n>:ESPectrum:PSEarch:MARGin <Threshold>
CALCulate<n>:ESPectrum:PEAKsearch:MARGin <Margin>

Defines the threshold of the list evaluation.

Suffix:
<n> Window 1 to 16

Parameters:
<Margin> Range: -200 to 200
*RST: 200
Default unit: dB

Example: //Set the margin to 100 dB.
`CALC:ESP:PSE:MARG 100`

Manual operation: See "Margin" on page 1057

CALCulate<n>:ESPectrum:PSEarch:PSHow <State>
CALCulate<n>:ESPectrum:PEAKsearch:PSHow <State>

Enables or disables the peak labels in the diagram.

Peak labels are blue squares.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: //Mark all peaks with blue squares.
`CALC:ESP:PSE:PSH ON`

Manual operation: See "Show Peaks" on page 1057

Performing an SEM measurement

The following commands are required to perform an SEM measurement:

- `SENS:SWE:MODE ESP`, see `[SENSe:]SWEep:MODE` on page 1322
- `INITiate<n>[:IMMediate]` on page 647

Retrieving results

The following commands analyze and retrieve measurement results for SEM measurements.

- CALCulate<n>:LIMit<li>:FAIL? on page 775
- TRACe<n>[:DATA] on page 688
- TRACe<n>[:DATA]:MEMory? on page 689
- TRACe<n>[:DATA]:X? on page 690
- CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult on page 1231

Example: SEM measurement

In this example we will configure and perform an SEM measurement. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task. For most common measurement standards, the FSWX performs the measurement optimally with the predefined settings, without further configuration.

```
//-----------Preparing the measurement ------------
//Reset the instrument
*RST

//------------ Preparing the measurement------------
//Activate SEM Measurement
SWE:MODE ESP

//Selects single sweep mode.
//SEM has to be in single sweep mode to be configured and no sweep operation
//may be running!
// If required, a sweep stop can be ensured by INIT:IMM;*WAI
INIT:CONT OFF


//------------ Managing Measurement Configurations----------
//Load the 3GPP configuration stored in the file '3GPP_UL.xml'
ESP:PRES 'WCDMA/3GPP/UL/3GPP_UL.xml'

//------------ Defining the Reference Range-----------------
//Query the current reference range.
ESP:RRAN?
//Select the channel power as the power reference.
ESP:RTYP CPOW
//Define a channel bandwidth of 4 MHz for the power reference.
ESP:BWID 4 MHZ
//Use an RRC filter with a roll-off factor of 0.5 when measuring
//the reference power.
ESP:FILT:RRC ON
ESP:FILT:ALPH 0.5

//------------ Configuring Power Classes--------------------
```

```
//Define 3 power classes.
CALC:LIM:ESP:PCL:COUN 3
//Define the value ranges of the three power classes as [dBm]:
//power class 1: -200 to -100
//power class 2: -100 to 0
//power class 3: 0 to 200
CALC:LIM:ESP:LIM -100,0
//Define an absolute limit check for class 1.
CALC:LIM:ESP:PCL1:LIM ABS
//Define a relative limit check for class 2.
CALC:LIM:ESP:PCL2:LIM REL
//Define a manual selection of the power class.
CALC:LIM:ESP:MODE MAN
//Activate the use of the second power class for the entire measurement.
CALC:LIM:ESP:PCL2 ON

//------------ Configuring a Sweep List---------------------
//Insert a range after range 2.
ESP:RANG2:INS AFT
//Insert a range before range 1.
ESP:RANG1:INS BEF
//Query the number of measurement ranges in the sweep list (currently 11).
ESP:RANG:COUNt?
//Delete the 11th range.
ESP:RANG5:DEL

//Define a stop frequency of -9 MHz for range 1.
ESP:RANG1:STOP -10000000

//Define a start frequency of -10 MHz for range 2.
ESP:RANG2:STAR -9000000

//Switch off Fast SEM mode so the ranges can be configured individually.
ESP:HSP OFF

//Define a resolution bandwidth of 1 MHz for range 2.
ESP:RANG2:BAND:RES 1000000

//Select an RRC filter for range 2.
ESP:RANG2:FILT:TYPE RRC

//Define a video bandwidth of 5 MHz for range 2.
ESP:RANG2:BAND:VID 5000000
//Define a sweep time of 1 second for range 2.
ESP:RANG2:SWE:TIME 1
//Define a reference level of 0 dBm for range 2.
ESP:RANG2:RLEV 0
//Define an input attenuation of 10 dB for range 2.
ESP:RANG2:INP:ATT 10
```

```
// Create a transducer that can be used.
// It has to cover the corresponding frequency range

SENSe1:CORRection:TRANsducer:SELect 'Transducer'
SENSe1:CORRection:TRANsducer:UNIT 'DB'
SENSe1:CORRection:TRANsducer:COMMent 'Test Transducer'
// Frequency Span 0 MHz bis 20 Ghz
SENSe1:CORRection:TRANsducer:DATA 0e6,5, 20e9,3


//Include a transducer called 'transducer' for range 2.
ESP:RANG2:TRAN 'Transducer'

//------------ Configuring the limit check------------------

//Check the absolute and relative limits for all ranges in power class 1 and
//fails if both limits are violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant. They are
//defined here to demonstrate the use of the MAX function for relative limits.
ESP:RANG:LIM1:STAT AND
//Enable the use of maximum function for relative limit start. If the value
//exceeds the larger of the absolute (-13 dBm) and relative (-10 dBc) start
//values, the check fails.
ESP:RANG2:LIM1:REL:STAR:FUNC MAX
ESP:RANG2:LIM1:REL:STAR -10
ESP:RANG2:LIM1:REL:STAR:ABS -13
ESP:RANG2:LIM1:REL:STOP:FUNC MAX
ESP:RANG2:LIM1:REL:STOP -10
ESP:RANG2:LIM1:REL:STOP:ABS -13

//Check the absolute and relative limits for all ranges in power class 2 and
//fails if either limit is violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant.
ESP:RANG:LIM2:STAT OR
//Define an absolute limit of 10 dBm for the entire range 2 for power class 2.
ESP:RANG2:LIM2:ABS:STAR 10
ESP:RANG2:LIM2:ABS:STOP 10
//Define a relative limit of -20 dBc for the entire range 2 for power class 2.
ESP:RANG2:LIM2:REL:STAR -20
ESP:RANG2:LIM2:REL:STOP -20

//------------ Configuring List Evaluation-----------------
//Activate list evaluation, i.e. the peak is determined for each range
//after each sweep.
CALC:ESP:PSE:AUTO ON
//Define a peak threshold of 10 dB.
CALC:ESP:PSE:MARG 10dB

//------------ Managing Measurement Configurations----------
```

```
//Save the current configuration in a new file named '3GPP_UL_User'
//in the same directory so the standard is not overwritten.
ESP:PRES:STOR 'WCDMA/3GPP/UL/3GPP_UL_User.xml'

//------------ Performing the measurement-------------------
//One sweep
INIT:ESP

//------------ Checking the Results-------------------------
//Query the result of the limit check for all ranges.
CALC:LIM:FAIL?
//Query the peak for each range of the SEM measurement as a list.
TRAC:DATA? LIST
```

To retrieve the limit line values

You cannot query the special SEM limit line values used for an SEM measurement directly, ("_SEM_LINE_<xxx>_ABS<0...3>"/ "_SEM_LINE_<xxx>_REL<0...3>", see "Limit lines in SEM measurements" on page 1032). However, you can retrieve the limit values using this workaround. The workaround is not possible for `CALCulate<n>:LIMit<li>:ESPectrum<sb>:PCLass<pc>[:EXCLusive] ON`).

```
//Query the used limit line name
CALC:LIM:ACT?
// => name of active limit line: 'SEM_LIMIT_ABS_0'

//Set this limit line as limit line 7
CALC:LIM7:NAME 'SEM_LIMIT_ABS_0'

//Get the frequency values of the limit line
CALC:LIM7:CONT?
// => f values:
//-1.275000000E+007,-8.000000000E+006,-8.000000000E+006,-4.000000000E+006,
//-4.000000000E+006,-3.515000000E+006,-3.515000000E+006,-2.715000000E+006,
//-2.715000000E+006,-2.515000000E+006,-2.515000000E+006,+2.515000000E+006,
//+2.515000000E+006,+2.715000000E+006,+2.715000000E+006,+3.515000000E+006,
//+3.515000000E+006,+4.000000000E+006,+4.000000000E+006,+8.000000000E+006,
//+8.000000000E+006,+1.275000000E+007

//Get the power values of the limit line
CALC:LIM7:UPP?
//-2.350000000E+001,-2.350000000E+001,-1.950000000E+001,-1.950000000E+001,
//-3.250000000E+001,-3.250000000E+001,-3.250000000E+001,-2.050000000E+001,
//-2.050000000E+001,-2.050000000E+001,+1.000000000E+002,+1.000000000E+002,
//-2.050000000E+001,-2.050000000E+001,-2.050000000E+001,-3.250000000E+001,
//-3.250000000E+001,-3.250000000E+001,-1.950000000E+001,-1.950000000E+001,
//-2.350000000E+001,-2.350000000E+001
```

5.5.1.8 Measuring spurious emissions

The following commands are required to perform spurious emissions measurements.

- Initializing the measurement 1359
- Configuring a sweep list 1359
- Configuring the list evaluation 1369
- Adjusting the X-axis to the range definitions 1371
- Performing a spurious measurement 1371
- Retrieving and saving settings and results 1371
- Programming example: spurious emissions measurement 1371

Initializing the measurement

Note that with the FSWX, the spurious measurement must be initialized before you can start configuring the sweep list or list evaluation.

INITiate<n>:SPURious 1359

INITiate<n>:SPURious

Initiates a Spurious Emission measurement.

Suffix:
<n> Window 1 to 16

Usage: Asynchronous command

Configuring a sweep list

The following commands configure the sweep list for spurious emission measurements.



The sweep list cannot be configured using remote commands during an on-going sweep operation.

Useful commands for configuring the sweep described elsewhere:

- `[SENSe:]SWEep:MODE` on page 1322

Remote commands exclusive to spurious measurements:

[SENSe:]LIST:RANGe<ri>:BANDwidth:RESolution 1360
[SENSe:]LIST:RANGe<ri>:BANDwidth:VIDeo 1360
[SENSe:]LIST:RANGe<ri>:BREak 1360
[SENSe:]LIST:RANGe<ri>:COUNt? 1361
[SENSe:]LIST:RANGe<ri>:DELete 1361
[SENSe:]LIST:RANGe<ri>:DETector 1361
[SENSe:]LIST:RANGe<ri>[:FREQuency]:STARt 1362
[SENSe:]LIST:RANGe<ri>[:FREQuency]:STOP 1363
[SENSe:]LIST:RANGe<ri>:FILTer:TYPE 1363
[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation 1364
[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation:AUTO 1364

[SENSe:]LIST:RANGe<ri>:INPut:GAIN:STATe....1364
[SENSe:]LIST:RANGe<ri>:INPut:SANalyzer:ATTenuation....1365
[SENSe:]LIST:RANGe<ri>:INPut:SANalyzer:ATTenuation:AUTO....1365
[SENSe:]LIST:RANGe<ri>:LIMit:STARt....1366
[SENSe:]LIST:RANGe<ri>:LIMit:STATe....1366
[SENSe:]LIST:RANGe<ri>:LIMit:STOP....1366
[SENSe:]LIST:RANGe<ri>:POINts[:VALue]....1367
[SENSe:]LIST:RANGe<ri>:RLEVel....1367
[SENSe:]LIST:RANGe<ri>:SWEep:TIME....1367
[SENSe:]LIST:RANGe<ri>:SWEep:TIME:AUTO....1368
[SENSe<ip>:]LIST:RANGe<ri>:SWEep:XFACtor....1368
[SENSe:]LIST:RANGe<ri>:TRANsducer....1368

[SENSe:]LIST:RANGe<ri>:BANDwidth:RESolution <RBW>

Defines the resolution bandwidth for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<RBW> Resolution bandwidth.
Refer to the specifications document for available resolution bandwidths.
Default unit: Hz

Example: `LIST:RANG2:BAND:RES 3KHZ`

Manual operation: See "RBW" on page 1077

[SENSe:]LIST:RANGe<ri>:BANDwidth:VIDeo <VBW>

Defines the video bandwidth for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<VBW> Video bandwidth.
Refer to the specifications document for available video bandwidths.
Default unit: Hz

Example: `LIST:RANG2:BAND:VID 3KHZ`

Manual operation: See "VBW" on page 1077

[SENSe:]LIST:RANGe<ri>:BREak <State>

Controls the sweep for all ranges.

Suffix:
<ri> Range 1 to 30

Parameters:
<State> **ON | 1**
The FSWX stops after measuring one range, and the status bit number 10 in the `STAT:OPER` register is set.
(See "STATus:OPERation register" on page 495.)
To continue with the next range, use `INITiate<n>:CONMeas` .

OFF | 0
The FSWX sweeps all ranges in one go.

*RST: 0

Example: `LIST:RANG2:BRE ON`

Manual operation: See "Stop After Sweep" on page 1079

[SENSe:]LIST:RANGe<ri>:COUNt?

Queries the number of ranges in the sweep list.

Suffix:
<ri> Range 1 to 30

Return values:
<Ranges> Number of ranges in the sweep list.

Example: `LIST:RANG:COUN?`

Usage: Query only

[SENSe:]LIST:RANGe<ri>:DELete

Removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:
<ri> 1 to 30
Range 1 to 30

Example: `LIST:RANG2:DEL`

Manual operation: See "Delete Range" on page 1080

[SENSe:]LIST:RANGe<ri>:DETector <Detector>

Selects the detector for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<Detector>

APEak
Autopeak

NEGative
minimum peak detector

POSitive
peak detector

SAMPle
sample detector

RMS
RMS detector

AVERage
average detector

*RST: RMS

Example: `LIST:RANG2:DET AVER`

Manual operation: See "Detector" on page 1077

[SENSe:]LIST:RANGe<ri>[:FREQuency]:STARt <Frequency>

Defines the start frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the FSWX will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the sweep list covers, the FSWX will adjust the start frequency of the first range and the stop frequency of the last range to the span

For more information see "Ranges and range settings" on page 1073 .

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<Frequency> Numeric value.

*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)
Default unit: Hz

Example: `LIST:RANG2:STAR 2MHZ`

Manual operation: See "Range Start/ Range Stop" on page 1076

[SENSe:]LIST:RANGe<ri>[:FREQuency]:STOP <Frequency>

Defines the stop frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the FSWX will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the sweep list covers, the FSWX will adjust the start frequency of the first range and the stop frequency of the last range to the span

For more information see "Ranges and range settings" on page 1073 .

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<Frequency> Numeric value.
*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
Default unit: Hz

Example: `LIST:RANG2:STOP 5MHZ`

Manual operation: See "Range Start/ Range Stop" on page 1076

[SENSe:]LIST:RANGe<ri>:FILTer:TYPE <FilterType>

Selects the filter type for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<FilterType> **NORMal**
Gaussian filters

CFILter
channel filters

RRC
RRC filters

P5
5 Pole filters

*RST: NORM
The available bandwidths of the filters are specified in the specifications document.

Example: `LIST:RANG2:FILT:TYPE NORM`

Manual operation: See "Filter Type" on page 1042
See "Filter Type" on page 1077

[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation <Attenuation>

Defines the input attenuation for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<Attenuation> Numeric value.
Refer to the specifications document for the attenuation range.
*RST: 10 dB
Default unit: dB

Example: `LIST:RANG2:INP:ATT 5`

[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation:AUTO <State>

Enables or disables automatic selection of the input attenuation for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `LIST:RANG2:INP:ATT:AUTO ON`

Manual operation: See "RF Att Mode" on page 1078

[SENSe:]LIST:RANGe<ri>:INPut:GAIN:STATe <State>

Prerequisite: optional preamplifier installed

Enables or disables 20 dB preamplification for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `LIST:RANG2:INP:GAIN:STAT ON`

Manual operation: See "Preamp" on page 1079

[SENSe:]LIST:RANGe<ri>:INPut:SANalyzer:ATTenuation <Attenuation>

Defines the input attenuation for a spurious emission measurement range.

If an external frontend is active (see `INP:SEL EFR`, see `INPut:SELect` on page 558), you can configure attenuation settings for the external frontend and the analyzer separately. This setting defines the attenuation for the analyzer.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<Attenuation> Numeric value.
Refer to the specifications document for the attenuation range.
*RST: 10 dB
Default unit: dB

Example:
```
LIST:RANG2:INP:SAN:ATT:AUTO OFF
LIST:RANG2:INP:SAN:ATT 5
```

Manual operation: See "SPA: RF Attenuation Mode / SPA: RF Attenuation" on page 1078

[SENSe:]LIST:RANGe<ri>:INPut:SANalyzer:ATTenuation:AUTO <State>

Turns automatic selection of the input attenuation for a spurious emission measurement range on and off.

If an external frontend is active (see `INP:SEL EFR`, see `INPut:SELect` on page 558), you can configure attenuation settings for the external frontend and the analyzer separately. This setting defines the attenuation for the analyzer.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
LIST:RANG2:INP:SAN:ATT:AUTO OFF
LIST:RANG2:INP:SAN:ATT 5
```

Manual operation: See "SPA: RF Attenuation Mode / SPA: RF Attenuation" on page 1078

[SENSe:]LIST:RANGe<ri>:LIMit:STARt <Level>

Defines an absolute limit for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<Level> Absolute limit at the start frequency of a SEM range.
Range: -400 to 400
*RST: 13
Default unit: dBm

Example: `LIST:RANG2:LIM:STAR 200`

Manual operation: See "Abs Limit Start / Abs Limit Stop" on page 1080

[SENSe:]LIST:RANGe<ri>:LIMit:STATe <State>

Enables or disables the limit check for all spurious emission measurement ranges.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `LIST:RANG2:LIM:STAT ON`

Manual operation: See "Limit Check" on page 1080

[SENSe:]LIST:RANGe<ri>:LIMit:STOP <Level>

Defines an absolute limit for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<Level> Absolute limit at the stop frequency of a SEM range.
Range: -400 to 400
*RST: 13
Default unit: dBm

Example: `LIST:RANG2:LIM:STOP 200`

Manual operation: See "Abs Limit Start / Abs Limit Stop" on page 1080

[SENSe:]LIST:RANGe<ri>:POINts[:VALue] <Points>

Defines the number of sweep points in a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<Points> For more information on sweep points see Section 4.3.3.8, "How much data is measured: sweep points and sweep count", on page 246.
*RST: 1001

Example: `LIST:RANG2:POIN 1000`

Manual operation: See "Sweep Points" on page 1079

[SENSe:]LIST:RANGe<ri>:RLEVel <RefLevel>

Defines the reference level for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<RefLevel> Reference level.
Refer to the specifications document for the reference level range.
*RST: 0 dBm
Default unit: dBm

Example: `LIST:RANG2:RLEV 1DBM`

[SENSe:]LIST:RANGe<ri>:SWEep:TIME <SweepTime>

Defines the sweep time for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<SweepTime> Sweep time.
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the specifications document for more information.

Example: `LIST:RANG2:SWE:TIME 2MS`

Manual operation: See "Sweep Time" on page 1077
See "Ref level" on page 1078

[SENSe:]LIST:RANGe<ri>:SWEep:TIME:AUTO <State>

Enables or disables automatic selection of the sweep time for a spurious emission measurement range.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `LIST:RANG2:SWE:TIME:AUTO ON`

Manual operation: See "Sweep Time Mode" on page 1077

[SENSe<ip>:]LIST:RANGe<ri>:SWEep:XFACtor <XCorrFactor>

Defines the number of sweep samples that are cross-correlated to determine a single sweep point if the "RMS X-Corr" detector is used.

Suffix:
<ip> Input

<ri> 1 to 30
Range 1 to 30

Parameters:
<XCorrFactor> integer

Example: `SENS:LIST:RANG:SWE:XFAC 3`

Manual operation: See "X-Corr Factor" on page 1043

[SENSe:]LIST:RANGe<ri>:TRANsducer <Transducer>

Selects a transducer factor for a spurious emission measurement range.

Note the following prerequisites for the selected transducer:

- The transducer must cover at least the span of the range.
- The x-axis has to be linear.
- The unit has to be dB.

Suffix:
<ri> 1 to 30
Range 1 to 30

Parameters:
<Transducer> String containing the transducer file name. Do not include a file extension or the file path.
The file must be located in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/trd` directory.

Example: `LIST:RANG2:TRAN 'MYTRANS'`

Manual operation: See "Transducer" on page 1079

Configuring the list evaluation

The following commands configure the list evaluation.

Useful commands for spurious emission measurements described elsewhere

- `MMEMory:STORe<n>:LIST` on page 803

Remote commands exclusive to spurious emission measurements

CALCulate<n>:PSEarch:AUTO 1369
CALCulate<n>:PEAKsearch:AUTO 1369
CALCulate<n>:ESPectrum:PSEarch:DETails 1369
CALCulate<n>:ESPectrum:PEAKsearch:DETails 1369
CALCulate<n>:PSEarch:MARGin 1370
CALCulate<n>:PEAKsearch:MARGin 1370
CALCulate<n>:PSEarch:PSHow 1370
CALCulate<n>:PEAKsearch:PSHow 1370
CALCulate<n>:PSEarch:SUBRanges 1370
CALCulate<n>:PEAKsearch:SUBRanges 1370

CALCulate<n>:PSEarch:AUTO <State>
CALCulate<n>:PEAKsearch:AUTO <State>

Enables or disables the list evaluation.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: //Deactivate the list evaluation.
`CALC:PSE:AUTO OFF`

Manual operation: See "Result Summary State" on page 1081

CALCulate<n>:ESPectrum:PSEarch:DETails <State>
CALCulate<n>:ESPectrum:PEAKsearch:DETails <State>

Configures how detailed the list in the Result Summary is.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 1 | 0

ON | 1
Includes all detected peaks (up to a maximum defined by CALCulate<n>:PEAKsearch:SUBRanges on page 1370).

OFF | 0
Includes only one peak per range.

*RST: 0

Example: //Include up to 10 peaks per range in the list.
```
CALC:ESP:PSE:DET ON
CALC:PSE:SUBR 10
```

Manual operation: See "Show Details" on page 1081

CALCulate<n>:PSEarch:MARGin <Threshold>
CALCulate<n>:PEAKsearch:MARGin <Margin>

Defines the threshold of the list evaluation.

Suffix:
<n> Window 1 to 16

Parameters:
<Margin> Range: -200 to 200
Default unit: dB

Example: //Set the threshold to 100 dB.
```
CALC:PSE:MARG 100
```

Manual operation: See "Margin" on page 1081

CALCulate<n>:PSEarch:PSHow <State>
CALCulate<n>:PEAKsearch:PSHow <State>

Enables or disables the peak labels in the diagram.

Peak labels are blue squares.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 1 | 0

*RST: 0

Example: //Mark all peaks with blue squares.
```
CALC:PSE:PSH ON
```

Manual operation: See "Show Peaks" on page 1081

CALCulate<n>:PSEarch:SUBRanges <NumberPeaks>
CALCulate<n>:PEAKsearch:SUBRanges <NumberPeaks>

Defines the number of peaks included in the peak list.

After this number of peaks has been found, the FSWX stops the peak search and continues the search in the next measurement range.

Suffix:
<n> Window 1 to 16

Parameters:
<NumberPeaks> Range: 1 to 50
*RST: 25

Example: //Set 10 peaks per range to be stored in the list.
`CALC:PSE:SUBR 10`

Manual operation: See "Peaks per Range" on page 1082

Adjusting the X-axis to the range definitions

[SENSe:]LIST:XADJust

Sets the x-axis range for the spurious emission measurement from the start frequency of the first sweep range to the stop frequency of the last sweep range.

Example: `SENS:LIST:XADJ`

Usage: Event

Performing a spurious measurement

The following commands are required to perform a Spurious measurement:

`SENS:SWE:MODE LIST`, see `[SENSe:]SWEep:MODE` on page 1322

`INITiate<n>[:IMMediate]` on page 647, see Section 5.5.1.1, "Performing RF measurements", on page 1230

Retrieving and saving settings and results

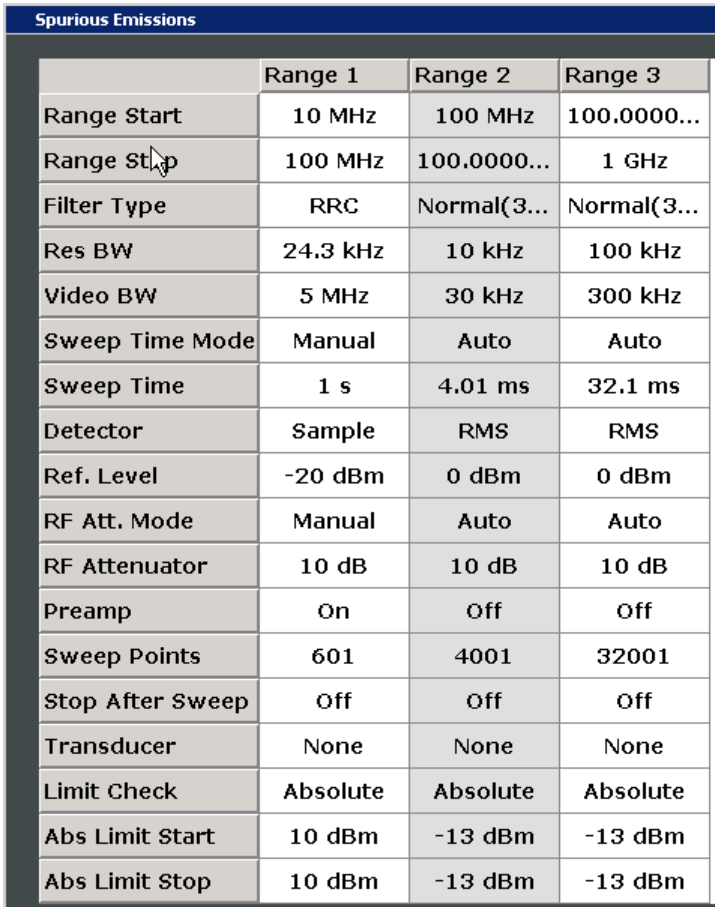
The following commands analyze and retrieve measurement results for Spurious measurements.

Useful commands for spurious emission measurements described elsewhere

- `CALCulate<n>:LIMit<li>:FAIL?` on page 775
- `TRACe<n>[:DATA]` on page 688
- `TRACe<n>[:DATA]:MEMory?` on page 689
- `TRACe<n>[:DATA]:X?` on page 690

Programming example: spurious emissions measurement

In the following example, the Spurious Emissions measurement is configured by defining ranges and parameters to create the following sweep list.



Spurious Emissions

	Range 1	Range 2	Range 3
Range Start	10 MHz	100 MHz	100.0000...
Range Stop	100 MHz	100.0000...	1 GHz
Filter Type	RRC	Normal(3...	Normal(3...
Res BW	24.3 kHz	10 kHz	100 kHz
Video BW	5 MHz	30 kHz	300 kHz
Sweep Time Mode	Manual	Auto	Auto
Sweep Time	1 s	4.01 ms	32.1 ms
Detector	Sample	RMS	RMS
Ref. Level	-20 dBm	0 dBm	0 dBm
RF Att. Mode	Manual	Auto	Auto
RF Attenuator	10 dB	10 dB	10 dB
Preamp	On	Off	Off
Sweep Points	601	4001	32001
Stop After Sweep	Off	Off	Off
Transducer	None	None	None
Limit Check	Absolute	Absolute	Absolute
Abs Limit Start	10 dBm	-13 dBm	-13 dBm
Abs Limit Stop	10 dBm	-13 dBm	-13 dBm

Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task.

```
//------------Preparing the measurement-------------
*RST
//Resets the instrument

SWE:MODE LIST
//Activates spurious emissions measurement

INIT:CONT OFF
//Selects single sweep mode.

//Spurious measurement has to be in single sweep mode to be configured
//and no sweep operation may be running!

// If required, a sweep stop can be ensured by INIT:IMM;*WAI

//---------------Configuring a Sweep List----------

LIST:RANG:COUNt?
//Returns the number of measurement ranges in the sweep list.
LIST:RANG4:DEL
```

```
//Deletes the fourth range.
LIST:RANG1:STAR 10000000
//Defines a start frequency of 10 MHz for range 1.
LIST:RANG1:STOP 100000000
//Defines a stop frequency of 100 MHz for range 1.
LIST:RANG1:BAND 500000
//Defines a resolution bandwidth of 500 kHz in range 1.
LIST:RANG1:BAND:VID 5000000
//Defines a video bandwidth of 5 MHz for range 1.
LIST:RANG1:INP:ATT:AUTO OFF
//Turns automatic selection of the input attenuation in range 1 off.

LIST:RANG1:INP:ATT 10
//Defines a input attenuation of 10 dBm for range 1.


LIST:RANG1:FILT:TYPE CFILter
//Selects an Channel filter for range 1.
LIST:RANG1:DET SAMP
//Selects a sample detector for range 1.
LIST:RANG1:POIN 601
//Defines 601 sweep points for range 1.
LIST:RANG1:RLEV -20
//Defines a reference level of -20 dBm for range 1.
LIST:RANG1:SWE:TIME 5
//Defines a manual sweep time of 5 second for range 1.

// Create a transducer that can be used.
// It has to cover the corresponding frequency range
//
SENSe1:CORRection:TRANsducer:SELect 'Test'
SENSe1:CORRection:TRANsducer:UNIT 'DB'
SENSe1:CORRection:TRANsducer:COMMent 'Test Transducer'
// Frequency Span 0 MHz to 20 Ghz
SENSe1:CORRection:TRANsducer:DATA 0e6,5, 20e9,3

SENS:LIST:RANG1:TRAN 'Test'
//Includes a transducer called 'Test' for range 1.

LIST:RANG1:LIM:STAR 10
LIST:RANG1:LIM:STOP 10
//Defines an absolute limit of 10 dBm at the start and stop frequencies of range 1.
LIST:RANG:LIM:STAT ON
//Turns the limit check for all ranges on.

//---------------Configuring the List Evaluation----------
CALC:PSE:MARG 100
//Sets the threshold to 100 dB.
CALC:PSE:PSH ON
//Marks all peaks in the diagram with blue squares.
```

```
CALC:PSE:SUBR 10
//Sets 10 peaks per range to be stored in the list.

//--------------Performing the Measurement-----

INIT:SPUR; *WAI
//Performs a spurious emission measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:LIM1:FAIL?
//Queries the result of the check for limit line 1.
TRAC? SPUR
//Queries the peak list of the spurious emission measurement.
```

5.5.1.9 Analyzing statistics (APD, CCDF)

All remote control commands specific to statistical measurements are described here.

- Activating statistical measurements....1374
- Configuring statistical measurements....1375
- Using gate ranges for statistical measurements....1376
- Scaling the diagram....1378
- Performing a statistical measurement....1381
- Retrieving results....1381
- Programming example: measuring statistics....1383

Activating statistical measurements

The following commands activate statistical measurements.

CALCulate<n>:STATistics:APD[:STATe]....1374
CALCulate<n>:STATistics:CCDF[:STATe]....1374

CALCulate<n>:STATistics:APD[:STATe] <State>

Enables or disables the APD measurement.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: //Switch on the APD measurement.
`CALC:STAT:APD ON`

CALCulate<n>:STATistics:CCDF[:STATe] <State>

Enables or disables the "CCDF".

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: //Switch on the "CCDF" measurement.
`CALC:STAT:CCDF ON`

Configuring statistical measurements

The following commands configure the measurement.

Useful commands for configuring statistical measurements described elsewhere:

- `[SENSe<ip>:]BANDwidth[:RESolution]` on page 1420
- `INPut<ip>:RLEVel` on page 614
  (Make sure the specified reference level is higher than the measured peak value, see `CALCulate<n>:MARKer<m>:Y?` on page 718).

Remote commands exclusive to statistical measurements:

CALCulate<n>:MARKer<m>:Y:PERCent 1375
CALCulate<n>:STATistics:NSAMples 1375
DISPlay[:WINDow<n>]:STATistics:CCDF:GAUSs 1376

CALCulate<n>:MARKer<m>:Y:PERCent <Probability>

Sets a marker to a particular probability value. You can query the corresponding level with `CALCulate<n>:MARKer<m>:X`.

Using the command turns delta markers into normal markers.

Is available for CCDF measurements.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Probability> Range: 0 % to 100 %
Default unit: %

Example: //Position the marker 1 to a probability of 95 %.
`CALC1:MARK:Y:PERC 95PCT`

Manual operation: See "Percent Marker (CCDF only)" on page 1015

CALCulate<n>:STATistics:NSAMples <Samples>

Defines the number of samples included in the analysis of statistical measurement functions.

Suffix:
<n> Window 1 to 16

Parameters:
<Samples> Range: Min: 100, Max: depends on the RBW filter
*RST: 100000

Example: //Set the number of measurement points to be acquired to 500.
`CALC:STAT:NSAM 500`

Manual operation: See "Number of Samples" on page 1016

DISPlay[:WINDow<n>]:STATistics:CCDF:GAUSs <State>

Enables or disables the red trace in the CCDF display indicating the normal distribution.

Suffix:
<n> Window 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 1

Example: `DISP:WIND:STAT:CCDF:GAUS OFF`

Manual operation: See "Normal Distribution (CCDF only)" on page 1016

Using gate ranges for statistical measurements

The following commands control gated statistical measurements.

[SENSe:]SWEep:EGATe:TRACe<t>:COMMent 1376
[SENSe:]SWEep:EGATe:TRACe<t>:PERiod 1377
[SENSe:]SWEep:EGATe:TRACe<t>:STARt<gr> 1377
[SENSe:]SWEep:EGATe:TRACe<t>[:STATe<gr>] 1377
[SENSe:]SWEep:EGATe:TRACe<t>:STOP<gr> 1378

[SENSe:]SWEep:EGATe:TRACe<t>:COMMent <Comment>

Defines a comment for the gate of a particular trace.

Suffix:
<t> Trace 1 to 6

Parameters:
<Comment> String containing the comment.

Example: //Define a comment for the gate in trace 1.
`SWE:EGAT:TRAC1:COMM 'MyComment'`

Manual operation: See "Comment" on page 1017

[SENSe:]SWEep:EGATe:TRACe<t>:PERiod <Length>

Defines the length of the gate for all traces.

The gate length applies to all traces.

Suffix:
<t> Trace 1 to 6

Parameters:
<Length> Range: 100 ns to 1000 s
*RST: 2 ms
Default unit: s

Example: //Define the period for gated triggering to 5 ms.
`SWE:EGAT:TRAC:PER 5ms`

Manual operation: See "Period" on page 1017

[SENSe:]SWEep:EGATe:TRACe<t>:STARt<gr> <Time>

Defines the start time for a gate range.

Suffix:
<t> Trace 1 to 6

<gr> 1 to 5
gate range

Parameters:
<Time> The value range depends on the gate period you have set for the selected trace with `[SENSe:]SWEep:EGATe:TRACe<t>:PERiod`. The following rules apply:
• the start time may not be higher than the length of the gate
• the start time may not be lower than the stop time of the gate range of a lower order
The reset values depend on the gate range.
• for gate range 1, the start time is 0 ms
• for gate range 3, the start time is 2 ms
• for gate range 5, the start time is 4 ms
Default unit: s

Example: //Set the Starting point for range 1 on trace 1 at 3 ms.
`SWE:EGAT:TRAC1:STAR1 3ms`

Manual operation: See "Range <n> Start / Range <n> Stop" on page 1018

[SENSe:]SWEep:EGATe:TRACe<t>[:STATe<gr>] <State>

Includes or excludes a gate range for a particular trace.

Suffix:
<t> Trace 1 to 6

<gr> gate range

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: //Activate gate range 1 for trace 1.
`SWE:EGAT:TRAC1:STAT1 ON`

Manual operation: See "Range <n> Use" on page 1018

[SENSe:]SWEep:EGATe:TRACe<t>:STOP<gr> <Time>

Defines the stop time for a gate range.

Suffix:
<t> Trace 1 to 6

<gr> 1 to 5
gate range

Parameters:
<Time> The value range depends on the gate period you have set for the selected trace with `[SENSe:]SWEep:EGATe:TRACe<t>:PERiod`. The following rules apply:
• the stop time may not be higher than the length of the gate
• the stop time may not be lower than the start time
The reset values depend on the gate range.
• for gate range 1, the stop time is 1 ms
• for gate range 3, the stop time is 3 ms
• for gate range 5, the stop time is 5 ms

Default unit: s

Example: //Set the stopping point for range 1 on trace 1 at 5 ms.
`SWE:EGAT:TRAC1:STOP1 5ms`

Manual operation: See "Range <n> Start / Range <n> Stop" on page 1018

Scaling the diagram

The following commands set up the diagram for statistical measurements.

CALCulate<n>:STATistics:PRESet 1379
CALCulate<n>:STATistics:SCALe:AUTO ONCE 1379
CALCulate<n>:STATistics:SCALe:X:RANGe 1379
CALCulate<n>:STATistics:SCALe:X:RLEVel 1380

CALCulate<n>:STATistics:SCALe:Y:LOWer 1380
CALCulate<n>:STATistics:SCALe:Y:UNIT 1380
CALCulate<n>:STATistics:SCALe:Y:UPPer 1381

CALCulate<n>:STATistics:PRESet

Resets the scale of the diagram (x- and y-axis).

- Reference level (x-axis)
  0.0 dBm
- Display range (x-axis) for APD measurements
  100 dB
- Display range (x-axis) for CCDF measurements
  20 dB
- Upper limit of the y-axis
  1.0
- Lower limit of the y-axis
  1E-6

Suffix:
<n> Window 1 to 16

Example: //Reset the scaling for statistical functions
`CALC:STAT:PRES`

Manual operation: See "Default Settings" on page 1020

CALCulate<n>:STATistics:SCALe:AUTO ONCE

Initiates an automatic scaling of the diagram (x- and y-axis).

To obtain maximum resolution, the level range is set as a function of the measured spacing between peak power and the minimum power for the APD measurement and of the spacing between peak power and mean power for the CCDF measurement. In addition, the probability scale for the number of test points is adapted.

To get a valid result, you have to synchronize to the end of the auto range process in a complete sweep. This is only possible in single sweep mode.

Note this command is not available when using an external frontend.

Suffix:
<n> Window 1 to 16

Manual operation: See "Adjust Settings" on page 1016
See "Adjust Settings" on page 1021

CALCulate<n>:STATistics:SCALe:X:RANGe <Range>

Defines the display range of the x-axis for statistical measurements.

The effects are identical to `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]`.

Suffix:
<n> Window 1 to 16

Parameters:
<Range> Range: 1 dB to 200 dB
*RST: 100 dB
Default unit: dB

Example: `CALC:STAT:SCAL:X:RANG 20dB`

Manual operation: See "Range" on page 1019

CALCulate<n>:STATistics:SCALe:X:RLEVel <RefLevel>

Sets the reference level for statistical measurements. The effects are identical to `INPut<ip>:RLEVel` on page 614.

Note that in case of statistical measurements the reference level applies to the x-axis.

Suffix:
<n> Window 1 to 16

Parameters:
<RefLevel> The unit is variable.
If a reference level offset is included, the range is adjusted by that offset.
Range: -130 dBm to 30 dBm
*RST: 0 dBm
Default unit: dBm

Example: `CALC:STAT:SCAL:X:RLEV -60dBm`

Manual operation: See "Ref Level" on page 1020

CALCulate<n>:STATistics:SCALe:Y:LOWer <Magnitude>

Defines the lower vertical limit of the diagram.

Suffix:
<n> Window 1 to 16

Parameters:
<Magnitude> The number is a statistical value and therefore dimensionless.
Range: 1E-9 to 0.1
*RST: 1E-6

Example: `CALC:STAT:SCAL:Y:LOW 0.001`

Manual operation: See "Y-Max / Y-Min" on page 1020

CALCulate<n>:STATistics:SCALe:Y:UNIT <Unit>

Selects the unit of the y-axis.

Suffix:
<n> Window 1 to 16

Parameters:
<Unit> PCT | ABS
*RST: ABS

Example: //Set the percentage scale.
`CALC:STAT:SCAL:Y:UNIT PCT`

Manual operation: See "Y-Unit" on page 1020

CALCulate<n>:STATistics:SCALe:Y:UPPer <Magnitude>

Defines the upper vertical limit of the diagram.

Suffix:
<n> Window 1 to 16

Parameters:
<Magnitude> The number is a statistical value and therefore dimensionless.
Range: 1E-5 to 1.0
*RST: 1.0

Example: `CALC:STAT:SCAL:Y:UPP 0.01`

Manual operation: See "Y-Max / Y-Min" on page 1020

Performing a statistical measurement

The following commands are required to perform a statistical measurement:

`INITiate<n>[:IMMediate]` on page 647, see Section 5.5.1.1, "Performing RF measurements", on page 1230

Retrieving results

The following commands are required to retrieve the measurement results.

Useful commands for retrieving results described elsewhere:

- `CALCulate<n>:MARKer<m>:X` on page 703

Remote commands exclusive to statistical results

CALCulate<n>:STATistics:CCDF:X<t>?.....1381
CALCulate<n>:STATistics:RESult<res>?.....1382

CALCulate<n>:STATistics:CCDF:X<t>? <Probability>

Queries the results of the CCDF.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Query parameters:

<Probability> P0_01 | P0_1 | P1 | P10

P0_01
Level value for 0.01 % probability

P0_1
Level value for 0.1 % probability

P1
P1: Level value for 1 % probability

P10
Level value for 10 % probability

Return values:

<CCDF Result>

Example: //Return the level values that are over 10 % above the mean value.

```
CALC:STAT:CCDF:X1? P10
```

Usage: Query only

CALCulate<n>:STATistics:RESult<res>? <ResultType>

Queries the results of a measurement for a specific trace.

Suffix:

<n> Window 1 to 16

<res> Trace 1 to 6

Query parameters:

<ResultType> MEAN | PEAK | CFACtor | ALL

MEAN
Average (=RMS) power in dBm measured during the measurement time.

PEAK
Peak power in dBm measured during the measurement time.

CFACtor
Determined crest factor (= ratio of peak power to average power) in dB.

ALL
Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

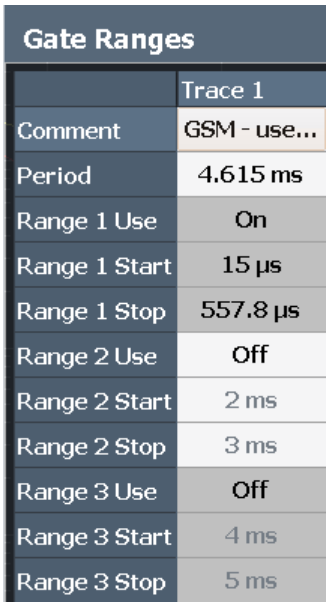
Example: //Read out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69 i.e. mean power: 5.56 dBm, peak power 19.25 dBm, crest factor 13.69 dB

```
CALC:STAT:RES2? ALL
```

Usage: Query only

Programming example: measuring statistics

This example demonstrates how to determine statistical values for a measurement in a remote environment using the gated statistics example described in "Configuration example: Gated statistics" on page 1022.




```
//-----------Configuring the measurement ------------
*RST
//Reset the instrument
TRIG:SOUR EXT
//Defines the use of an external trigger.
TRIG:HOLD 25us
//Defines a trigger offset of 25 µs.
CALC:STAT:APD ON
//Activates APD measurement.
CALC:STAT:NSAM 1000
//Sets the number of samples to be included in the statistical evaluation to 1000.

//-------------Defining Gate ranges -----------------

SWE:EGAT:TRAC1:COMM 'GSM - useful part'
//Defines a comment for the gate
SWE:EGAT:TRAC1:PER 4.61536ms
//Sets the gate period to 4.61536ms.
SWE:EGAT:TRAC1:STAR1 15us
//Sets the start of range 1 to 15 µs.
SWE:EGAT:TRAC1:STOP1 557.8us
//Sets the end of range 1 to 15 µs (start time) + 542.77 µs (useful part) = 557.8 µs.
SWE:EGAT:TRAC1:STAT1 ON
//Activates the use of range 1.

//--------------Performing the Measurement-----
```

```
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results-------------
CALC:STAT:RES1? MEAN
//Returns the mean average power for the useful part of the GSM signal.

//------------- Determining the CCDF values-------------------

CALC:STAT:CCDF ON
//Activates CCDF measurement.
CALC:MARK2:Y:PERC 95PCT
//Sets marker 2 to the 95% probability value.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
CALC:STAT:CCDF:X? P1
//Returns the level value for 10% probability for the CCDF.
CALC:MARK2:X?
//Returns the level for a probability of 95%.


//----------- Scaling the diagram -------------------------
CALC:STAT:SCAL:X:RLEV -70dBm
//Sets the reference level to -70 dBm (x-axis!)
CALC:STAT:SCAL:X:RANG 20dB
//Defines a power level range of 20 dB for the x-axis
CALC:STAT:SCAL:Y:LOW 0.0001
//Sets the minimum of the y-axis to 0.01% probability
CALC:STAT:SCAL:Y:UPP 1.0
//Sets the maximum of the y-axis to 100% probability
CALC:STAT:SCAL:Y:UNIT PCT
//Displays percentage values on y-axis scale
```

5.5.1.10 Measuring the time domain power

All remote control commands specific to time domain power measurements are described here.

- Configuring the measurement....1384
- Performing a time domain power measurement....1388
- Retrieving measurement results....1388
- Programming example: time domain power....1393

Configuring the measurement

The following remote commands measure the time domain power.

Useful commands for time domain power measurements described elsewhere

- CALCulate<n>:MARKer<m>:X:SLIMits:LEFT
- CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt
- CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]

Remote commands exclusive to time domain power measurements

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AOFF 1385
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage 1385
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd 1386
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary[:STATe] 1386
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe] 1386
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe] 1387
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe] 1387
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation[:STATe] 1387

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AOFF

Turns all time domain power evaluation modes off.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage <State>

Enables or disables averaging for the active power measurement in zero span in the window specified by the suffix <n>. If activated, a time domain value is calculated from the trace after each sweep; in the end, all values are averaged to calculate the final result.

The number of results required for the calculation of average is defined with [SENSe<ip>:]AVERage<n>:COUNt.

Averaging is reset by switching it off and on again.

Synchronization to the end of averaging is only possible in single sweep mode.

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

Example: //Switch to single sweep mode.
```
INIT:CONT OFF
```
//Switch on the calculation of average.
```
CALC:MARK:FUNC:SUMM:AVER ON
```
//Set the measurement counter to 200.
```
AVER:COUN 200
```
//Start a sweep and waits for the end.
```
INIT;*WAI
```

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd <State>

Enables or disables the peak-hold function for the active power measurement in zero span in the window specified by the suffix <n>. If activated, the peak for each sweep is compared to the previously stored peak; the maximum of the two is stored as the current peak.

The peak-hold function is reset by switching it off and on again.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary[:STATe] <State>

Prerequisite: zero span

Enables or disables time domain power measurements.

When you turn the measurement on, the FSWX activates a marker and positions it on the peak power level in the marker search range.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example:
```
CALC:MARK:FUNC:SUMM:STAT OFF
```

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN[:STATe] <State>

Enables or disables the evaluation to determine the mean time domain power.

The FSWX performs the measurement on the trace marker 1 is positioned on.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `CALC:MARK:FUNC:SUMM:MEAN:STAT OFF`

Manual operation: See "Results" on page 1144

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak[:STATe] <State>

Enables or disables the evaluation to determine the positive peak time domain power.

The FSWX performs the measurement on the trace marker 1 is positioned on.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `CALC:MARK:FUNC:SUMM:PPE:STAT OFF`

Manual operation: See "Results" on page 1144

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS[:STATe] <State>

Enables or disables the evaluation to determine the RMS time domain power.

The FSWX performs the measurement on the trace marker 1 is positioned on.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `CALC:MARK:FUNC:SUMM:RMS:STAT OFF`

Manual operation: See "Results" on page 1144

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation[:STATe] <State>

Enables or disables the evaluation to determine the standard deviation of the time domain power.

The FSWX performs the measurement on the trace marker 1 is positioned on.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `CALC:MARK:FUNC:SUMM:SDEV:STAT OFF`

Performing a time domain power measurement

The following commands are required to perform a Time Domain Power measurement:

`INITiate<n>[:IMMediate]` on page 647

See Section 5.5.1.1, "Performing RF measurements", on page 1230

Retrieving measurement results

The following commands query the results for time domain measurements.

Measuring the mean power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:AVERage:RESult? 1388
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:PHOLd:RESult? 1389
CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult? 1389

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:AVERage:RESult?

Queries the average mean time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 1385.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646 .

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:PHOLd:RESult?

Queries the maximum mean time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:MEAN:RESult?

Queries the mean time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<MeanPower> Mean power of the signal during the measurement time.

Example: `CALC:MARK:FUNC:SUMM:MEAN:RES?`

Usage: Query only

Manual operation: See "Results" on page 1144

Measuring the peak power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:AVERage:RESult?

Queries the average positive peak time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 1385.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also INITiate<n>:CONTinuous on page 646 .

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:PHOLd:RESult?

Queries the maximum positive peak time domain power. The query is only possible if the peak hold function has been activated previously using CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See alsoINITiate<n>:CONTinuous on page 646 .

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PPEak:RESult?

Queries the positive peak time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also INITiate<n>:CONTinuous on page 646.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<PeakPower> Peak power of the signal during the measurement time.

Example: CALC:MARK:FUNC:SUMM:PPE:RES?

Usage: Query only

Manual operation: See "Results" on page 1144

Measuring the RMS power

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:AVERage:RESult?

Queries the average RMS of the time domain power. The query is only possible if averaging has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage` on page 1385.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646 .

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Return values:

<RMSPower> RMS power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:PHOLd:RESult?

Queries the maximum RMS of the time domain power. The query is only possible if the peak hold function has been activated previously using `CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd`.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646 .

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Return values:

<RMSPower> RMS power of the signal during the measurement time.

Example: `CALC:MARK:FUNC:SUMM:RMS:PHOL:RES?`

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:RMS:RESult?

Queries the RMS of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<RMSPower> RMS power of the signal during the measurement time.

Example: CALC:MARK:FUNC:SUMM:RMS:RES?

Usage: Query only

Manual operation: See "Results" on page 1144

Measuring the standard deviation

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:AVERage:RESult?

Queries the average standard deviation of the time domain power. The query is only possible if averaging has been activated previously using CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage on page 1385.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See alsoINITiate<n>:CONTinuous on page 646.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<StandardDeviation> Standard deviation of the signal during the measurement time.

Example: CALC:MARK:FUNC:SUMM:SDEV:AVER:RES?

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:PHOLd:RESult?

Queries the maximum standard deviation of the time domain power. The query is only possible if the peak hold function has been activated previously using CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also INITiate<n>:CONTinuous on page 646 .

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<StandardDeviation> Standard deviation of the signal during the measurement time.

Example: `CALC:MARK:FUNC:SUMM:SDEV:PHOL:RES?`

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:SDEViation:RESult?

Queries the standard deviation of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 646.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<StandardDeviation> Standard deviation of the signal during the measurement time.

Example: `CALC:MARK:FUNC:SUMM:SDEV:RES?`

Usage: Query only

Programming example: time domain power

This programming example demonstrates the measurement example described in Section 5.3.8.6, "Measurement example", on page 1145 in a remote environment.

```
//-------------Configuring the Measurement----------------------
*RST
//Resets the instrument

INIT:CONT OFF
//Turns on single sweep mode.

FREQ:CENT 1.8GHz
//Sets the center frequency to 1.8 GHz.

BAND:RES 100kHz
//Sets the bandwidth to 100 kHz.

SWE:TIME 10ms
//Sets the sweep time to 640 µs.

FREQ:SPAN 0
//Sets the instrument to zero span.
```

```
CALC:MARK:FUNC:SUMM:STAT ON
//Turns on time domain power measurements.

CALC:MARK:FUNC:SUMM:MEAN ON
CALC:MARK:FUNC:SUMM:PPE ON
CALC:MARK:FUNC:SUMM:RMS ON
//Turns the evalution of the mean, peak and RMS time domain power.

CALC:MARK:X:SLIM ON
//Activates limit lines for evaluation.

CALC:MARK:X:SLIM:LEFT 1ms
//Sets the left limit line to 326 µs.

CALC:MARK:X:SLIM:RIGH 6ms
//Sets the right limit line to 538 µs.

//--------------Performing the Measurement-----------------------

INIT;*WAI
//Initiates the measurement and waits until the measurement is finished.

//-------------Retrieving the Results-------------------------------
CALC:MARK:FUNC:SUMM:MEAN:RES?
CALC:MARK:FUNC:SUMM:PPE:RES?
CALC:MARK:FUNC:SUMM:RMS:RES?
//Queries the mean, peak and RMS time domain power.
```

5.5.1.11 Measuring the harmonic distortion

All remote control commands specific to harmonic distortion measurements are described here.

- Activating the measurement....1394
- Configuring the measurement....1395
- Performing the measurement....1396
- Retrieving results....1396
- Example: measuring the harmonic distortion....1397

Activating the measurement

The following command activates harmonic distortion measurement.

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics[:STATe]....1394

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics[:STATe] <State>

Enables or disables the harmonic distortion measurement.

Note the following:

- If you perform the measurement in the frequency domain, the search range for the frequency of the first harmonic, whose power is determined, is defined by the last span.
- If you perform the measurement in the time domain, the current center frequency is used as the frequency of the first harmonic. Thus, the frequency search is bypassed. The first harmonic frequency is set by a specific center frequency in zero span before the harmonic measurement is started.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 1 | 0

*RST: 0

Example: //Activate the harmonic distortion measurement.
`CALC:MARK:FUNC:HARM ON`

Configuring the measurement

The following commands control the harmonic distortion measurement.

Useful commands for harmonic distortion measurements described elsewhere

- `CALCulate<n>:MARKer<m>:FUNCtion:CENTer` on page 1413
- `[SENSe:]SWEep:TIME:AUTO` on page 1427

Remote commands exclusive to harmonic distortion measurements

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO 1395
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics 1396
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet 1396

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO <State>

Selects the resolution bandwidth of the harmonic in respect to the bandwidth of the first harmonic.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
identical

ON | 1
a multiple

*RST: 1

Example: CALC:MARK:FUNC:HARM:BAND:AUTO OFF

Manual operation: See "Harmonic RBW Auto" on page 1151

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics <NoHarmonics>

Selects the number of harmonics that the FSWX looks for.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<NoHarmonics> Range: 1 to 26
*RST: 10

Example: CALC:MARK:FUNC:HARM:NHAR 20

Manual operation: See "Number of Harmonics" on page 1151

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet

Initiates a measurement to determine the ideal configuration for the harmonic distortion measurement.

The method depends on the span.

- Frequency domain (span > 0)
  Frequency and level of the first harmonic are determined and used for the measurement list.
- Time domain (span = 0)
  The level of the first harmonic is determined. The frequency remains unchanged.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: CALC:MARK:FUNC:HARM:PRES

Manual operation: See "Adjust Settings" on page 1152

Performing the measurement

The following commands are required to perform a harmonic distortion measurement:

INITiate<n>[:IMMediate] on page 647, see Section 5.5.1.1, "Performing RF measurements", on page 1230

Retrieving results

The following commands retrieve the results of the harmonic distortion measurement.

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion? 1397
CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST 1397

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:DISTortion? [<Result>]

Queries the total harmonic distortion of the signal.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also INITiate<n>:CONTinuous on page 646.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Query parameters:
<Result> TOTal

Return values:
<DistortionPct>

<DistortionDb>

Example: CALC:MARK:FUNC:HARM:DIST? TOT

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST

Queries the position of the harmonics.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also INITiate<n>:CONTinuous on page 646 .

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<Harmonics> Returns one value for every harmonic.
The first value is the absolute power of the first harmonic. The unit is variable.
The other values are power levels relative to the first harmonic. The unit for these is dB.

Example: CALC:MARK:FUNC:HARM:LIST?

Example: measuring the harmonic distortion

```
//-------------Configuring the Measurement-------------
*RST
//Resets the instrument.
```

```
INIT:CONT OFF
//Turns on single sweep mode.

CALC:MARK:FUNC:HARM ON
//Turns on the harmonic distortion measurement.
CALC:MARK:FUNC:HARM:NHAR 3
//Defines three harmonics to be found.

CALC:MARK:FUNC:HARM:BAND:AUTO OFF
//Turns off automatic bandwidth selection.
CALC:MARK:FUNC:HARM:PRES
//Determines the ideal configuration.

//-------------Performing the Measurement-------------------

INIT;*WAI
//Initiates the measurement and finishes the sweep.

//-------------Retrieving the Results------------------------
CALC:MARK:FUNC:HARM:LIST?
//Queries the position of the harmonics.
CALC:MARK:FUNC:HARM:DIST? TOT
//Queries the total harmonic distortion.
```

5.5.1.12 Measuring the third order intercept point

- Determining the TOI 1398
- Programming example: measuring the TOI 1401

Determining the TOI

All remote control commands specific to TOI measurements are described here.

Useful commands for TOI measurements described elsewhere

- `CALCulate<n>:DELTamarker<m>:X` on page 700
- `CALCulate<n>:DELTamarker<m>:X:RELative?` on page 701
- `CALCulate<n>:DELTamarker<m>:Y` on page 718
- `CALCulate<n>:MARKer<m>:X` on page 703
- `CALCulate<n>:DELTamarker<m>:Y` on page 718

Remote commands exclusive to TOI measurements

CALCulate<n>:MARKer<m>:FUNCtion:TOI[:STATe] 1399
CALCulate<n>:MARKer<m>:FUNCtion:TOI:SEARchsignal ONCE 1399
CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult? 1399
CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult:MAXimum? 1400
CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult:MINimum? 1400

CALCulate<n>:MARKer<m>:FUNCtion:TOI[:STATe] <State>

Initiates a measurement to determine the third intercept point.

A two-tone signal with equal carrier levels is expected at the RF input of the instrument. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Delta marker 3 and delta marker 4 are positioned to the intermodulation products. The delta markers can be modified separately afterwards with the `CALCulate<n>:DELTamarker<m>:X` command.

The third-order intercept is calculated from the level spacing between the normal markers and the delta markers.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 1 | 0

*RST: 0

Example: //Switch on the measurement of the third-order intercept.
`CALC:MARK:FUNC:TOI ON`

CALCulate<n>:MARKer<m>:FUNCtion:TOI:SEARchsignal ONCE

Initiates a search for signals in the current trace to determine the third intercept point.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:FUNC:TOI:SEAR ONCE`

Manual operation: See "Search Signals" on page 1160

CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult?

Queries the results for the third order intercept point measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<TOI> Third order intercept point.

Example: //Switch to single sweep mode.
```
INIT:CONT OFF
```
//Switch the intercept measurement.
```
CALC:MARK:FUNC:TOI ON
```
//Start a sweep and waits for the end.
```
INIT;*WAI
```
//Output the measured value.
```
CALC:MARK:FUNC:TOI:RES?
```

Usage: Query only

Manual operation: See "TOI" on page 1159

CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult:MAXimum?

Queries the results for the maximum third order intercept point measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:
<TOI> Maximum third order intercept point.

Example: //Switch to single sweep mode.
```
INIT:CONT OFF
```
//Switch the intercept measurement.
```
CALC:MARK:FUNC:TOI ON
```
//Start a sweep and waits for the end.
```
INIT;*WAI
```
//Return the maximum TOI.
```
CALC:MARK:FUNC:TOI:RES:MAX?
```

Usage: Query only

Manual operation: See "TOI (max)" on page 1159

CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult:MINimum?

Queries the results for the minimum third order intercept point measurement .

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Return values:

<TOI> Minimum third order intercept point.

Example:

```
//Switch to single sweep mode.
INIT:CONT OFF
//Switch the intercept measurement.
CALC:MARK:FUNC:TOI ON
//Start a sweep and waits for the end.
INIT;*WAI
//Return the minimum TOI.
CALC:MARK:FUNC:TOI:RES:MIN?
```

Usage: Query only

Manual operation: See "TOI (min)" on page 1159

Programming example: measuring the TOI

This example demonstrates how to determine the TOI in a remote environment.

```
//----------Configuring the measurement ------------
*RST
//Reset the instrument
CALC:MARK:FUNC:TOI ON
//Activate TOI measurement.

//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.

CALC:MARK:FUNC:TOI:SEAR ONCE
//Initiates a search for signals in the current trace.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:TOI:RES?
//Returns the TOI.
```

5.5.1.13 Measuring the AM modulation depth

All remote control commands specific to AM modulation depth measurements are described here.

- Configuring and performing the measurement.....1401
- Example: measuring the AM modulation depth..... 1403

Configuring and performing the measurement

The following commands control the measurement.

Useful commands for AM modulation depth described elsewhere

- `CALCulate<n>:DELTamarker<m>:X` on page 700

- CALCulate<n>:DELTamarker<m>:X:RELative? on page 701
- CALCulate<n>:MARKer<m>:X on page 703

Remote commands exclusive to AM modulation depth measurements

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth[:STATe] 1402
CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARchsignal ONCE 1402
CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult<t>? 1402

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth[:STATe] <State>

Prerequisite: AM modulated signal

Enables or disables the "AM Modulation Depth" measurement.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: CALC:MARK:FUNC:MDEP:STAT

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARchsignal ONCE

Initiates a search for the signals required for the AM depth measurement.

Note that the command does not perform a new measurement, but looks for the signals on the current trace.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: //Execute the search of an AM modulated signal at the currently available trace.
CALC:MARK:FUNC:MDEP:SEAR ONCE

Manual operation: See "Search Signals" on page 1165

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:RESult<t>?

Queries the results of the AM modulation depth measurement..

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also INITiate<n>:CONTinuous on page 646.

Suffix:

<n>	Window 1 to 16
<m>	Marker 1 to 16
<t>	Trace 1 to 6

Return values:

<ModulationDepth>	Modulation depth in %.
Example:	`CALC:MARK:FUNC:MDEP:RES?`
Usage:	Query only

Example: measuring the AM modulation depth

This example demonstrates how to determine the AM modulation depth in a remote environment. Note that without a real input signal this measurement will not return useful results.

```
//-----------Configuring the measurement ------------
*RST
//Reset the instrument
FREQ:CENT 100MHz
//Set center frequency
FREQ:SPAN 10KHz
// Set span
CALC:MARK:FUNC:MDEP ON
//Activate AM modulation depth measurement.

//--------------Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT:IMM
// Perform a single measurement
CALC:MARK:FUNC:MDEP:SEAR ONCE
//Initiates a search for signals in the current trace.

//---------------Retrieving Results-------------
CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results.

//If the results are not accurate, change the position of the
//the temporary markers manually.

//----Changing the position of the temp markers-----
CALC:MARK:X 100MHZ
//Positions the reference marker on 100 MHz.
CALC:DELT2:X 5KHZ
//Positions delta marker 2 and 3 at a distance of 5 kHz to the reference marker.
CALC:DELT3:X 1KHZ
//Corrects the position of delta marker 3 by 1 kHz.
```

```
CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results for the repositioned markers.
```

5.5.1.14 List evaluations

A list evaluation is a multiple power measurement that measures the power at up to 200 frequencies. The measurement itself is a time domain measurement. Note that if you set a span greater than 0, the FSWX aborts the list evaluation.

Noise cancellation in list evaluations

Noise cancellation is also available in zero span and thus also for list evaluations. See "Noise Cancellation" on page 184 for details.

List evaluations allow for a different instrument setup for each frequency you want to measure. You can define most of the settings with the commands described here. Settings not covered by the commands listed below can be controlled with the common commands (see Section 5.5.2, "Spectrum analysis commands", on page 1413. Note that these commands have to be sent prior to the commands that control the list evaluation.

In case of a triggered measurement, a separate trigger event is required for each frequency to initiate that measurement. Note that you have to make changes to the trigger level in the time domain in order for it to take effect for the List Evaluation commands.

The list evaluation is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the FSWX aborts the list evaluation.

The FSWX also aborts the list evaluation if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. This method causes the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.
- Instrument setup and querying of the result list at the end of the measurement: With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

Performing list evaluations

All remote control commands specific to list evaluations (which are available via remote control only) are described here.

Useful commands for list evaluation described elsewhere:

- `[SENSe:]POWer:NCORrection` on page 614

Remote commands exclusive to list evaluation

[SENSe:]LIST:POWer:RESult? 1405
[SENSe:]LIST:POWer[:SEQuence] 1405
[SENSe:]LIST:POWer:SET 1406
[SENSe:]LIST:POWer:STATe 1407

[SENSe:]LIST:POWer:RESult?

Queries the results of the list evaluation.

May be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:

<PowerLevel> Power level for each frequency included in the measurement.
The command returns up to 3 power levels for each frequency, depending on the number of evaluation modes you have turned on with `[SENSe:]LIST:POWer:SET`.
The result is a list of floating point values separated by commas.
The unit depends on `CALCulate<n>:UNIT:POWer`.

Example: `SENS:LIST:POW:RES?`

Usage: Query only

[SENSe:]LIST:POWer[:SEQuence] {<Frequency>, <RefLevel>, <RFAttenuation>, <FilterType>, <RBW>, <VBW>, <MeasTime>, <TriggerLevel>, <PowerLevel>}...

Configures and initiates the List Evaluation measurement.

The list can contain up to 200 entries (frequencies). You can define a different instrument setup for each frequency that is in the list.

If you synchronize the measurement with `*OPC`, the FSWX produces a service request when all frequencies have been measured and the number of individual measurements has been performed.

Note that using the command as a query initiates the measurement and returns the results if all frequencies have been measured. For more information on querying the results, see `[SENSe:]LIST:POWer:RESult?` .

Parameters:

<Frequency> Defines the frequency. Each frequency corresponds to one list entry.

Range: 0 to Fmax
Default unit: Hz

<RefLevel> Defines the reference level for a list entry.

Range: -130 to 30
Increment: 0.01
Default unit: dBm

<RFAttenuation> Defines the RF attenuation for a list entry.

Range: 0 to 70
Increment: 1
Default unit: dB

<FilterType> Selects the filter type for a list entry. For more information see [SENSe<ip>:]BANDwidth[:RESolution]:TYPE on page 1422.

<RBW> Defines the resolution bandwidth for a list entry.

<VBW> Defines the measurement time for a list entry.

<MeasTime> Defines the measurement time for a list entry.

Range: 1 µs to 16000 s
Default unit: s

<TriggerLevel> Reserved for future use; currently: must be 0.

<PowerLevel> Default unit: percent

Example: See "Example: performing list evaluation" on page 1407.

Example:

```
LIST:POW
935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,
935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,
935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0;
```

Usage: Asynchronous command

[SENSe:]LIST:POWer:SET <State>, <State>, <State>, <TriggerSource>, <TriggerSlope>, <TriggerOffset>, <GateLength>

Defines global List Evaluation parameters.

These parameters are valid for every frequency you want to measure.

The state of the first three parameters (<PeakPower>, <RMSPower> and <AVGPower>) define the number of results for each frequency in the list.

Note that you have to set the trigger level *after* sending this command.

Parameters:

<State> ON | OFF | 0 | 1

Enables or disables peak power evaluation.

*RST: 1

<State> ON | OFF | 0 | 1

Enables or disables RMS power evaluation.

*RST: 0

<State> ON | OFF | 0 | 1

Enables or disables average power evaluation.

*RST: 0

<TriggerSource> EXTernal | EXT2 | EXT3 | IMMediate | POWer | VIDeo

Selects a trigger source.
For more information see Section 4.14.7, "Configuring triggered and gated measurements", on page 629.

<TriggerSlope> POSitive | NEGative

Selects the trigger slop.

<TriggerOffset> Defines the trigger delay.

Range: negative measurement time to 30 s
*RST: 0
Default unit: s

<GateLength> Defines the gate length for gated measurements.
Setting 0 seconds turns gated measurements off.
To perform gated measurements, the trigger source must be different from `IMMediate`.

Range: 31.25 ns to 30 s
*RST: 0 s
Default unit: s

Example:

```
LIST:POW:SET ON,ON,OFF,EXT,POS,10us,434us
```

[SENSe:]LIST:POWer:STATe <State>

Turns the List Evaluation off.

Parameters:

<State> OFF | 0

*RST: 0

Example:

```
SENS:LIST:POW:STAT OFF
```

Example: performing list evaluation

The following example shows a list evaluation with the following configuration.

No	Freq [MHz]	Ref Level [dBm]	RF Attenu-ation [dB]	EI Attenu-ation [dB]	Filter	RBW	VBW	Meas Time	Trigger Level
1	935.2	0	10	---	Normal	1 MHz	3 MHz	440 µs	0
2	935.4	0	10	10	Channel	30 kHz	100 kHz	440 µs	0
3	935.6	0	10	20	Channel	30 kHz	100 kHz	440 µs	0

```
-----Measurement with synchronization via service request-----
*ESE 1
*SRE 32
// Configures the status reporting system to produce a service request.
```

```
LIST:POW:SET ON,ON,OFF,EXT,POS,10us,434us
//Turns on the list evaluation, configures the global list evaluation settings and
//evaluates the peak and RMS power.
LIST:POW
935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,
935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,
935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0;
*OPC
//Defines a list with 3 entries and initiates the measurement with synchronization to the end
//Analyzer produces a service request
//On service request:
SENS:LIST:POW:RES?
//Returns the results of the measurements, two for each frequency (peak and RMS power).

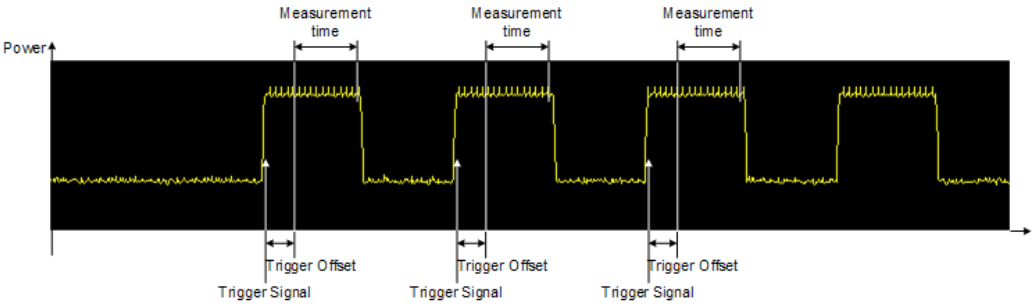
-----Initiliazing the measurement and querying results simultaneously-----
LIST:POW?
935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,
935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,
935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0
//Defines a list with 3 entries, initiates the measurement and queries the results.
//Result example:
-28.3,-30.6,-38.1
```

5.5.1.15 Measuring the pulse power

All remote control commands specific to measuring the mean or peak pulse power (e.g. bursts in various telecommunications standards) are described here. This measurement is available via remote control only.

The Pulse Power measurement is a gated measurement that determines the power over a particular number of pulses. The measurement is controlled by an external trigger or the video signal. A separate trigger event is required for each burst included in the measurement. In case of an external trigger source, the trigger level corresponds to the TTL level. In case of a video signal, you can define any threshold.

The figure below shows the relations between the available trigger settings.



The measurement is always on trace 1, either with the peak detector to determine the peak power or the RMS detector to determine the RMS power. Overall, you can configure the measurement independent of the instrument setup with the commands listed below only, which results in faster measurements.

The Pulse Power measurement is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the FSWX aborts the Pulse Power measurement.

The FSWX also aborts the Pulse Power measurement if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. With this method, there is the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.
- Instrument setup and querying of the result list at the end of the measurement: With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

Performing pulse power measurements

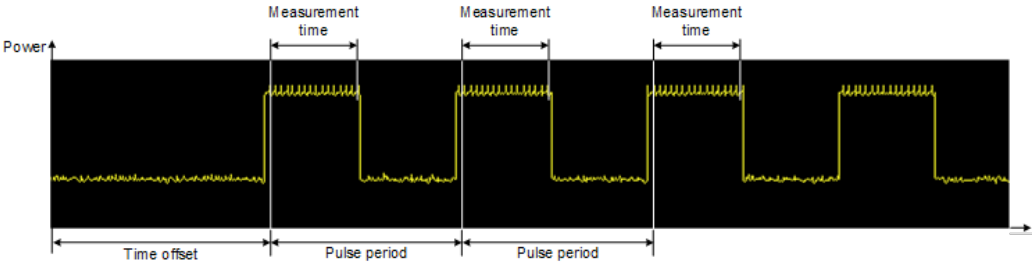
The following commands control pulse power measurements.

CALCulate<n>:MARKer<m>:FUNCtion:MSUMmary 1409
[SENSe:]MPOWer:FTYPe 1410
[SENSe:]MPOWer:RESult[:LIST]? 1410
[SENSe:]MPOWer[:SEQuence] 1411
[SENSe:]MPOWer:RESult:MIN? 1412

CALCulate<n>:MARKer<m>:FUNCtion:MSUMmary <TimeOffset>, <MeasTime>, <PulsePeriod>, <OfPulses>

Configures power measurements on pulses in the time domain.

To evaluate the pulse power, the FSWX uses the data captured during a previous measurement. The data recorded during the set measurement time is combined to a measured value for each pulse according to the detector specified and the indicated number of results is output as a list.



To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also INITiate<n>:CONTinuous on page 646 .

Suffix:

<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:

<TimeOffset> Defines a time offset to start the measurement at the first pulse of a trace.

*RST: 0
Default unit: s

<MeasTime> Defines the measurement time.

Default unit: s

<PulsePeriod> Defines the pulse period.

Default unit: s

<OfPulses> Defines the number of pulses to measure.

Example: //Evaluate data that contains 8 pulses during a measurement time of 450 µs and a pulse period of 576.9 µs. The evaluation starts with an offset of 50 µs.

```
CALC:MARK:FUNC:MSUM 50US,450US,576.9US,8
```

[SENSe:]MPOWer:FTYPe <FilterType>

Selects the filter type for pulse power measurements.

Parameters:

<FilterType>

CFILter

NORMal

P5

RRC

Example:

```
SENS:MPOW:FTYP P5
```

[SENSe:]MPOWer:RESult[:LIST]?

Queries the results of the pulse power measurement.

May be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:

<PulsePower> List of pulse powers.
The number of values depends on the number of pulses you have been measuring.
The unit is dBm.

Example:

```
SENS:MPOW:RES:LIST?
```

Usage: Query only

[SENSe:]MPOWer[:SEQuence] <Frequency>, <RBW>, <MeasTime>, <TriggerSource>, <TriggerLevel>, <TriggerOffset>, <Detector>, <OfPulses>

Configures and initiates the pulse power measurement.

The FSWX caches all measurement parameters that you can set with this command. If you use the command repeatedly, the FSWX only changes those settings that you have actually changed before initiating the measurement. Thus, measurement times are kept as low as possible.

If you synchronize the measurement with `*OPC`, the FSWX produces a service request when all frequencies have been measured and the number of individual measurements has been performed.

Note that using the command as a query initiates the measurement and returns the results if all frequencies have been measured. For more information on querying the results see `[SENSe:]LIST:POWer:RESult?`.

Parameters:

<Frequency> Defines the pulse frequency.

Range: 0 to Fmax
Default unit: Hz

<RBW> Defines the resolution bandwidth.

Default unit: Hz

<MeasTime> Defines the measurement time.

Range: 1 µs to 30 s
Default unit: s

<TriggerSource> EXTernal | EXT2 | EXT3 | VIDeo | POWer

Selects a trigger source.
For more information see Section 4.14.7, "Configuring triggered and gated measurements", on page 629.

<TriggerLevel> Defines a trigger level.
The trigger level is available for the video trigger. In that case, the level is a percentage of the diagram height.
In case of an external trigger, the FSWX uses a fix TTL level.

Range: 0 to 100
Default unit: PCT

<TriggerOffset> Defines the trigger delay.

Range: 0 s to 30 s
*RST: 0 s
Default unit: s

<Detector> MEAN | PEAK

Selects the detector and therefore the way the measurement is evaluated.

MEAN
Calculates the RMS pulse power.

PEAK
Calculates the peak pulse power.

<OfPulses> Defines the number of pulses included in the measurement.
Range: 1 to 32001

Return values:
<PowerLevel> Pulse power level.
The result is a list of floating point values separated by commas.
The unit is dBm.

Example:
```
SENS:MPOW:SEQ
6MHZ,3KHZ,0.1s,POW,-30,0,PEAK,1000
```

Usage: Asynchronous command

[SENSe:]MPOWer:RESult:MIN?

Queries the lowest pulse power that has been measured during a pulse power measurement.

If there are no results, the command returns an error.

Return values:
<PulsePower> Lowest power level of the pulse power measurement.
The unit is dBm.

Example:
```
SENS:MPOW:RES:MIN?
```

Usage: Query only

Example: performing a pulse power measurement

The following example shows a pulse power measurement.

```
-----Measurement with synchronization via service request-----
*ESE 1
*SRE 32
// Configures the status reporting system to produce a service request.
MPOW:FTYP NORM
//Selects a Gaussian filter for the measurement.
MPOW 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20;
*OPC
//Configures and initiates a measurement on 20 pulses with synchronization to the end.
//Analyzer produces a service request
//On service request:
MPOW:RES?
//Returns the results of the measurements (20 power levels).
MPOW:RES:MIN?
//Returns the lowest of the 20 power level that have been measured.

-----Initiliazing the measurement and querying results simultaneously-----
MPOW? 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20
//Configures, initiates and queries the results of the measurement.
```

```
//Result example:
-105.225059509,-105.656074524,-105.423065186,-104.374649048,-103.059822083,-101.29511261,
-99.96534729,-99.7452468872,-99.6610794067,-100.327224731,-100.96686554,-101.450386047,
-102.150642395,-103.240142822,-105.95476532,-110.583129883,-115.7760849,-126.279388428,
-124.620399475,-116.97366333
```

5.5.2 Spectrum analysis commands

All commands that set general spectrum analysis parameters are described here.

- Defining the frequency and span 1413
- Configuring bandwidth and sweep settings 1420
- Scaling the Y-axis 1429

5.5.2.1 Defining the frequency and span

The commands required to configure the frequency and span settings in a remote environment are described here. The settings for manual operation are described in Section 5.2.2, "Frequency and span configuration", on page 958.

- Defining the frequency range 1413
- Configuring signal tracking 1418

Defining the frequency range

The following commands are required to define the frequency range.

Useful commands for defining the frequency range described elsewhere:

- `[SENSe<ip>:]FREQuency:CENTer` on page 612
- `[SENSe<ip>:]FREQuency:OFFSet` on page 612

Remote commands exclusive to defining the frequency range

CALCulate<n>:MARKer<m>:FUNCtion:CENTer 1413
CALCulate<n>:MARKer<m>:FUNCtion:CSTep 1414
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:X:SPACing 1414
[SENSe:]FREQuency:ANNotation 1414
[SENSe<ip>:]FREQuency:CENTer:STEP 1415
[SENSe<ip>:]FREQuency:CENTer:STEP:AUTO 1416
[SENSe<ip>:]FREQuency:CENTer:STEP:LINK:FACTor 1416
[SENSe:]FREQuency:CENTer:STEP:LINK 1416
[SENSe<ip>:]FREQuency:SPAN 1417
[SENSe<ip>:]FREQuency:SPAN:FULL 1417
[SENSe<ip>:]FREQuency:STARt 1417
[SENSe<ip>:]FREQuency:STOP 1418

CALCulate<n>:MARKer<m>:FUNCtion:CENTer

Matches the center frequency to the frequency of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: //Set the center frequency to the frequency of marker 2.
`CALC:MARK2:FUNC:CENT`

Manual operation: See "Set Center Freq to Marker Freq" on page 1193

CALCulate<n>:MARKer<m>:FUNCtion:CSTep

Matches the center frequency step size to the current marker frequency.

The command turns delta markers into normal markers.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Example: `CALC:MARK:FUNC:CST`

Manual operation: See "Center Frequency Stepsize" on page 960

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:X:SPACing <Scale>

Selects the scaling of the x-axis.

Suffix:
<n> Window 1 to 16

<w> subwindow

<t> Trace 1 to 6

Parameters:
<Scale> LINear | LOGarithmic

LOGarithmic
Logarithmic scaling.

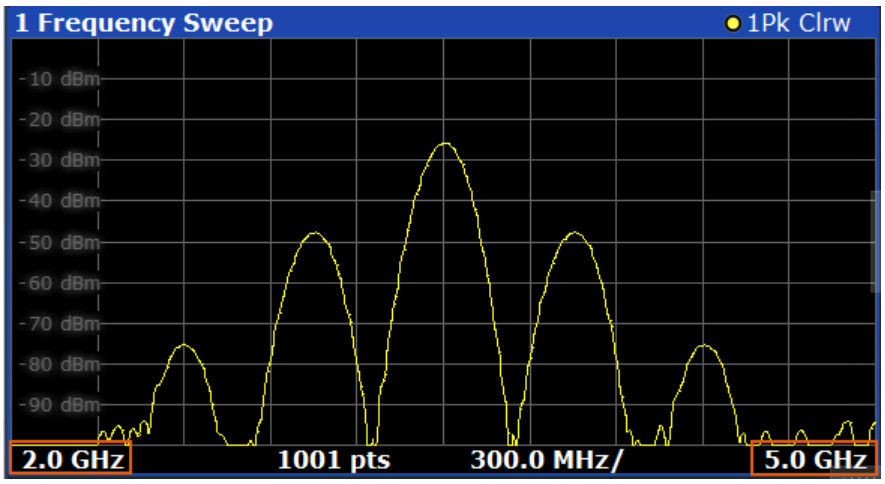
LINear
Linear scaling.

*RST: LINear

Example: `DISP:TRAC:X:SPAC LOG`

[SENSe:]FREQuency:ANNotation <Mode>

Switches the labelling of the y-axis for frequency-based result diagrams. The frequency range itself is not changed.



This function is not available in all applications and measurements.

Parameters:

<Mode> CSPan | SSTop

CSPan
span / center

SSTop
start / stop frequency

Example: `FREQ:ANN SST`

[SENSe<ip>:]FREQuency:CENTer:STEP <Frequency>

Defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` AND `SENS:FREQ DOWN` commands, see `[SENSe<ip>:]FREQuency:CENTer` on page 612.

Suffix:

<ip> Input

Parameters:

<StepSize> f_{max} is specified in the specifications document.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example: //Set the center frequency to 110 MHz.

```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Manual operation: See "Center Frequency Stepsize" on page 960

[SENSe<ip>:]FREQuency:CENTer:STEP:AUTO <State>

Couples or decouples the center frequency step size to the span.

In time domain (zero span) measurements, the center frequency is coupled to the RBW.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: //Activate the coupling of the step size to the span.
```
FREQ:CENT:STEP:AUTO ON
```

[SENSe<ip>:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>

Defines a step size factor if the center frequency step size is coupled to the span or the resolution bandwidth.

Suffix:
<ip> Input

Parameters:
<Factor> 1 to 100 PCT
*RST: 10
Default unit: percent

Example: //Couple frequency step size to span and define a step size factor
```
FREQ:CENT:STEP:LINK SPAN
FREQ:CENT:STEP:LINK:FACT 20PCT
```

Manual operation: See "Center Frequency Stepsize" on page 960

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

Couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:
<CouplingType> SPAN | RBW | OFF

SPAN
Couples the step size to the span. Available for measurements in the frequency domain.

RBW
Couples the step size to the resolution bandwidth. Available for measurements in the time domain.

OFF
Decouples the step size.

*RST: SPAN

Example: //Couple step size to span
`FREQ:CENT:STEP:LINK SPAN`

Manual operation: See "Center Frequency Stepsize" on page 960

[SENSe<ip>:]FREQuency:SPAN <Span>

Defines the frequency span that is swept during a single measurement.

Suffix:
<ip> Input

Parameters:
<Span> Default unit: Hz

Example: `SENS:FREQ:SPAN 2000`

Manual operation: See "Span" on page 961
See "Set to Zero Span" on page 961
See "Set to Last Span" on page 961
See "Zero Span" on page 987

[SENSe<ip>:]FREQuency:SPAN:FULL

Restores the full span.

The full span depends on the current receiver frequency.

Suffix:
<ip> Input

Example: `SENS:FREQ:SPAN:FULL`

Manual operation: See "Set to Full Span" on page 961

[SENSe<ip>:]FREQuency:STARt <Frequency>

Defines a start frequency for measurements in the frequency domain.

Suffix:
<ip> Input

Parameters:
<Frequency> 0 to (fmax - min span)
*RST: 0
Default unit: Hz

Example: `FREQ:STAR 20MHz`

Manual operation: See "Start/ Stop" on page 960
See "Frequency Sweep" on page 987

[SENSe<ip>:]FREQuency:STOP <Frequency>

Defines a stop frequency for measurements in the frequency domain.

Suffix:
<ip> Input

Parameters:
<Frequency> min span to fmax
*RST: fmax
Default unit: Hz

Example: `FREQ:STOP 2000 MHz`

Manual operation: See "Start/ Stop" on page 960
See "Frequency Sweep" on page 987

Configuring signal tracking

When signal tracking is activated, the maximum signal is determined after each frequency sweep and the center frequency is set to the frequency of this signal. Thus with drifting signals the center frequency follows the signal.

For more details see Section 4.3.1.3, "Keeping the center frequency stable - signal tracking", on page 237.

CALCulate<n>:MARKer<m>:FUNCtion:STRack[:STATe] 1418
CALCulate<n>:MARKer<m>:FUNCtion:STRack:BWIDth 1419
CALCulate<n>:MARKer<m>:FUNCtion:STRack:BANDwidth 1419
CALCulate<n>:MARKer<m>:FUNCtion:STRack:THReshold 1419
CALCulate<n>:MARKer<m>:FUNCtion:STRack:TRACe 1420

CALCulate<n>:MARKer<m>:FUNCtion:STRack[:STATe] <State>

Enables or disables signal tracking.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
//Activate signal tracking to keep the center frequency
//on the signal peak. After each sweep the maximum on
//trace 1 is searched within a range of 20 MHz around the
//center frequency. It must have a minimum power of -90dBm.
CALC:MARK:FUNC:STR ON
CALC:MARK:FUNC:STR:BAND 20MHz
CALC:MARK:FUNC:STR:THR -90dBm
CALC:MARK:FUNC:STR:TRAC 1
```

Manual operation: See "Signal Tracking State" on page 962

CALCulate<n>:MARKer<m>:FUNCtion:STRack:BWIDth <Bandwidth>
CALCulate<n>:MARKer<m>:FUNCtion:STRack:BANDwidth <Bandwidth>

Defines the bandwidth around the center frequency that is included in the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Bandwidth>
Range: 10 Hz to Max span
*RST: (= span/10 on activating the function)
Default unit: Hz

Example:
```
CALC:MARK:FUNC:STR:BAND 2000
```

Manual operation: See "Tracking Bandwidth" on page 962

CALCulate<n>:MARKer<m>:FUNCtion:STRack:THReshold <Level>

Defines the threshold level for the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<Level>
The unit depends on `CALCulate<n>:UNIT:POWer`.
Range: -130 dBm to 30 dBm
*RST: -120 dBm
Default unit: dBm

Example:
```
CALC:MARK:FUNC:STR:THR 10
```

Manual operation: See "Tracking Threshold" on page 962

CALCulate<n>:MARKer<m>:FUNCtion:STRack:TRACe <TraceNumber>

Selects the trace on which the largest signal is searched for.

Suffix:
<n> Window 1 to 16

<m> Marker 1 to 16

Parameters:
<TraceNumber> 1 to 6

Range: 1 to 6
*RST: 1

Example: `CALC:MARK:FUNC:STR:TRAC 4`

Manual operation: See "Signal Track Trace" on page 962

5.5.2.2 Configuring bandwidth and sweep settings

The commands required to configure the bandwidth, sweep and filter settings in a remote environment are described here. The settings for manual operation are described in Section 5.2.4, "Bandwidth, filter and sweep settings", on page 967.

- Configuring the bandwidth and filter....1420
- Configuring the sweep....1424

Configuring the bandwidth and filter

[SENSe<ip>:]BWIDth[:RESolution]....1420
[SENSe<ip>:]BANDwidth[:RESolution]....1420
[SENSe<ip>:]BWIDth[:RESolution]:AUTO....1421
[SENSe<ip>:]BANDwidth[:RESolution]:AUTO....1421
[SENSe<ip>:]BWIDth[:RESolution]:RATio....1421
[SENSe<ip>:]BANDwidth[:RESolution]:RATio....1421
[SENSe<ip>:]BWIDth[:RESolution]:TYPE....1422
[SENSe<ip>:]BANDwidth[:RESolution]:TYPE....1422
[SENSe<ip>:]BWIDth:VIDeo....1422
[SENSe<ip>:]BANDwidth:VIDeo....1422
[SENSe<ip>:]BWIDth:VIDeo:AUTO....1422
[SENSe<ip>:]BANDwidth:VIDeo:AUTO....1422
[SENSe<ip>:]BWIDth:VIDeo:RATio....1423
[SENSe<ip>:]BANDwidth:VIDeo:RATio....1423
[SENSe<ip>:]BWIDth:VIDeo:TYPE....1423
[SENSe<ip>:]BANDwidth:VIDeo:TYPE....1423

[SENSe<ip>:]BWIDth[:RESolution] <Bandwidth>
[SENSe<ip>:]BANDwidth[:RESolution] <Bandwidth>

Defines the resolution bandwidth.

For statistics measurements, this command defines the **demodulation** bandwidth.

The 6 MHz Gaussian filter is provided for special measurements, such as 5G NR spurious emissions measurements. It is only available if you enter the value manually, not using the `BAND:RES MAX` command. It is not supported by all applications.

Suffix:
<ip> Input

Parameters:
<Bandwidth> refer to specifications document
*RST: RBW: AUTO is set to ON; DBW: 3MHz
Default unit: Hz

Example: //Set the resolution bandwidth to 1 MHz
`BAND 1 MHz`

Manual operation: See "RBW Mode/RBW Manual" on page 971
See "Analysis Bandwidth" on page 1015

[SENSe<ip>:]BWIDth[:RESolution]:AUTO <State>
[SENSe<ip>:]BANDwidth[:RESolution]:AUTO <State>

Couples and decouples the resolution bandwidth to the span.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: //Switch off the coupling of the resolution bandwidth to the span.
`BAND:AUTO OFF`

Manual operation: See "RBW Mode/RBW Manual" on page 971

[SENSe<ip>:]BWIDth[:RESolution]:RATio <Ratio>
[SENSe<ip>:]BANDwidth[:RESolution]:RATio <Ratio>

Defines the ratio between the resolution bandwidth (Hz) and the span (Hz).

Note that the ratio defined with this remote command (RBW/span) is reciprocal to that of the coupling ratio (span/RBW).

Changing this ratio also affects the FFT length, which in turn affects the time resolution of the FFT. Furthermore, the ratio also affects the RBW value according to:

RBW = Span / Coupling ratio

Suffix:
<ip> Input

Parameters:
<Ratio> Range: 0.0001 to 1
*RST: 0.01

Example: `BAND:RAT 0.1`

Manual operation: See "Span/RBW (expert parameter)" on page 972

[SENSe<ip>:]BWIDth[:RESolution]:TYPE <FilterType>
[SENSe<ip>:]BANDwidth[:RESolution]:TYPE <FilterType>

Defines the filter type used for the measurement.

Suffix:
<ip> Input

Parameters:
<FilterType>

CFILter
Channel filters

NORMal
Gaussian filters

P5
5-pole filters
The 5-pole filter is not available for FFT sweeps.

RRC
RRC filters
The RRC filter is not available for FFT sweeps.

*RST: NORMal

Example:
```
BAND:TYPE NORM
```

Manual operation: See "Filter Type (expert parameter)" on page 972

[SENSe<ip>:]BWIDth:VIDeo <Bandwidth>
[SENSe<ip>:]BANDwidth:VIDeo <Bandwidth>

Defines the video bandwidth.

The command decouples the video bandwidth from the resolution bandwidths.

Suffix:
<ip> Input

Parameters:
<Bandwidth> refer to specifications document

*RST: AUTO is set to ON
Default unit: Hz

Example:
```
BAND:VID 10 kHz
```

Manual operation: See "VBW Mode / VBW Manual" on page 971

[SENSe<ip>:]BWIDth:VIDeo:AUTO <State>
[SENSe<ip>:]BANDwidth:VIDeo:AUTO <State>

Couples and decouples the video bandwidth to the resolution bandwidth.

Suffix:
<ip> Input

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `BAND:VID:AUTO OFF`

Manual operation: See "VBW Mode / VBW Manual" on page 971

[SENSe<ip>:]BWIDth:VIDeo:RATio <Ratio>
[SENSe<ip>:]BANDwidth:VIDeo:RATio <Ratio>

Defines the coupling ratio of the video bandwidth to the resolution bandwidth (VBW/ RBW).

Suffix:
<ip> Input

Parameters:
<Ratio> Range: 0,001 to 1000
*RST: 1

Example: //Set the video bandwidth to 3*resolution bandwidth.
`BAND:VID:RAT 3`

Manual operation: See "Optimization RBW/VBW (expert parameter)" on page 972

[SENSe<ip>:]BWIDth:VIDeo:TYPE <Mode>
[SENSe<ip>:]BANDwidth:VIDeo:TYPE <Mode>

Enables or disables the logarithmic amplifier in front of the video filter in the signal path.

Suffix:
<ip> Input

Parameters:
<Mode> LINear | LOGarithmic

LINear
The logarithmic amplifier in front of the video filter is bypassed to process linear detector samples.

LOGarithmic
The logarithmic amplifier in front of the video filter is enabled to process logarithmic detector samples.

*RST: LOGarithmic

Example: //Disable the logarithmic amplifier in front of the video filter.
`BAND:VID:TYPE LIN`

Manual operation: See "VBW Mode / VBW Manual" on page 971

Configuring the sweep

Useful commands for configuring sweeps described elsewhere:

- [SENSe<ip>:]AVERage<n>:COUNt on page 675
- [SENSe<ip>:]AVERage<n>[:STATe<t>] on page 675
- [SENSe<ip>:]AVERage<n>:TYPE on page 676

Remote commands exclusive to configuring sweeps:

[SENSe<ip>:]BWIDth[:RESolution]:FFT....1424
[SENSe<ip>:]BANDwidth[:RESolution]:FFT....1424
[SENSe<ip>:]SWEep:COUNt....1425
[SENSe:]SWEep:DURation?....1425
[SENSe:]SWEep:FFTSubspan?....1425
[SENSe:]SWEep:OPTimize....1426
[SENSe:]SWEep[:WINDow<n>]:POINts....1426
[SENSe<ip>:]SWEep:TIME....1427
[SENSe:]SWEep:TIME:AUTO....1427
[SENSe:]SWEep:TYPE....1428
[SENSe:]SWEep:TYPE:USED....1428
[SENSe<ip>:]SWEep:XFACtor....1428

[SENSe<ip>:]BWIDth[:RESolution]:FFT <FilterMode>
[SENSe<ip>:]BANDwidth[:RESolution]:FFT <FilterMode>

Defines the filter mode to be used for FFT filters by defining the subspan size. The subspan is the span which is covered by one FFT analysis.

Prerequisite: Sweep type "FFT".

Note: this command is maintained for compatibility reasons only. For new remote control programs, use the [SENSe:]SWEep:OPTimize command.

Suffix:
<ip> Input

Parameters:
<FilterMode> WIDE | AUTO | NARRow

AUTO
Automatically applies the sweep optimization mode that is best for the current measurement.

NARRow
Optimizes the sweep mode for a large dynamic range.

WIDE
Optimizes the sweep mode for high performance.

*RST: AUTO

Example: //Select FFT filter.
```
BAND:TYPE FFT
```

Example: //Select narrow subspan for FFT filter.
```
BAND:FFT NARR
```

[SENSe<ip>:]SWEep:COUNt <Count>

Suffix:
<ip> Input

Parameters:
<Count> When you set a sweep count of 0 or 1, the FSWX performs one single sweep in single sweep mode.
In continuous sweep mode, if the sweep count is set to 0, a moving average over 10 sweeps is performed.

Range: 0 to 200000
*RST: 0

Example:
```
SWE:COUN 64
```
Sets the number of sweeps to 64.
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
INIT;*WAI
```
Starts a sweep and waits for its end.

Manual operation: See "Sweep Count" on page 969

[SENSe:]SWEep:DURation?

Currently not supported.

Return values:
<Time>

Example:
```
SWE:TIME 1s
SWE:DUR?
```
Reply:
```
27.9734842578
```

Usage: Query only

Manual operation: See "Data capturing takes too long" on page 1481

[SENSe:]SWEep:FFTSubspan?

Returns the number of FFT subspans required to cover the entire measurement range (read-only).

Only available in FFT sweep mode in the Spectrum application, and not for SEM, ACLR, or Spurious emissions measurements.

Return values:
<NoOfPartialSpans> integer

Usage: Query only

[SENSe:]SWEep:OPTimize <Mode>

In FFT mode, several FFT analysis steps are required to cover the entire measurement span. The span which is covered by one FFT analysis step is called *subspan*. The subspan cannot be defined directly, but it can be optimized according to measurement requirements.

Table 5-21: Optimization parameters in FFT mode

Optimization mode	Description
`DYNamic`	Optimizes the dynamic range by using the narrowest possible subspan (depending on the RBW). The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.
`SPEed`	Optimizes the sweep rate by using the widest possible subspan (depending on the RBW). The autorange function for the internal IF gain calculation is deactivated. (Note: set the reference level accordingly to optimize the control range for the A/D converter). It is recommended that you set the "Sweep Time" to "Auto" to optimize the sweep rate.
`AUTO`	Uses a medium-sized subspan to obtain a compromise between a large dynamic range and a fast sweep rate. The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.

Zero span mode

For zero span measurements, the optimization mode defines the selection of the A/D converter prefilter.

Table 5-22: Optimization parameters in zero span mode

Optimization mode	Description
DYNamic	The narrowest filter possible (depending on the RBW) is used.
SPEed	The widest filter possible (depending on the RBW) is used.
AUTO	A medium-sized prefilter is used.

Parameters:

<Mode> AUTO | DYNamic | SPEed

*RST: AUTO

Example: //Select optimization for dynamic range.

```
SWE:OPT DYN
```

Manual operation: See "Sweep Optimization (expert parameter)" on page 970

[SENSe:]SWEep[:WINDow<n>]:POINts <NoPoints>

Defines the number of sweep points to analyze after a sweep.

For EMI measurements, 200001 sweep points are available.

Suffix:
<n> Window 1 to 16

Parameters:
<NoPoints> Range: 101 to 100001
*RST: 1001

Example: `SWE:POIN 251`

Manual operation: See "Sweep Points" on page 969

[SENSe<ip>:]SWEep:TIME <Time>

Determines the amount of time used to sample data for one spectrum or one PVT diagram.

Suffix:
<ip> Input

Parameters:
<Time> refer to specifications document
Default unit: s

Example: Window 1: "Real-Time Spectrum"
Window 2: PVT diagram
```
SWE:TIME 0.3s
SENS2:SWE:TIME 0.128s
```

Manual operation: See "Sweep Time Mode / Sweep Time" on page 969
See "Sweep Time Mode / Sweep Time" on page 974
See "Sweep Time" on page 1104

[SENSe:]SWEep:TIME:AUTO <State>

Couples and decouples the sweep time to the span and the resolution and video bandwidths.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: //Activate automatic sweep time.
```
SWE:TIME:AUTO ON
```

Manual operation: See "Sweep Time Mode / Sweep Time" on page 969
See "Sweep Time Mode / Sweep Time" on page 974
See "Harmonic Sweep Time" on page 1151

[SENSe:]SWEep:TYPE <Type>

Selects the sweep type.

Parameters:

<Type> AUTO | FFT | SWEep

AUTO
Automatic selection of the sweep type between sweep mode and FFT.

FFT
FFT mode

SWE
Sweep list

*RST: AUTO

Example: `SWE:TYPE FFT`

Manual operation: See "Sweep Type (expert parameter)" on page 970

[SENSe:]SWEep:TYPE:USED

Queries the sweep type if you have turned on automatic selection of the sweep type.

Return values:

<Type> **SWE**
Normal sweep

FFT
FFT mode

Example: `SENS:SWE:TYPE:USED?`

[SENSe<ip>:]SWEep:XFACtor <XCorrFactor>

Defines the number of sweep samples that are cross-correlated to determine a single sweep point if the "RMS X-Corr" detector is used.

Suffix:

<ip> Input

Parameters:

<XCorrFactor> integer

Example: `SENS:SWE:XFAC 2`

Manual operation: See "X-Corr Factor" on page 970
See "X-Corr Factor" on page 973
See "X-Corr Factor" on page 1221

5.5.2.3 Scaling the Y-axis

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe] 1429
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE 1429
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE 1429
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:PDIVision 1430
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition 1430
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing 1431

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe] <Range>

Defines the display range of the y-axis (for all traces).

Note that the command works only for a logarithmic scaling. You can select the scaling with `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing` on page 1431.

Suffix:

<n> Window 1 to 16

<w> subwindow
Not supported by all applications

<t> Trace 1 to 6

Parameters:

<Range>
Range: 1 dB to 200 dB
*RST: 100 dB
Default unit: dB

Example:
```
DISP:TRAC:Y 110dB
```

Manual operation: See "Reference Value" on page 965
See "Top to Bottom Scaling" on page 965
See "Axis Labels" on page 966

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again (for all traces).

(Not available for statistical results.)

Suffix:

<n> Window 1 to 16

<t> Trace 1 to 6

Example:
```
DISP:WIND:SUBW:TRAC:Y:SCAL:AUTO ONCE
```

Manual operation: See "Auto Scale Once" on page 965

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE <Mode>

Selects the type of scaling of the y-axis (for all traces).

When the display update during remote control is off, this command has no immediate effect.

Suffix:
<n> Window 1 to 16

<w> subwindow

<t> Trace 1 to 6

Parameters:
<Mode> ABSolute | RELative

ABSolute
absolute scaling of the y-axis

RELative
relative scaling of the y-axis

*RST: ABSolute

Example:
```
DISP:TRAC:Y:MODE REL
```

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:PDIVision
<GridSpacing>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

In spectrum displays, for example, this command is not available.

Suffix:
<n> Window 1 to 16

<w> subwindow
Not supported by all applications

<t> Trace 1 to 6

Parameters:
<GridSpacing> numeric value WITHOUT UNIT (unit according to the result display)

Defines the range per division (total range = 10*<Value>)

*RST: depends on the result display
Default unit: dB

Example: //Set the grid spacing to 10 units (e.g. dB) per division
```
DISP:TRAC:Y:PDIV 10
```

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition
<Position>

Defines the vertical position of the reference level on the display grid (for all traces).

The FSWX adjusts the scaling of the y-axis accordingly.

Suffix:
<n> Window 1 to 16

<w> subwindow
Not supported by all applications

<t> Trace 1 to 6

Parameters:
<Position> 0 PCT corresponds to the lower display border, 100% corresponds to the upper display border.

*RST: 100 PCT = frequency display; 50 PCT = time display
Default unit: PCT

Example:
```
DISP:TRAC:Y:RPOS 50PCT
```

Manual operation: See "Reference Position" on page 965

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing <ScalingType>

Selects the scaling of the y-axis (for all traces, <t> is irrelevant).

Suffix:
<n> Window 1 to 16

<w> subwindow

<t> Trace 1 to 6

Parameters:
<ScalingType> LINear | LOGarithmic | PERCent | LDB

LOGarithmic
Logarithmic scaling.

LINear
Linear scaling in %.

LDB
Linear scaling in the specified unit.

PERCent
Linear scaling in %.

*RST: LOGarithmic

Example:
```
//Select linear scaling in %.
DISP:TRAC:Y:SPAC LIN
```

Manual operation: See "Trace Scaling" on page 965

5.5.3 Programming examples

Some advanced programming examples for complex measurement tasks are provided here.

Further programming examples for common measurement tasks are described in the individual measurement sections, for example:

- Section 4.14.4.2, "Performing a sequence of measurements", on page 544
- "Programming example: using limit lines" on page 776
- "Programming examples for channel power measurements" on page 1293
- "Programming example: Measuring the carrier-to-noise ratio" on page 1301
- "Programming example: OBW measurement" on page 1303
- "Example: SEM measurement" on page 1355
- "Programming example: spurious emissions measurement" on page 1371
- "Programming example: measuring statistics" on page 1383
- "Programming example: time domain power" on page 1393
- "Example: measuring the harmonic distortion" on page 1397
- "Programming example: measuring the TOI" on page 1401
- "Example: measuring the AM modulation depth" on page 1403
- "Programming example: measuring the noise power ratio" on page 1319
- "Example: performing a pulse power measurement" on page 1412
- "Programming example: configuring a spectrogram" on page 693
- "Programming example: using touchstone files" on page 844

- Programming example: performing a basic frequency sweep 1432
- Service request 1435

5.5.3.1 Programming example: performing a basic frequency sweep

This example demonstrates how to configure and perform a basic frequency sweep measurement in a remote environment.

This example assumes a signal is measured at 100 MHz, with a maximum power level of -3 dBm.

Some commands in the following examples may not be necessary as they reflect the default settings; however, they are included to demonstrate the command usage.

```
//--------------Preparing the measurement ---------------------
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.

//--------------Configuring the Frequency and Span-------------
FREQ:CENT 100MHz
//Defines the center frequency
FREQ:SPAN 100MHz
//Sets the span to 50 MHz on either side of the center frequency.
```

```
//--------------Configuring the Bandwidth----------------------
BAND:AUTO OFF
BAND 1MHz
BAND:TYPE RRC
//Defines the RBW as 1 MHz using an RRC filter

BAND:VID 500kHz
//Decouples the VBW from the RBW and decreases it to smooth the trace.

//--------------Configuring the Sweep--------------------------
SENS:SWE:COUN 10
//Defines 10 sweeps to be performed in each measurement.
SENS:SWE:POIN 500
//During each sweep, 500 trace points will be measured.
SENS:SWE:TIME 50ms
//Decouples the sweep time from the RBW,VBW and span and increases it to
//make the measurement more precise.

//--------------Configuring Attenuation------------------------
INP:ATT:AUTO OFF
//Disables automatic attenuation
//Only if enhanced electronic ranging is available:
//INP:EATT:RANG ON
//Switches on the enhanced electronic range.
INP:ATT 30dB
//Sets the overall RF attenuation to 30 dB.
//If enhanced electronic ranging is enabled: only electronic attenuator used
//otherwise: 20 dB mechanical + 10 dB electronic attenuation

//--------------Configuring the Amplitude and Scaling----------
INP:RLEV:OFFS 10dB
//Shifts the trace display in the diagram up by 10dB.
CALC:UNIT:POW V
//Sets the unit of the y-axis to Volt. The reference level is now 70.711 mV.
DISP:TRAC1:Y:SPAC LOG
//Uses logarithmic scaling with absolute values (V).
DISP:TRAC1:Y 110dB
//Increases the displayed range of the y-axis to 110 dB.
DISP:TRAC1:Y:RPOS 80PCT
//Shifts the display of the reference level down, it is no longer the top line
//in the diagram. The reference level is displayed as a red line.

//--------------Triggering-------------------------------------
TRIG:SOUR POW
TRIG:LEV:POW -10dBm
TRIG:SLOP POS
TRIG:DTIM 50ms
TRIG:POW:HYST 5dB
```

```
TRIG:HOLD 10ms
//Defines triggering when the second intermediate frequency rises to a level
//of -10 dBm, with a dropout time of 50 ms, a hysteresis of 5 dB and a delay
//of 10 ms.


SWE:EGAT ON
SWE:EGAT:TYPE EDGE
SWE:EGAT:LENG 5ms
//Defines gating. Values are measured for 5 ms after triggering.

OUTP:TRIG2:DIR OUTP
OUTP:TRIG2:OTYP UDEF
OUTP:TRIG2:LEV HIGH
OUTP:TRIG2:PULS:LENG 100us
OUTP:TRIG2:PULS:IMM
//Configures a high trigger signal with a pulse length of 100 us to be output at
//the front TRIGGER INPUT/OUTPUT connector once.

//--------------Configuring the Trace--------------------------
DISP:TRAC2:MODE AVER
DISP:TRAC3:MODE MAXH
//Configures 3 traces: 1 (default): clear/write; 2: average; 3: max hold

SENS:DET1 POS
SENS:DET2 RMS
SENS:DET3 POS
//Configures traces 1 and 3 to use the positive peak detector; trace 2 uses
//the RMS detector.

TRAC:COPY TRACE4,TRACE1
//Copies trace 1 to a new trace 4 which will then be averaged.

SENS:AVER:STAT4 ON
SENS:AVER:COUN 10
SENS:AVER:TYPE LIN
//Configures trace 4 to be averaged linearly over 10 sweeps.

CALC:MATH:STAT ON
CALC:MATH:MODE LIN
CALC:MATH (TRACE1-TRACE2)
CALC:MATH:POS 100
//Calculates the linear difference between the measured and average values.
//The resulting trace is displayed at the top of the diagram.

//--------------Performing the Measurement---------------------
INIT;*WAI
//Initiates a new measurement and waits until the last sweep has finished.

//---------------Retrieving Results----------------------------
```

```
TRAC:DATA? TRACE1
TRAC:DATA? TRACE2
TRAC:DATA? TRACE3
TRAC:DATA? TRACE4
//Returns one power value per sweep point for each trace.
TRAC:DATA:X?
//Returns one frequency value per sweep point for each trace.
```

5.5.3.2 Service request

The service request routine requires an extended initialization of the instrument in which the relevant bits of the transition and enable registers are set. In addition the service request event must be enabled in the VISA session.

Initiate service request

```
REM ---- Example of initialization of the SRQ in the case
' of errors -------
PUBLIC SUB SetupSRQ()
CALL InstrWrite (analyzer, "*CLS") 'Reset status reporting system
CALL InstrWrite (analyzer, "*SRE 168") 'Enable service request for
'STAT:OPER, STAT:QUES and ESR
'register
CALL InstrWrite (analyzer, "*ESE 60") 'Set event enable bit for
'command, execution, device-
'dependent and query error
CALL InstrWrite (analyzer, "STAT:OPER:ENAB 32767")
'Set OPERation enable bit for
'all events
CALL InstrWrite (analyzer, "STAT:OPER:PTR 32767")
'Set appropriate OPERation
'Ptransition bits
CALL InstrWrite (analyzer, "STAT:QUES:ENAB 32767")
'Set questionable enable bits
'for all events
CALL InstrWrite (analyzer, "STAT:QUES:PTR 32767")
'Set appropriate questionable
'Ptransition bits
CALL viEnableEvent(analyzer, VI_EVENT_SERVICE_REQ, VI_QUEUE, 0)
'Enable the event for service
'request
Status = viWaitOnEvent(analyzer, VI_EVENT_SERVICE_REQ, SRQWaitTimeout, VI_NULL,
 VI_NULL)
IF (status = VI_SUCCESS) THEN CALL Srq
'If SRQ is recognized =>
'subroutine for evaluation
END SUB
REM ***************************************************************************
```

```
Private mbSession As MessageBasedSession

Sub Main()
    Console.WriteLine("Example of initialization    _
                of the SRQ in the case of errors.")
    Dim SRQWaitTimeout = 4000 ' Timeout As Integer for WaitOnEvent
    'Opening session
    Try
        'Analyzer is alias, instead of using resource string.
                'For example on TCP use TCPIP0::192.168.1.2::inst0::INSTR
        mbSession = CType(ResourceManager.GetLocalManager().Open("Analyzer"), _
                                    MessageBasedSession)
        mbSession.TerminationCharacterEnabled = True
        Try
            mbSession.Write("*CLS") 'Reset status reporting system
            mbSession.Write("*SRE 168") 'Enable service request for
            'STAT:OPER, STAT:QUES and ESR register
            mbSession.Write("*ESE 60") 'Set event enable bit for
            'command, execution, device-dependent and query error
            mbSession.Write("STAT:OPER:ENAB 32767")
            'Set OPERation enable bit for all events
            mbSession.Write("STAT:OPER:PTR 32767")
            'Set appropriate OPERation Ptransition bits
            mbSession.Write("STAT:QUES:ENAB 32767")
            'Set questionable enable bits for all events
            mbSession.Write("STAT:QUES:PTR 32767")
            'Set appropriate questionable Ptransition bits
            Console.WriteLine("Wait on event - Blocking")
            mbSession.EnableEvent(MessageBasedSessionEventType.ServiceRequest, _
                                            EventMechanism.Queue)
            'Enable the event for service request

            '-----------------------------------------------
            ' Your command plase use here
            ' mbSession.Write("Your command")
            '-----------------------------------------------

            Dim Status = mbSession.WaitOnEvent( _
                                MessageBasedSessionEventType.ServiceRequest, SRQWaitTimeout)
            If (Status.EventType() = _
                                MessageBasedSessionEventType.ServiceRequest) Then
                Console.WriteLine("SRQ is recognized")
                'If SRQ is recognized => subroutine for evaluation
                Srq()
            End If
        Catch exp As Exception
            Console.WriteLine(exp.Message)
        End Try
    Catch exp As InvalidCastException
        Console.WriteLine("Resource selected must be a message-based session")
```

```
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try

    ' Close session
    mbSession.Dispose()
    ' Wait for end
    Console.WriteLine("Press any key to end")
    Console.ReadKey()
End Sub
```

Waiting for the arrival of a service request

There are basically two methods of waiting for the arrival of a service request:

Blocking (user inputs not possible):

This method is appropriate if the waiting time until the event to be signaled by an SRQ is short (shorter than the selected timeout), if no response to user inputs is required during the waiting time, and if – as the main criterion – the event is absolutely certain to occur.

Reason:

From the time the viWaitOnEvent() function is called until the occurrence of the expected event, it does not allow the program to respond to mouse clicks or key entries during the waiting time. Moreover, it returns an error if the SRQ event does not occur within the predefined timeout period.

The method is, therefore, in many cases not suitable for waiting for measurement results, especially when using triggered measurements.

The following function calls are required:

```
Status = viWaitOnEvent(analyzer, VI_EVENT_SERVICE_REQ, SRQWaitTimeout, VI_NULL,
 VI_NULL)
'Wait for service request user
'inputs are not possible during
'the waiting time!
IF (status = VI_SUCCESS) THEN CALL Srq
'If SRQ is recognized =>
'subroutine for evaluation


'--------- Sweep in first Spectrum Tab and query marker --------------------
Dim Status = mbSession.WaitOnEvent( _
MessageBasedSessionEventType.ServiceRequest, SRQWaitTimeout)
'Wait for service request user inputs are not possible
'during the waiting time!
If (Status.EventType() = MessageBasedSessionEventType.ServiceRequest) Then
'If SRQ is recognized => subroutine for evaluation
    Srq()
End If
```

Non-blocking (user inputs possible):

This method is recommended if the waiting time until the event to be signaled by an SRQ is long (longer than the selected timeout), and user inputs should be possible during the waiting time, or if the event is not certain to occur. This method is, therefore, the preferable choice for waiting for the end of measurements, i.e. the output of results, especially in the case of triggered measurements.

The method necessitates a waiting loop that checks the status of the SRQ line at regular intervals and returns control to the operating system during the time the expected event has not yet occurred. In this way, the system can respond to user inputs (mouse clicks, key entries) during the waiting time.

It is advisable to employ the Hold() auxiliary function, which returns control to the operating system for a selectable waiting time (see section Waiting without blocking the keyboard and mouse), so enabling user inputs during the waiting time.

```
result% = 0
For i = 1 To 10 'Abort after max. 10 loop
'iterations
Status = viWaitOnEvent(analyzer, VI_EVENT_SERVICE_REQ, VI_TMO_IMMEDIATE, VI_NULL,
 VI_NULL)
'Check event queue
If (status = VI_SUCCESS) Then
result% = 1
CALL Srq 'If SRQ is recognized =>
'subroutine for evaluation
Else
CALL Hold(20) 'Call hold function with
'20 ms 'waiting time. User inputs
'are possible.
Endif
Next i
If result% = 0 Then
Debug.Print "Timeout Error; Program aborted"'Output error message
STOP 'Stop software
Endif
```

Waiting without blocking the keyboard and mouse

A frequent problem with remote control programs using Visual Basic is to insert waiting times without blocking the keyboard and the mouse.

If the program is to respond to user inputs also during a waiting time, control over the program events during this time must be returned to the operating system. In Visual Basic, this is done by calling the `DoEvents` function. This function causes keyboard-or mouse-triggered events to be executed by the associated elements. For example, it allows the operation of buttons and input fields while the user waits for an instrument setting to be completed.

The following programming example describes the `Hold()` function, which returns control to the operating system for the period of the waiting time selectable in milliseconds.

```
Rem ***********************************************************************
Rem The waiting function below expects the transfer of the desired
Rem waiting time in milliseconds. The keyboard and the mouse remain
Rem operative during the waiting period, thus allowing desired elements
Rem to be controlled
Rem ***********************************************************************
Public Sub Hold(delayTime As Single)
Start = Timer 'Save timer count on calling the
'function
Do While Timer < Start + delayTime/1000 'Check timer count
DoEvents 'Return control to operating
'system to enable control of
'desired elements as long as
'timer has not elapsed
Loop
End Sub
Rem ***********************************************************************
```

The waiting procedure is activated simply by calling `Hold(<Waiting time in milliseconds>)`.

Service request routine

A service request is processed in the service request routine.



The variables userN% and userM% must be pre-assigned usefully!

```
REM ------------ Service request routine ---------------------------------
Public SUB Srq()
ON ERROR GOTO noDevice 'No user existing
CALL viReadSTB(analyzer, STB%) 'Serial poll, read status byte
IF STB% > 0 THEN 'This instrument has bits set in
'the STB
SRQFOUND% = 1
IF (STB% AND 16) > 0 THEN CALL Outputqueue
IF (STB% AND 4) > 0 THEN CALL ErrorQueueHandler
IF (STB% AND 8) > 0 THEN CALL Questionablestatus
IF (STB% AND 128) > 0 THEN CALL Operationstatus
IF (STB% AND 32) > 0 THEN CALL Esrread
END IF
noDevice:
END SUB 'End of SRQ routine
REM ***********************************************************************

REM ---------- Subroutine for evaluation Service Request Routine ----------

Public Sub Srq()
    Try
        Dim mySTB As Short = mbSession.ReadStatusByte()
```

```
                                'Serial poll, read status byte
        Console.WriteLine("Reading Service Request Routine:" + mySTB.ToString())
        If mySTB > 0 Then 'This instrument has bits set in the STB
            If (mySTB And 16) > 0 Then Call Outputqueue()
            If (mySTB And 4) > 0 Then Call ErrorQueueHandler()
            If (mySTB And 8) > 0 Then Call Questionablestatus()
            If (mySTB And 128) > 0 Then Call Operationstatus()
            If (mySTB And 32) > 0 Then Call Esrread()
        End If
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try
End Sub 'End of SRQ routine
```

Reading out the status event registers, the output buffer and the error/event queue is effected in subroutines.

Reading out the output buffer

```
REM -------- Subroutine for the individual STB bits -----------------------
Public SUB Outputqueue() 'Reading the output buffer
result$ = SPACE$(100) 'Make space for response
CALL InstrRead(analyzer, result$)
Debug.Print "Contents of Output Queue:"; result$
END SUB
REM ***************************************************************************
```

```
REM -------- Subroutine for the output queue -----------------------
Public Sub Outputqueue() 'Reading the output buffer
    Try
        Dim result As String = mbSession.ReadString()
        Console.WriteLine("Contents of Output Queue:" + result)
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try
End Sub
```

Reading error messages

```
REM -------- Subroutine for reading the error queue -----------------------
Public SUB ErrorQueueHandler()
ERROR$ = SPACE$(100) 'Make space for error variable
CALL InstrWrite (analyzer, "SYSTEM:ERROR?")
CALL InstrRead(analyzer, ERROR$)
Debug.Print "Error Description:"; ERROR$
END SUB
REM ***************************************************************************
```

```
REM -------- Subroutine for reading the error queue -----------------------
Sub ErrorQueueHandler()
    Dim result As String
    Dim hasErr As Boolean = True
```

```
    Do
        mbSession.Write("SYST:ERR?")
        result = mbSession.ReadString()
        Dim parts As String() = result.Split(",")
        If parts(0) = 0 Then
            hasErr = False
            Console.WriteLine(result)
        Else
            Console.WriteLine(result)
        End If
    Loop While hasErr
End Sub
```

Evaluation of SCPI status registers

```
REM ------ Subroutine for evaluating Questionable Status Register ---------
Public SUB Questionablestatus()
Ques$ = SPACE$(20)
'Preallocate blanks to text
'variable
CALL InstrWrite (analyzer, "STATus:QUEStionable:EVENt?")
CALL InstrRead(analyzer, Ques$)
Debug.Print "Questionable Status:"; Ques$
END SUB
REM *************************************************************************
REM ------ Subroutine for evaluating Operation Status Register ------------
Public SUB Operationstatus()
Oper$ = SPACE$(20) 'Preallocate blanks to text
'variable
CALL InstrWrite (analyzer, "STATus:OPERation:EVENt?")
CALL InstrRead(analyzer, Oper$)
Debug.Print "Operation Status:"; Oper$
END SUB
REM *************************************************************************

REM ------ Subroutine for evaluating Questionable Status Register ---------
Public Sub Questionablestatus()
    Dim myQSR As String = Nothing
    Try
        myQSR = mbSession.Query("STATus:QUEStionable:EVENt?") 'Read QSR
        Console.WriteLine("Questionable Status:" + myQSR)
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try
End Sub

REM ------ Subroutine for evaluating Operation Status Register ------------
Public Sub Operationstatus()
    Dim myOSR As String = Nothing
    Try
        myOSR = mbSession.Query("STATus:OPERation:EVENt?") 'Read OSR
```

```
        Console.WriteLine("Operation Status:" + myOSR)
    Catch exp As Exception
        Console.WriteLine(exp.Message)
    End Try
End Sub
```

Evaluation of event status register

```
REM ------ Subroutine for evaluating the Event Status Register ------------
Public SUB Esrread()
Esr$ = SPACE$(20) 'Preallocate blanks to text
'variable
CALL InstrWrite (analyzer, "*ESR?") 'Read ESR
CALL InstrRead(analyzer, Esr$)
IF (VAL(Esr$) AND 1) > 0 THEN Debug.Print "Operation complete"
IF (VAL(Esr$) AND 2) > 0 THEN Debug.Print "Request Control"
IF (VAL(Esr$) AND 4) > 0
THEN Debug.Print "Query Error"
IF (VAL(Esr$) AND 8) > 0
THEN Debug.Print "Device dependent error"
IF (VAL(Esr$) AND 16) > 0
THEN Debug.Print "Execution Error; Program aborted"'Output error message
STOP 'Stop software
END IF
IF (VAL(Esr$) AND 32) > 0
THEN Debug.Print "Command Error; Program aborted"'Output error message
STOP 'Stop software
END IF
IF (VAL(Esr$) AND 64) > 0 THEN Debug.Print "User request"
IF (VAL(Esr$) AND 128) > 0 THEN Debug.Print "Power on"END SUB
REM ********************************************************************

REM ------ Subroutine for evaluating the Event Status Register ------------
Public Sub Esrread()
    Try
        Dim myESR As Short = mbSession.Query("*ESR?") 'Read ESR
        If (myESR And 1) > 0 Then Console.WriteLine("Operation complete")
        If (myESR And 2) > 0 Then Console.WriteLine("Request Control")
        If (myESR And 4) > 0 Then Console.WriteLine("Query Error")
        If (myESR And 8) > 0 Then Console.WriteLine("Device dependent error")
        If (myESR And 16) > 0 Then
            Console.WriteLine("Execution Error; Program aborted") 'Output error message
            Stop 'Stop software
        End If
        If (myESR And 32) > 0 Then
            Console.WriteLine("Command Error; Program aborted") 'Output error message
            Stop 'Stop software
        End If
        If (myESR And 64) > 0 Then Console.WriteLine("User request")
        If (myESR And 128) > 0 Then Console.WriteLine("Power on")
    Catch exp As Exception
```

```
            Console.WriteLine(exp.Message)
        End Try
    End Sub
```

5.6 List of commands (Spectrum application)

[SENSe:]ESPectrum<sb>:BWID....1340
[SENSe:]ESPectrum<sb>:FILTer[:RRC]:ALPHa....1340
[SENSe:]ESPectrum<sb>:FILTer[:RRC][:STATe]....1341
[SENSe:]ESPectrum<sb>:HSPeed....1324
[SENSe:]ESPectrum<sb>:MSR:APPLy....1347
[SENSe:]ESPectrum<sb>:MSR:BAND....1348
[SENSe:]ESPectrum<sb>:MSR:BCATegory....1348
[SENSe:]ESPectrum<sb>:MSR:CLASs....1349
[SENSe:]ESPectrum<sb>:MSR:GSM:CARRier....1350
[SENSe:]ESPectrum<sb>:MSR:GSM:CPResent....1351
[SENSe:]ESPectrum<sb>:MSR:LTE:CPResent....1351
[SENSe:]ESPectrum<sb>:MSR:MPOWer....1352
[SENSe:]ESPectrum<sb>:MSR:RFBWidth....1352
[SENSe:]ESPectrum<sb>:PRESet:RESTore....1321
[SENSe:]ESPectrum<sb>:PRESet:STORe....1321
[SENSe:]ESPectrum<sb>:PRESet[:STANdard]....1320
[SENSe:]ESPectrum<sb>:RANGe<ri>:BANDwidth:RESolution....1325
[SENSe:]ESPectrum<sb>:RANGe<ri>:BANDwidth:VIDeo....1325
[SENSe:]ESPectrum<sb>:RANGe<ri>:COUNt?....1325
[SENSe:]ESPectrum<sb>:RANGe<ri>:DELete....1326
[SENSe:]ESPectrum<sb>:RANGe<ri>:FILTer:TYPE....1326
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:ATTenuation....1328
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:ATTenuation:AUTO....1328
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:GAIN:STATe....1329
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:GAIN[:VALue]....1329
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:SANalyzer:ATTenuation....1329
[SENSe:]ESPectrum<sb>:RANGe<ri>:INPut:SANalyzer:ATTenuation:AUTO....1330
[SENSe:]ESPectrum<sb>:RANGe<ri>:INSert....1331
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STARt....1331
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STOP....1332
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt....1332
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:ABS....1333
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:FUNCtion....1333
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP....1334
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:ABS....1334
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:FUNCtion....1335
[SENSe:]ESPectrum<sb>:RANGe<ri>:LIMit<li>:STATe....1336
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6 I/Q Capture application

6.1 Welcome to the I/Q Capture application

The FSWX provides a basic I/Q data capturing application as part of the base unit. You can also export the captured I/Q data to a file for analysis in another application.

For I/Q data analysis, use the optional "I/Q Spectrum Analyzer" application, for example.



This section describes the functionality that the application provides, including remote control operation.

All functions not discussed here are general functionality.

For more information, see Section 4, "General functionality", on page 102.

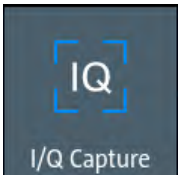
6.1.1 Starting the I/Q Capture application

To activate the I/Q Capture application

1. Select [Mode].

   A dialog box opens that contains all applications currently available on your FSWX.

2. Select "I/Q Capture".



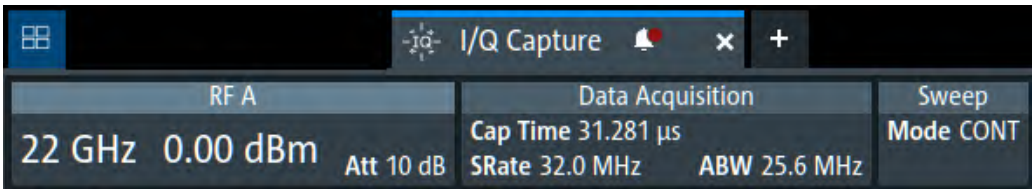
A new application instance opens for the "I/Q Capture" application.

A measurement starts immediately with the default settings.

You configure the "I/Q Capture" application in the "Overview" dialog box, which is displayed when you select "Overview" from any menu. See Section 6.3.1, "Configuration overview", on page 1454.

6.1.2 Application-specific display information

Beneath the application name, important settings for the application instance are displayed in the application info panel. If you double-click a setting in the application info panel, the corresponding settings dialog box or links to the corresponding settings are displayed.



The application info panel shows the following information for the "I/Q Capture":

RF settings per input source (RF A/B)
For each RF input, the following settings are displayed.

- "Center Frequency"
- "Reference level"
- "Att": Overall mechanical and electronic RF attenuation
- "SAN: Att": Analyzer attenuation when using an (optional) external frontend
- "ExtFE: Att": External frontend attenuation when measuring external frontend input.
- "PA": The preamplifier is enabled. / Data compensation is performed using data from the (optional) external preamplifier.
- "LPN": Low phase noise signal path is enabled. ("Spectrum" application only)
- "YIG": The YIG preselector is enabled.
- "DC": DC coupling is used for the input.

If an overload occurs at one of the RF input connectors, the corresponding RF input label is highlighted red.



I/Q file
For each I/Q file input source, the following settings are displayed:
- "File name"

Correction
If applicable, the following correction values are displayed for each input source:
- "Ref Lev Offset"
- "Freq Offset": A frequency offset ≠ 0 Hz is set.
- "75 Ω": The input impedance of the instrument is set to 75 Ω.
- "IFCorr": IF cable correction for an active optional external frontend is enabled and a valid correction file is available.
- "ExtDev": An optional external frontend is active with an external device connected to it, or a correction file for the external device is loaded and active.
- "TDF": a transducer factor is enabled

Data Acquisition
The following data acquisition values are displayed for each input source:
- "Cap Time": Capture time
  See "Capture Time" on page 177.
- "SRate": Sample rate
  See "Sample Rate" on page 176.
- "ABW": Analysis bandwidth
  See "Analysis Bandwidth (expert parameter)" on page 177.

Sweep
The following sweep values are displayed for each input source:
- "Mode": Sweep mode
  - "SGL": single sweep mode
  - "CONT": continuous sweep mode

6.2 Measurements and results

Access: [Meas]

Or:"Overview" > "Display Config"

The basic I/Q Capture measurement captures I/Q data from one or more input signals and displays the data.

For details, refer to Section 4.1.4.2, "Basics on I/Q data input and output", on page 116.

The I/Q Capture provides two basic result displays, one in the time domain, one in the frequency domain.

Note that for these I/Q data capture displays, only the following common result evaluation functions are available:

- Zooming
  For more information, see Section 4.8.6, "Zoomed displays", on page 333.
- I/Q data export
  For more information, see "I/Q Export" on page 379.

Magnitude
Shows the level values in the time domain.

Remote command:
`LAY:ADD:WIND? '1',RIGH,MAGN`, see `LAYout:ADD[:WINDow]?` on page 656
Results:
`TRACe:IQ:DATA?` on page 1465

FFT Spectrum
Displays the frequency spectrum of the captured I/Q samples. The spectrum of each input source is indicated by colored vertical lines.

Remote command:
`LAY:ADD:WIND? '1',RIGH,FREQ`, see `LAYout:ADD[:WINDow]?` on page 656
Results:
`TRACe:IQ:DATA?` on page 1465

Custom View / Tabbed View
For multi-input data capture, switches between the different displays.

For details, see Section 3.6.3.4, "Switching between a tabbed and custom multi-result window display", on page 84.

"Custom View" The results are combined in one display. The display contains multiple traces, one for each source.

"Tabbed View" Each trace from each input source is displayed in a separate tab of the window. In addition, an overview tab displays all traces in one window.

Remote command:
`DISPlay[:WINDow<n>]:LAYout` on page 609

6.3 I/Q capture configuration

- Configuration overview....1454
- Receiving data input and providing data output....1456
- Trigger setup....1456
- Scale configuration....1460
- I/Q trace configuration....1462
- Aligning the input in phase and time....1462
- Sweep settings....1463

6.3.1 Configuration overview

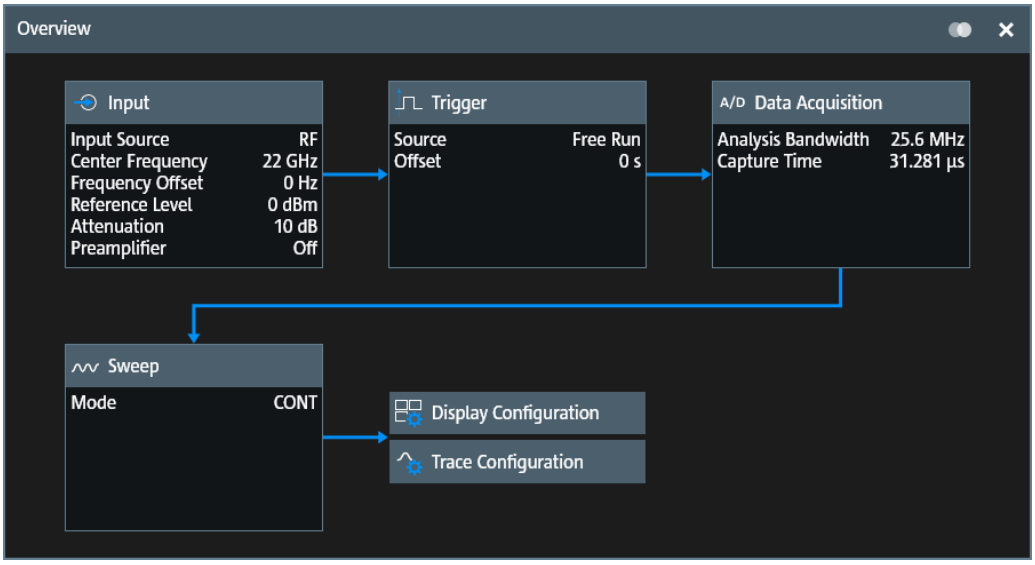


Access: all menus

Throughout the application instance configuration, an overview of the most important currently defined settings is provided in the "Overview".

In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in

the order of the data flow. Thus, you can easily configure an entire application instance from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".



The "Overview" for the I/Q Capture application provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Input configuration
   See Section 6.3.2, "Receiving data input and providing data output", on page 1456
2. Trigger configuration
   See Section 6.3.3, "Trigger setup", on page 1456
3. Data acquisition configuration
   See Section 4.2.1.4, "Data acquisition settings", on page 176
4. Sweep configuration
   See Section 6.3.7, "Sweep settings", on page 1463.
5. Display configuration
   See Section 6.2, "Measurements and results", on page 1453
6. Trace configuration
   See Section 6.3.5, "I/Q trace configuration", on page 1462

To configure settings

► Select any button in the "Overview" to open the corresponding dialog box.
Select a setting in the application info panel to change a specific setting.

For step-by-step instructions on configuring I/Q Capture measurements, see Section 4.2.2.2, "How to capture I/Q data", on page 190.

Preset application instance
Select "Preset Application" in the "Overview" to restore all measurement settings *in the current application instance* to their default values.

Note:
Do not confuse the "Preset Application" button with the [Preset] *key*. The [Preset] key restores the entire instrument to its default values, and thus closes *all application instances* on the FSWX (except for the default application instance).

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 791

Specifics for
The application instance can contain several windows for different results. Thus, the settings indicated in the "Overview" and configured in the dialogs vary depending on the selected window.

Select an active window from the "Specifics for" selection list that is displayed in the "Overview" and in all window-specific configuration dialogs.

The "Overview" and dialogs are updated to indicate the settings for the selected window.

6.3.2 Receiving data input and providing data output

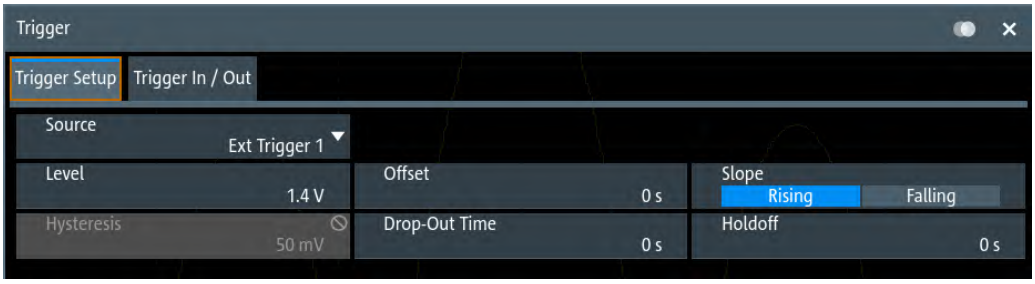
The "I/Q Capture" application can perform I/Q measurements on signals from the following input sources:

- RF connectors ("RF A | B")
- I/Q file
- Power sensor
- Probe

Input and output configuration in the "I/Q Capture" application is the same as in the "Spectrum" application. See Section 4.2, "Receiving data input and providing data output", on page 168.

6.3.3 Trigger setup

Access: "Overview" > "Trigger/Gate"



For step-by-step instructions on configuring triggered measurements, see Section 4.4.3, "How to configure a triggered measurement", on page 263.

Trigger Source....1457
└ Free Run....1457
└ Ext Trigger1 to 4....1457
└ Enhanced Power....1458
└ I/Q Power....1458
└ Power Sensor....1458
Repetition Interval....1458
Trigger Offset....1458
Slope....1459
Hysteresis....1459
Drop-Out Time....1459
Trigger Holdoff....1459
Correct TPIS....1460

Trigger Source
Selects the trigger source. If you select a trigger source other than "Free Run", the trigger source is indicated in the application panel.

For more information, see Section 4.3.4.1, "Initiating a measurement: trigger source", on page 247.

For an active external frontend, only external triggers, I/Q power triggers and (periodic) time triggers are supported as trigger sources. See "Basic configuration settings" on page 212.

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 633

Free Run ← Trigger Source
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

Remote command:
`TRIG:SOUR IMM`

Ext Trigger1 to 4 ← Trigger Source
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified "Trigger Level".

"Ext Trigger 1"
Trigger signal from the "Trigger 1 Input" connector.

"Ext Trigger 2"
Trigger signal from the connector.
Note: You must configure the connector for input in the trigger input/output settings.

See Section 4.2.7.1, "Trigger input/output settings", on page 234.

"Ext Trigger 3"
Trigger signal from the "Trigger 3 Input" connector.

"Ext Trigger 4"

Trigger signal from the "Trigger 4 In / Out" connector.
Note: You must configure the connector for input in the trigger input/ output settings.

See Section 4.2.7.1, "Trigger input/output settings", on page 234.

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`

Enhanced Power ← Trigger Source
This trigger source requires the Enhanced Power Trigger option.

The power level from a separate RF input signal with a user-defined frequency and bandwidth triggers the measurement. Thus, you can trigger the measurement using different settings than the measurement itself uses.

Remote command:
`TRIG:SOUR EPOW`

I/Q Power ← Trigger Source
This trigger source is only available for I/Q measurements and in applications that process I/Q data.

Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

The trigger bandwidth corresponds to the analysis bandwidth setting for I/Q data acquisition.

Remote command:
`TRIG:SOUR IQP`

Power Sensor ← Trigger Source
Uses an external power sensor as a trigger source. This option is only available if a power sensor is connected and configured.

For a power sensor trigger, you define the trigger level in the power sensor settings.

For more information, see Section 4.2.3.2, "Power sensor settings", on page 193.

Remote command:
`TRIG:SOUR PSE`

Repetition Interval
Defines the repetition interval for a time trigger.

The shortest interval is 2 ms.

Set the repetition interval to the exact pulse period, burst length, frame length or other repetitive signal characteristic. If you cannot set the required interval with the available granularity, configure a multiple of the interval that is supported. Thus, the trigger remains synchronized to the signal.

Remote command:
`TRIGger[:SEQuence]:TIME:RINTerval` on page 635

Trigger Offset
Defines the time offset between the trigger event and the start of the sweep.

For more information, see Section 4.3.4.2, "Pretrigger and posttrigger: trigger offset", on page 248.

Offset > 0:	Start of the sweep is delayed
Offset < 0:	Sweep starts earlier (pretrigger) Only possible for zero span and if gated trigger is disabled. The maximum allowed range is limited by the sweep time: $Pretrigger_{max}$ = $sweep\ time_{max}$

Remote command:
`TRIGger[:SEQuence]:HOLDoff` on page 630

Slope
Defines whether triggering occurs when the signal rises to the trigger level or falls down to it.

This setting is available for all trigger sources except time.

Remote command:
`TRIGger[:SEQuence]:SLOPe` on page 633

Hysteresis
Defines the distance in dB to the trigger level that the trigger source must exceed before the next trigger event occurs. Setting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step size of 1 dB.

For more information, see Section 4.3.4.3, "Avoiding unwanted triggers by level: trigger hysteresis", on page 248.

Remote command:
`TRIGger<ip>[:SEQuence]:POWer:HYSTeresis` on page 633

Drop-Out Time
Defines the time that the input signal must stay below the trigger level before triggering again.

For more information, see Section 4.3.4.4, "Stabilizing triggers in pulsed signals: trigger dropout time", on page 249.

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 630

Trigger Holdoff
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

For more information, see Section 4.3.4.5, "Reducing the number of triggers in time: Trigger holdoff", on page 250.

Remote command:
`TRIGger[:SEQuence]:POWer:HOLDoff` on page 632

Correct TPIS
If enabled, the trigger event is set to the actual trigger point within the sample (TPIS).
See also Section 4.3.4.7, "Determining the exact trigger point - TPIS", on page 252.

This setting is available for all trigger sources except "Free Run".

Remote command:
`TRIGger[:SEQuence]:CTPis` on page 629

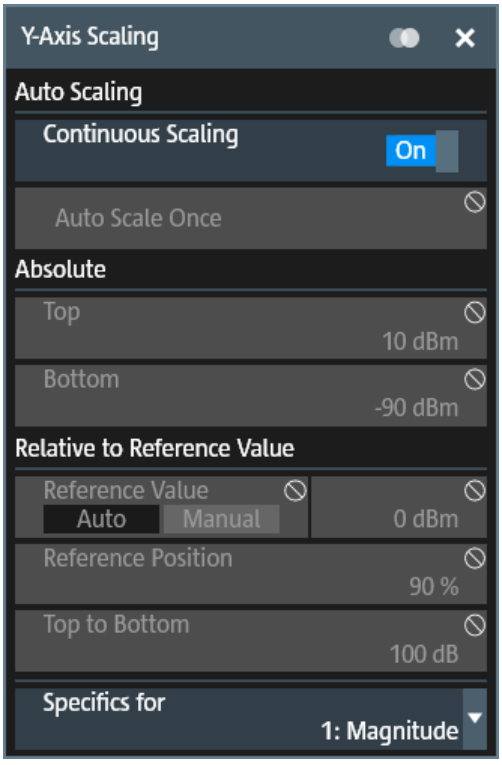
6.3.4 Scale configuration

The individual scaling settings that affect the vertical axis are described here.

Access: "Overview" > "Amplitude" > "Scale" tab

Or: [Ampt / Scale] > "Scale Config"

The remote commands required to define these settings are described in Section 6.4.2, "Scaling the Y-axis", on page 1466.



Continuous Scaling 1461
Auto Scale Once 1461
Top / Bottom 1461
Reference Value 1461
Reference Position 1461
Top to Bottom Scaling 1461

Continuous Scaling
Automatically determines the optimal range and reference level position to be displayed for the current measurement settings. If the measurement settings change, the scaling is automatically re-adapted.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE` on page 1467

Auto Scale Once
Automatically determines the optimal range and reference level position to be displayed for the current measurement settings.

The display is only adjusted once; it is not adjusted again if the measurement settings change.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE` on page 1467

Top / Bottom
Defines the y-axis range using absolute values.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum` on page 1467
`DISPlay[:WINDow<n>]:TRACe<n>:Y[:SCALe]:MINimum` on page 1468

Reference Value
Defines a reference value for relative y-axis scaling in the currently selected diagram. By default, this value defines the maximum value of the y-axis (see "Reference Position" on page 1461).

In "Auto" mode, the FSWX selects the optimal reference level for the current measurement settings.

In "Manual" mode, define a fixed value manually.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 1467

Reference Position
Defines the position of the reference value, i.e. the position of the maximum AD converter value on the level axis in percent.

0 % corresponds to the lower and 100 % to the upper limit of the diagram.

Values from -120 % to +280 % are supported.

Larger values are useful for:
- Small scales, such as a power range of 10 dB or 20 dB
- Low signal levels, for example 60 dB below the reference level

In these cases, large reference position values allow you to see the trace again.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 1469

Top to Bottom Scaling
Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] on page 1467

6.3.5 I/Q trace configuration

For all I/Q data capture displays, the "Auto Peak" is used. For multi-input measurements, you must define which RF input the trace is based on. Thus, you can combine the results from different RF inputs in one display.



Add Trace....1462
Trace State....1462
Input Source....1462

Add Trace
Enables the next available trace in the selected result display and displays the "Trace Configuration" dialog to configure the trace.

For more information, see Section 4.8.1.2, "How to configure a standard trace", on page 299.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>[:STATe] on page 1464

Trace State
Enables or disables the trace in the selected display.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>[:STATe] on page 1464

Input Source
Defines which input source provides the data for the trace, as configured in the Section 4.2.1.1, "Input source configuration (Input Assistant)", on page 169.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:INPut on page 609

6.3.6 Aligning the input in phase and time

Access: [Auto Set]

Perform Phase & Time Self-Alignment....1463

Perform Phase & Time Self-Alignment
Self-aligns the FSWX signal paths in phase and time. The measured values are then used as a reference for subsequent measurements. Alignment is important for phase-aligned or time-aligned measurements on multiple signal paths, such as phase difference or group delay between different inputs. Phase and time self-alignment requires a successful general self-alignment on the instrument.

This function is only available for applications that support multi-input.

Perform phase and time self-alignment after:
- Switching application instances
- Changing the frequency for any of the RF inputs
- Changing the reference level or other amplitude settings for any of the RF inputs
- Changing the sampling rate or analysis bandwidth

Remote command:
`[SENSe<ip>:]ADJust:PTIMe` on page 644

6.3.7 Sweep settings

Access: [Sweep]

The sweep settings allow you to perform measurements.

[Run Cont] / Continuous Sweep....1463
[RUN SINGLE] / Run Single Sweep....1463
Continue Single Sweep....1464

[Run Cont] / Continuous Sweep
After triggering, the sweep starts and repeats continuously until you press [Run Cont] or "Continuous Sweep" again.

While the measurement is running, the [Run Cont] key and the "Continuous Sweep" softkey are highlighted. The results are not deleted until a new measurement starts.

Note: If the "Sequencer" is active, the [Run Cont] key controls the "Sequencer", not individual sweeps. [Run Cont] starts the "Sequencer" in continuous mode.

Remote command:
`INITiate<n>:CONTinuous` on page 646

[RUN SINGLE] / Run Single Sweep
After triggering, the sweep starts and repeats continuously until the defined number of sweeps are finished.

While the measurement is running, the Run Single key and the "Run Single Sweep" softkey are highlighted. Abort the running measurement by selecting Run Single or "Run Single Sweep" again. The results are not deleted until a new measurement starts.

Note: If the "Sequencer" is active, the [Run Single] key controls the "Sequencer", not individual sweeps. [Run Single] starts the "Sequencer" in single mode.
If the "Sequencer" is off, only the evaluation for the currently displayed application instance is updated.

For details on the "Sequencer", see Section 4.1.1.2, "Running a sequence of measurements - the Sequencer concept", on page 103.

Remote command:
`INITiate<n>[:IMMediate]` on page 647

Continue Single Sweep
After triggering, repeats the defined number of sweeps, without deleting the trace of the last measurement.

While the measurement is running, the "Continue Single Sweep" softkey and the [Run Single] key are highlighted. Abort the running measurement by selecting the highlighted softkey or key again.

Remote command:
`INITiate<n>:CONMeas` on page 645

6.4 I/Q data capturing commands

The following commands are required to configure I/Q data capturing in the "I/Q Capture" application.

Useful commands for capturing I/Q data described elsewhere:

- `INST:CRE:NEW IQC, 'I/Q Capture'`, see `INSTrument:CREate[:NEW]` on page 541
- Section 4.14.6.10, "Configuring I/Q data acquisition", on page 622
- Section 4.14.6.9, "Configuring the amplitude", on page 613
- Section 4.14.6.8, "Defining the frequency", on page 612
- Section 4.14.7.1, "Configuring the triggering conditions", on page 629

- Trace commands 1464
- Scaling the Y-axis 1466

6.4.1 Trace commands

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] 1464
DISPlay[:WINDow<n>]:TRACe<t>:INPut 1465
TRACe:IQ:DATA? 1465
TRACe:IQ:DATA:FORMat 1466
MMEMory:STORe<n>:IQCap:MEAS 1466

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

Turns a trace on and off.

The measurement continues in the background.

Suffix:
<n> Window 1 to 16
Irrelevant in the Receiver application.

<t> Trace 1 to 6

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP:TRAC3 ON`

Manual operation: See "Add Trace" on page 1462
See "Trace State" on page 1462

DISPlay[:WINDow<n>]:TRACe<t>:INPut <input>

Defines which input source provides the data for the trace in a multi-input setup.

Suffix:

<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:

<input> integer

Index of the input source

Example: `DISPlay:WINDow2:TRAC4:INPut 3`

Manual operation: See "Input Source" on page 1462

TRACe:IQ:DATA? [<ip>]

Initiates a measurement with the current settings and returns the captured data from I/Q measurements.

Query parameters:

<ip> Input

Return values:

<IQData> Measured RMS voltage for I and Q component for each sample that has been captured during the measurement.

Default unit: V

Example: //Start measurement and read results from stream 1
`TRAC:IQ:DATA? 1`

Usage: Query only

Manual operation: See "Magnitude" on page 1454
See "FFT Spectrum" on page 1454

TRACe:IQ:DATA:FORMat <Format>

Selects the order of the I/Q data.

For more information, see "Reference: format description for I/Q data files" on page 153.

For input from SnP files, not all settings are supported.

For more information, see Section 4.14.13.4, "Compensating for frequency response using touchstone files", on page 826.

Parameters:

<Format> COMPatible | IQBLock | IQPair

COMPatible
I and Q values are separated and collected in blocks: A block (512k) of I values is followed by a block (512k) of Q values, followed by a block of I values, followed by a block of Q values etc.
(I,I,I,I,Q,Q,Q,Q,I,I,I,I,Q,Q,Q,Q...)

IQBLock
First all I values are listed, then the Q values
(I,I,I,I,I,I,...Q,Q,Q,Q,Q,Q)
This option is not available for input from SnP files.

IQPair
One pair of I/Q values after the other is listed
(I,Q,I,Q,I,Q...).
This option is the default for input from SnP files.

*RST: IQBL

Example:
```
TRAC:IQ:DATA:FORM IQBL
```

MMEMory:STORe<n>:IQCap:MEAS <FileName>

Stores the current measurement results (all enabled traces of all windows) into the specified file in `CSV` format.

Suffix:

<n> Window 1 to 16

Parameters:

<FileName> String containing the path and name of the file.

Example:
```
MMEM:STOR:IQC:MEAS 'MyMeas.csv'
```

Usage: Setting only

6.4.2 Scaling the Y-axis

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] 1467
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE 1467
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum 1467

DISPlay[:WINDow<n>]:TRACe<n>:Y[:SCALe]:MINimum....1468
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE....1468
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision....1468
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition....1469
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue....1469
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue:AUTO....1470
DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing....1470

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] <Range>

Defines the display range of the y-axis (for all traces).

Note that the command works only for a logarithmic scaling. You can select the scaling with `DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 1470.

Suffix:
<n> Window 1 to 16

<t> irrelevant

Parameters:
<Range> Range: 1 dB to 200 dB
*RST: 100 dB

Example: `DISP:TRAC:Y 110dB`

Manual operation: See "Reference Value" on page 1461
See "Top to Bottom Scaling" on page 1461

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE <Auto>

Automatic scaling of the y-axis is performed once, then switched off again (for all traces).

Suffix:
<n> Window 1 to 16

<t> irrelevant

Example: `DISP:WIND:TRAC:Y:SCAL:AUTO ONCE`

Manual operation: See "Continuous Scaling" on page 1461
See "Auto Scale Once" on page 1461

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum <Max>

Defines the maximum reference value assigned to the reference position in the specified window.

Suffix:
<n> Window 1 to 16

<t> irrelevant

Parameters:

<Max> Range: 1 dB to 200 dB
*RST: 100 dB

Example: `DISP:TRAC:Y:MAX 110dB`

Manual operation: See "Top / Bottom" on page 1461

DISPlay[:WINDow<n>]:TRACe<n>:Y[:SCALe]:MINimum <Min>

Defines the minimum reference value assigned to the reference position in the specified window.

Suffix:

<n> Window 1 to 16

<t> irrelevant

Parameters:

<Min> Range: 1 dB to 200 dB
*RST: 100 dB

Example: `DISP:TRAC:Y:MIN 110dB`

Manual operation: See "Top / Bottom" on page 1461

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE <Mode>

Selects the type of scaling of the y-axis (for all traces).

When the display update during remote control is off, this command has no immediate effect.

Suffix:

<n> Window 1 to 16

<t> irrelevant

Parameters:

<Mode> ABSolute | RELative

ABSolute
absolute scaling of the y-axis

RELative
relative scaling of the y-axis

*RST: ABSolute

Example: `DISP:TRAC:Y:MODE REL`

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision <GridSpacing>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

Suffix:
<n> Window 1 to 16

<t> irrelevant

Parameters:
<GridSpacing> numeric value WITHOUT UNIT (unit according to the result display)

Defines the range per division (total range = 10*<Value>)

*RST: depends on the result display
Default unit: dB

Example: //Set the grid spacing to 10 units (e.g. dB) per division
```
DISP:TRAC:Y:PDIV 10
```

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition <Position>

Defines the vertical position of the reference level on the display grid (for all traces).

The FSWX adjusts the scaling of the y-axis accordingly.

Suffix:
<n> Window 1 to 16

<t> irrelevant

Parameters:
<Position> 0 PCT corresponds to the lower display border, 100% corresponds to the upper display border.

*RST: 100 PCT = frequency display; 50 PCT = time display
Default unit: PCT

Example:
```
DISP:TRAC:Y:RPOS 50PCT
```

Manual operation: See "Reference Position" on page 1461

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue <RefValue>

Defines the reference value assigned to the reference position in the specified window. Separate reference values are maintained for the various displays.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<RefValue>

Example: //Set the value assigned to the reference position to 0 Hz
```
DISP:TRAC:Y:RVAL 0
```

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue:AUTO <RefValAuto>

Defines whether the reference value is determined automatically by the application or defined manually by the user.

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
The value is defined by `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue` on page 1469.

ON | 1
The value is determined automatically.

*RST: 0

DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing <ScalingType>

Selects the scaling of the y-axis (for all traces, <t> is irrelevant).

Suffix:
<n> Window 1 to 16

<t> Trace 1 to 6

Parameters:
<ScalingType> LINear | LOGarithmic | PERCent | LDB

LOGarithmic
Logarithmic scaling.

LINear
Linear scaling in %.

LDB
Linear scaling in the specified unit.

PERCent
Linear scaling in %.

*RST: LOGarithmic

Example: //Select linear scaling in %.
```
DISP:TRAC:Y:SPAC LIN
```

6.5 List of commands (I/Q capture)

DISPlay[:WINDow<n>]:TRACe<n>:Y[:SCALe]:MINimum ... 1468
DISPlay[:WINDow<n>]:TRACe<t>:INPut ... 1465
DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing ... 1470
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] ... 1467

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE 1467
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum 1467
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE 1468
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision 1468
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition 1469
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue 1469
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue:AUTO 1470
DISPlay[:WINDow<n>]:TRACe<t>[:STATe] 1464
MMEMory:STORe<n>:IQCap:MEAS 1466
TRACe:IQ:DATA:FORMat 1466
TRACe:IQ:DATA? 1465

7 Troubleshooting

If you need to transport or ship the product, see Section 8.3, "Transporting", on page 1485.

- Error information 1472
- Error messages in remote control mode 1474
- Troubleshooting remote operation 1475
- Reference: Status bar messages for CrossACT 1476
- Troubleshooting external frontend control 1477
- Miscellaneous troubleshooting hints 1480
- Collecting information for support 1482
- Contacting customer support 1484

7.1 Error information

If errors or irregularities occur, an icon and a message, if available, are displayed in the status bar.



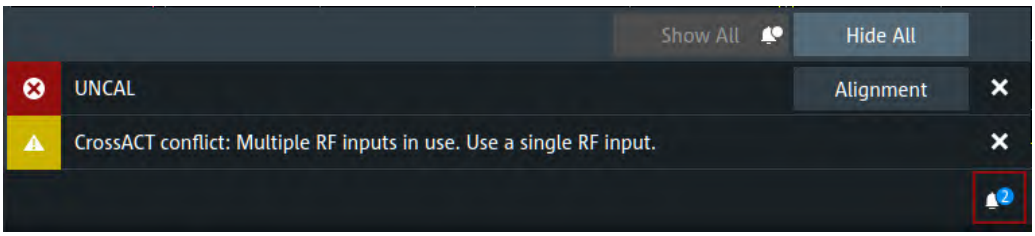
The color of the icon indicates the severity of the message.

Table 7-1: Status bar information - color coding

Color	Type	Description
Red	Error	An error occurred at the start or during a measurement, e.g. due to missing data or wrong settings, so that the measurement cannot be started or completed correctly.
Orange	Warning	An irregular situation occurred during measurement, e.g. the settings no longer match the displayed results, or the connection to an external device was interrupted temporarily.
Gray	Information	Information on the status of individual processing steps.
Green	Measurement successful	Some applications visualize that the measurement was successful by showing a message.
No color	No errors	No message displayed - normal operation.



If multiple messages are available, only the most severe message is visible. New but less severe messages are displayed shortly, then the most severe message returns. An icon indicates further messages. Select the icon to display a list of all messages.



Additional action buttons

The status bar can also contain a button if the displayed status information requires a specific action. For example, if the "UNCAL" error is displayed, an "Alignment" button allows you to open the self-alignment configuration dialog to solve the issue directly.

If any error information is available for an application instance, an alarm bell is displayed next to the application instance name ( ). This is particularly useful when the "MultiView" tab is displayed, as the status bar in the "MultiView" tab always displays the information for the currently selected measurement only.

Furthermore, a status bit is set in the `STATus:QUEStionable:EXTended:INFO` register for the application concerned, see "STATus:QUEStionable:EXTended:INFO register" on page 498. You can query messages of a specific type using the `SYST:ERR:EXT?` command, see `SYSTem:ERRor:EXTended` on page 860. Some errors also change particular status bits in other registers, as indicated in Table 7-2.

For more information, see Section 4.13.3, "Status reporting system", on page 491.

Table 7-2: List of keywords

Keyword	Description	Bit in status register
"INPUT OVLD"	The signal level at the RF input connector exceeds the maximum. The RF input is disconnected from the input mixer to protect the device. To re-enable measurement, decrease the level at the RF input connector and reconnect the RF input to the mixer input. (See "RF input protection" on page 172).	`STATus:QUEStionable:POWer`, bit 3
"OVLD"	Overload of the input signal path after the input mixer • Reduce the input level.	`STATus:QUEStionable:POWer`, bit 2
"RF OVLD"	Overload of the input mixer or of the analog IF path. • Increase the RF attenuation (for RF input). • Reduce the input level (for digital input)	`STATus:QUEStionable:POWer`, bit 0
"LO UNL"	Error in the instrument's frequency processing hardware was detected.	`STAT:QUES:FREQuency`, bit 1
"NO REF"	Instrument was set to an external reference but no signal was detected on the reference input.	`STAT:QUES:FREQuency`, bit 8
"OVENCOLD"	The optional OCXO reference frequency has not yet reached its operating temperature. The message usually disappears a few minutes after power has been switched on.	`STAT:QUES:FREQuency`, bit 0
"UNCAL"	One of the following conditions applies: • Correction data has been switched off. • No correction values are available, for example after a firmware update. • Record the correction data by performing a self-alignment (For details refer to Section 3.3.17, "Performing a self-alignment", on page 30).	`STATus:QUEStionable`, bit 8

Keyword	Description	Bit in status register
"OLD CAL"	Calibration data outdated. Perform a new self-alignment. Also displayed if Reuse Old Alignment Data is enabled. (For details refer to Section 3.3.17, "Performing a self-alignment", on page 30).	
"WRONG_FW"	The firmware version is out-of-date and does not support the currently installed hardware. Until the firmware version is updated, this error message is displayed and self-alignment fails. (For details refer to Section 4.11.8.2, "Versions and firmware", on page 447).	

7.2 Error messages in remote control mode

In remote control mode error messages are entered in the error/event queue of the status reporting system and can be queried with the command `SYSTem:ERRor?`. The answer format of FSWX to the command is as follows:

```
<error code>, "<error text with queue query>;<remote control command concerned>"
```

The indication of the remote control command with prefixed semicolon is optional.

Example:

The command `TEST:COMMAND` generates the following answer to the query `SYSTem:ERRor?`:

```
-113,"Undefined header;TEST:COMMAND"
```

There are two types of error messages:

- Error messages defined by SCPI are marked by negative error codes. These messages are defined and described in the SCPI standard and not listed here. See https://www.ivifoundation.org/downloads/SCPI/scpi-99.pdf, chapters 21.8.9 to 21.8.16.
- Device-specific error messages use positive error codes. These messages are described below.

Table 7-3: Device-specific error messages

Error code	Error text for queue poll Error explanation
1006	`Failed to connect to server (code. 1006)` LAN browser access to the instrument has been disabled.
1052	`Frontend LO is Unlocked` This message is displayed when the phase regulation of the local oscillator fails in the RF frontend.

Error code	Error text for queue poll Error explanation
1060	`Trigger-Block Gate Delay Error- gate length < Gate Delay` This message is displayed when the gate signal length is not sufficient for the pull-in delay with a predefined gate delay.
2028	`Hardcopy not possible during measurement sequence` This message is displayed when a printout is started during scan sequences that cannot be interrupted. Such sequences are for example: ● Recording the system error correction data (alignment) ● Instrument self-test In this case, synchronize to the end of the scan sequence before starting the printout.
2033	`Printer Not Available` This message is displayed when the selected printer is not included in the list of available output devices. A possible cause is that the required printer driver is missing or incorrectly installed.
2034	`CPU Temperature is too high` This message is displayed when the temperature of the processor exceeds 70 °C.

Table 7-4: Power Sensor errors

Status bar message	Description
Zeroing could not be performed	Zeroing could not be performed because the RF power applied is too high.
Power sensor zero failed	

7.3 Troubleshooting remote operation

If problems arise during measurement in remote operation, try the following methods to solve them.

Incompleted sequential commands - blocked remote channels

If a sequential command cannot be completed, the remote control program never finishes. The remote channel to the FSWX is blocked for further commands. For example, a triggered sweep never receives a trigger. In this case, you must interrupt processing on the remote channel to abort the measurement.

To regain control over a blocked remote channel

Usually, if you wait a minute for the VISA connection to detect the lost connection and clear the control channel by itself, you can then re-establish the connection again. If this fails, try the following:

1. Select "Local" on the front panel of the FSWX to return to manual operation (if not disabled). Then re-establish the connection.

2. Send a `Device Clear` command from the control instrument to the FSWX to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:
   - **Visa**: `viClear()`
   - **GPIB**: `ibclr()`
   - **RSIB**: `RSDLLibclr()`

   The remote channel currently processing the incompleted command is then ready to receive further commands again.
3. On the remote channel performing the measurement, send the SCPI command `ABORt` to abort the current measurement and reset the trigger system.
4. If the FSWX still does not react to the remote commands, switch it off and back on.

Ignored commands

When a remote command attempts to define incompatible settings, the command is ignored and the instrument status remains unchanged. Other settings are not automatically adapted. Therefore, always start control programs by defining an initial instrument status, e.g. using the `*RST` command. Then implement the required settings.

Detecting false commands - log file

If a remote program does not provide the expected results and you are using a GPIB connection, you can log the commands and any errors that occur. To enable the SCPI error log function, in the "Network & Remote" dialog box, in the "Remote" tab, select "I/O Logging".

All remote control commands received by the FSWX are recorded in log files with the following syntax:

`home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpilogging/ScpiLog.<xx>`

Where <xx> is a consecutive number, starting with 00;

A new file is created each time you stop and restart the logging function. The lowest available number is used for the <xx> extension.

Logging the commands can be extremely useful for debug purposes, e.g. to find misspelled keywords in control programs. However, remember to turn off the logging function after debugging to avoid unnecessary access to the hard disk drive and use of storage space.

7.4 Reference: Status bar messages for CrossACT

As "CrossACT" groups can contain very different applications, several restrictions apply to the supported measurement settings. See also Section 4.1.2.4, "Restrictions and limitations of CrossACT", on page 113. If conflicts arise while configuring a "CrossACT" group, messages describing the problem are displayed in the status bar.

Select the "Show" button in the status bar to display the "CrossACT Group Overview". There you can change the configuration to resolve the conflict. See Section 4.6.4.2, "CrossACT Group Overview", on page 274.

Table 7-5: Status bar messages for Cross-Application Control and Triggering

Conflict message	Solution / Comment
"Multiple sweeps detected. Adjust Sweep Count to 1."	Measurements that require multiple data captures cannot be performed in a "CrossACT" group.
"Non-I/Q measurement detected. Select I/Q-based measurement."	Only I/Q-based measurements can be part of a "CrossACT" group.
"File input detected. Deactivate file input."	Measurements based on file input cannot be part of a "CrossACT" group.
"RMS X-Corr trace detector not supported. Select a different one."	Cross-correlation functionality is not supported in a "CrossACT" group. Select a different trace detector, e.g. the common RMS detector.
"Switch off Optimization."	"CrossACT" groups do not support optimization functions.
"Multicarrier configuration requires multiple captures. Reconfigure."	Measurements that require multiple data captures cannot be performed in a "CrossACT" group.
"Multiple RF inputs in use. Use a single RF input."	Each application instance in the "CrossACT" group can only use a single input source. Disable one of the RF inputs for the conflicting application.
"Same RF input used in multiple applications. Use a distinct RF input."	Each input source can only be used by a single application instance within a "CrossACT" group. Select a different RF input for each application.
""<App>" is not supported."	The selected application cannot be part of a "CrossACT" group. It does not support the functionality. For a list of supported applications, see Section 4.1.2.4, "Restrictions and limitations of CrossACT", on page 113.
""<App>" is not supported in non-I/Q-measurement. Select I/Q-based measurement."	The selected application is configured to perform an RF measurement. Only I/Q-based measurements can be part of a "CrossACT" group.

7.5 Troubleshooting external frontend control

If problems arise during external frontend control, try the following measures to optimize the connection or setup.

For additional information, see the external frontend documentation.

7.5.1 Error messages

If errors occur, status messages in the external frontend configuration dialog box and in the status bar of the display inform you about them.

Query the error message queue using the remote command `SYST:ERR?` to determine if any or which errors occurred during operation. For details, see Section 7.2, "Error messages in remote control mode", on page 1474.

If any errors occur that are not described here, contact the Rohde & Schwarz customer support, see Section 7.8, "Contacting customer support", on page 1484.

Table 7-6: Status and error messages

Status bar message	Dialog status	SYST:ERR? result	Description/ Possible solution
External Frontend [x]: Connecting...	Connecting...		Connection to the external frontend is being established. It can take up to 10 seconds to determine that LAN connection failed.
Connected	Connected		Connection established, ready for operation.
No External Frontend Connected	Not connected		No external frontend detected. Connect an external frontend to the FSWX.
External Frontend [x]: Invalid Host IP	Invalid Host IP	`300, "Invalid Host IP"`	Verify the specified IP address of the external frontend.
External Frontend [x]: LAN Connection Failed	Not connected	`301, "LAN Connection Failed"`	Verify that the external frontend is connected to the same network as the FSWX. Verify the specified IP address of the external frontend.
External Frontend [x]: Incompatible Analyzer Firmware	Incompatible Analyzer Firmware	`302, "Incompatible Analyzer Firmware"`	The frontend hardware is not compatible with the installed analyzer firmware. Update your analyzer firmware. See Section 4.11.8.2, "Versions and firmware", on page 447.
External Frontend [x]: Incompatible Frontend Firmware	Incompatible Frontend Firmware	`303, "Incompatible Frontend Firmware"`	The firmware of the external frontend is not up-to-date. Perform a firmware update. See "FW Update" on page 214.
External Frontend [x]: Device Locked	Device Locked	`304, "Device Locked"`	External frontend is accessible via ping, but no SSL-connection could be established. Disconnect another device that is currently accessing the external frontend and try reconnecting. A single frontend supports up to 2 LAN/SSL connections.
External Frontend [x]: Wrong Device Type	Wrong Device Type	`306, "Wrong Device Type"`	The connected external frontend is not of the specified type. Disconnect the device, select the correct external frontend type in the configuration dialog box, and reconnect.

Status bar message	Dialog status	SYST:ERR? result	Description/ Possible solution
External Frontend [x]: LAN Connection Lost	LAN Connection Lost	`314, "LAN Connection Lost"`	The connection to the external frontend has been lost. The analyzer attempts to reconnect periodically. Wait for the "Connecting…" message.
External Frontend [x]: Firmware Update Failed	Firmware Update Failed	`315, "Firmware Update Failed"`	The firmware of the external frontend was not updated successfully.
External Frontend [x]: <Frontend_Name> is not allowed, RF input frequency of at least <Max_RF> GHz is required.	Connected	`316, "External Frontend Not Allowed"`	The FSWX does not support any IF frequencies required by the external frontend.
External Frontend [x]: Current RF frequency is out of valid range. Please check Frontend Config dialog for more information	Connected	`317, "RF frequency is out of valid range."`	The selected measurement (RF) frequency is not supported by the selected frequency band of the external frontend. Select a different frequency on the FSWX, or a different frequency band for the frontend.
External Frontend [x]: Settings Mismatch - reinitiate frontend by changing a measurement parameter	Connected	`332, "Settings Mismatch"`	The conversion settings on the external frontend were changed by another instrument during the measurement on the FSWX. The measurement results no longer match the original measurement settings. To restore the original measurement settings on the frontend, change a frontend setting in the FSWX dialog.
External Frontend [x]: Not Connected – Device Busy	Device busy	`333, "Device Busy"`	The external frontend is currently blocked by another instrument, e.g. for initial connection or a firmware update. After the other instrument finishes its task, try reconnecting the FSWX. (Switch the "Connection" state off and on again.)
External Frontend [x]: Device Busy	Connected	`333, "Device Busy"`	During a running measurement, the external frontend is blocked by another instrument, e.g. for initial connection or a firmware update. The current measurement is aborted. After the other instrument finishes its task, start a new measurement on the FSWX.
External Frontend [x]: Touchstone file insufficient frequency range		`350, "Touchstone file frequency range insufficient"`	The `.s2p` file does not cover the used frequency. Correct the file or select a different correction file.
	"<filename>.s2p has wrong file format"	`-150, "String data error"` (Result for `[SENSe<ip>:]EFRontend:ALIGnment<ch>:FILE` on page 576)	The `.s2p` file does not have the correct syntax. Correct the file.
		`-256, "File name not found"` (Result for `[SENSe<ip>:]EFRontend:ALIGnment<ch>:FILE` on page 576)	The specified `.s2p` file does not exist. Correct the path and filename and make sure that the file is stored on the instrument under `external_frontends/<frontend_type>/touchstonefiles`.

Touchstone file errors

Some errors concerning `.s2p` correction files do not cause warnings in the status bar and do not provide results in the system error queue, but do display messages or return errors in remote control.

7.5.2 Problems with connection

If you cannot connect to the external frontend, check the status bar or error queue of the FSWX for error messages (see also Section 7.5.1, "Error messages", on page 1478).

If no messages are available, check the "LAN" and "POWER" status LEDs on the external frontend. Permanent red lights indicate an error, usually hardware problems, e.g. if the fans are off. In this case, the instrument is automatically put in a safe (error) state to avoid damage. A LAN connection is no longer possible. Try switching the external frontend off and on again.

If the problem persists, contact Rohde & Schwarz service, as described in Section 7.8, "Contacting customer support", on page 1484.

7.5.3 Problems during operation

Problem: The analyzer does not show the signal sent by a signal generator using the same external frontend 1480

Problem: The analyzer does not show the signal sent by a signal generator using the same external frontend
Possible Solution: Although the generator and the analyzer are set to the same frequency, possibly they are not using the same IF for conversion.

Make sure that both instruments are set to the same Frequency Band Configuration in the LO configuration settings.

7.6 Miscellaneous troubleshooting hints

Power levels for low frequency signals not correct 1480
Data capturing takes too long 1481
Multiple user access to one instrument 1481
Browser access to instrument fails 1481
The transducer factors/limit lines applied to my measurement are different to those displayed in the Transducer/Lines dialog box 1481

Power levels for low frequency signals not correct
By default, the FSWX uses AC coupling for RF input. For very low frequencies, the input signal can be distorted with this setting. In this case, use DC coupling instead. To change the setting, select "INPUT/OUPUT" > "Input Source Config" > "Radio Frequency" > "Input Coupling" > "DC".

Data capturing takes too long
Particularly for FFT sweeps, the time required to process the data can be considerably longer than the time required to capture the data. Thus, if you only consider the defined sweep time, you might assume that an error has occurred if the measurement takes longer than expected.

However, while the sweep time only defines the time in which data is actually captured, the total sweep *duration* includes the time required for capturing *and processing* the data. Thus, for FFT sweeps in the "Spectrum" application, the sweep duration is also indicated in the application panel, behind the sweep time. In remote operation, you can query the estimated sweep duration for all sweep modes (also zero span and frequency sweeps).

Tip: To determine the necessary timeout for data capturing in a remote control program, double the estimated time and add 1 second.

Remote command:
`[SENSe:]SWEep:DURation?` on page 1425

Multiple user access to one instrument
Using the FSWX's browser interface, several users can access *and operate* the same instrument simultaneously. This is useful for troubleshooting or training purposes.

Type the instrument's host name or IP address in the address field of the browser on your PC, for example *http://10.113.10.203*. The instrument homepage (welcome page) opens.

For details see Section 4.13.2.4, "Web control", on page 487.

Note: This function can be disabled for the instrument. After a firmware update, it is automatically re-enabled.

Browser access to instrument fails
If an error message ("Failed to connect to server (code. 1006)") is displayed in the browser instead of the instrument's user interface, then the LAN browser interface was probably disabled.

For details see Section 4.13.2.6, "How to disable the browser interface", on page 489.

The transducer factors/limit lines applied to my measurement are different to those displayed in the Transducer/Lines dialog box
If a transducer file was in use when the save set was stored (with the save item "Current Settings" only), these transducer values must remain valid every time you recall that save set. Thus, even if the transducer file is changed and you recall the original save set file later, the *originally stored* transducer values are recalled and applied to the measurement. In the "Transducer" dialog box, however, the *changed* transducer file values are displayed as no updated transducer file was loaded.

The same applies to limit line settings.

If you want to apply the changed transducer values after recalling the save set, you must force the application to reload the transducer file. To do so, simply open the "Edit Transducer" dialog box (see Section 4.11.3.1, "Transducer settings", on page 402) and toggle the "X-Axis" option from "Lin" to "Log" and back. Due to that change, the transducer file is automatically reloaded, and the changed transducer values are applied to the current measurement. Now you can create a new save set with the updated transducer values.

Similarly, if you want to apply the changed limit values after recalling the save set you must force the application to reload the limit file. To do so, simply open the "Edit Limit Line" dialog box (see Section 4.8.5.2, "Limit line settings and functions", on page 323) and toggle the "Y-Axis" unit. Due to that change, the limit line file is automatically reloaded, and the changed limit values are applied to the current measurement. Now a new save set with the updated limit values can be created.

7.7 Collecting information for support

If problems occur, the instrument generates error messages which are usually sufficient for you to detect the cause of an error and find a remedy.

Error messages are described in Section 7.1, "Error information", on page 1472.

In addition, our customer support centers are there to assist you in solving any problems that you encounter with your FSWX. We find solutions more quickly and efficiently if you provide us with the information listed below.

- **System configuration:** The ⚙ > "Instrument Configuration" dialog box provides information on:
  - **Hardware information:** hardware assemblies
  - **Versions and options:** the status of all software and hardware options installed on your instrument
  - **System messages:** messages on any errors that occur

  An XML file with information on the system configuration ("Device Footprint") can be created automatically (using the `DIAGnostic:SERVice:SINFo` command or as described in "To collect the support information" on page 1483).
- **Error log:** The `RSError.log` file (in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpilogging` directory) contains a chronological record of errors.
- **Support file:** a *ZIP file with important support information can be created automatically (in the `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user` directory). The *ZIP file contains the system configuration information ("Device Footprint"), the current EEPROM data and a screenshot of the screen display. See also "Create R&S Support Information File" on page 455.
- **SCPI recorder output file** storing a manual operation sequence: helps customer support reproduce the problematic situation
  See also Section 4.13.4, "Automating tasks with remote command scripts", on page 504.

- **SCPI recorder logging file**: contains all remote control commands received by the FSWX. Helps solve problems in automated operation.
  See also "I/O Logging" on page 518.

To collect the support information

1. Select ⚙ > "Service & Support" > "R&S Support".
2. Select "Create R&S Support Information".

   The file is stored as
   `home/instrument/.local/share/rohde-schwarz/esmain/fswx/user/<inst_model>_<serial-no>_<date_and_time>.zip`.
   For example,
   `home/instrument/.local/share/rohde-schwarz/es-main/fswx/user/FSWX-26_134`

To capture a manual operation sequence

Using the SCPI recorder, you can record the SCPI command and settings value of each step you perform manually, and then save the commands to the file system.



1. On the toolbar, select the "SCPI Recorder" icon.

   The "SCPI Recorder" dialog box is displayed.
2. Select "Auto Recording": "On".

   From now on, the commands required to execute all steps you perform on the instrument are recorded.



3. To stop SCPI recording, select the "SCPI Recorder" icon again.

   The "SCPI Recorder" dialog box with the recorded command list is displayed.
4. Select "Auto Recording": "Off".
5. Save the recorded command list to a file.
   a) Select "Save As".
   b) Define a filename for the script file.

To log received remote control commands on the instrument

1. Press [Setup].
2. Select "Network + Remote" > "Remote" > "I/O Logging" > "On".
3. Run your remote control program.

   The file with the received commands is stored as
   `home/instrument/.local/share/rohde-schwarz/esmain/fswx/scpilogging/ScpiL`
   on the instrument.
   Where <no.> is a sequential number.
   A new log file is started each time logging was stopped and is restarted.

Collect the error information and log files and attach them to an email in which you describe the problem. Send the email to the customer support address for your region as described in Section 7.8, "Contacting customer support", on page 1484.

Packing and transporting the instrument

If the instrument needs to be transported or shipped, observe the notes described in Section 8.3, "Transporting", on page 1485.

7.8 Contacting customer support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz product, contact our customer support center. A team of highly qualified engineers provides support and works with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz products.

Contact information

Contact our customer support center at www.rohde-schwarz.com/support, or follow this QR code:



Figure 7-1: QR code to the Rohde & Schwarz support page

8 Maintenance, storage, transport and disposal

We advise to check the nominal data from time to time.

Avoiding electrical and mechanical damage to the instrument

In addition to the recommendations provided in this section, also consider the information provided here:

- Instrument Health Guide, available from the product page on the Rohde & Schwarz website.
- Environmental conditions described in the instrument's Specifications document
- Switching the instrument on and off on page 23
- Allowing sufficient airflow on page 19
- Considerations for test setup on page 22
- Connecting to RF coaxial connectors on page 25
- RF input protection on page 115
- Expected input levels: Reference level on page 238
- Sensitivity of the hardware: RF attenuation on page 239

8.1 Cleaning

How to clean the product is described in "Cleaning the product" on page 9.

Cleaning agents, solvents, acids and bases can damage the front panel labeling, plastic parts and display. If liquid is required for cleaning, use a slightly damp microfiber cloth with clear water but no other liquid cleaning agents.

8.2 Storage

Protect the product against dust. Ensure that the environmental conditions, e.g. temperature range and climatic load, meet the values specified in the specifications document.

8.3 Transporting

Lifting and carrying

For safety information, see:

- "Lifting and carrying the product" on page 8

- Section 3.3.1, "Lifting and carrying", on page 18

Packing

Use the original packaging material. It consists of antistatic wrap for electrostatic protection and packing material designed for the product.

If you do not have the original packaging, use similar materials that provide the same level of protection. You can also contact your local Rohde & Schwarz service center for advice.

Securing

When moving the product in a vehicle or using transporting equipment, make sure that the product is properly secured. Observe the following:

- Use the handles of the product to secure it. See also Section 3.3.1, "Lifting and carrying", on page 18.
- Only use items of the vehicle or transporting equipment intended for securing objects.

Transport altitude

The maximum transport altitude without pressure compensation is specified in the specifications document.

8.4 Disposal

Rohde & Schwarz is committed to making careful, ecologically sound use of natural resources and minimizing the environmental footprint of our products. Help us by disposing of waste in a way that causes minimum environmental impact.

Disposing of electrical and electronic equipment

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.



Figure 8-1: Labeling in line with EU directive WEEE

Rohde & Schwarz has developed a disposal concept for the eco-friendly disposal or recycling of waste material. As a manufacturer, Rohde & Schwarz completely fulfills its obligation to take back and dispose of electrical and electronic waste. Contact your local service representative to dispose of the product.

Glossary: Abbreviations

D

DSP: Digital signal processing

E

EVM: Error vector magnitude

I

ISI: Inter-symbol interference

T

TOI: Third order intercept point
The intermodulation product generated from one of the wanted signals and the second harmonic of the second wanted signal for two-tone modulation.

List of commands (base unit)

[SENSe:] see also [SENSe<ip>]....933
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]....676
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO....677
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:ADJust:RLEVel:STATe....829
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:CATalog?....829
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:CLEar....830
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:INSert....830
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:MAGNitude[:STATe]....831
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:PHASe[:STATe]....831
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:REMove....832
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:SELect....832
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:FLISt<fli>:SIZE?....833
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:LOAD....834
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:PRESet....834
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:REFResh....834
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:CATalog?....836
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:CLEar....836
[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:INSert....837
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[SENSe:]CORRection:FRESponse<ip>:FILE:USER:SLISt<sli>:PORTs:TO....839
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[SENSe:]CORRection:FRESponse<ip>:FILE:USER:STORe....843
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[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:CATalog?....829
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[SENSe:]CORRection:FRESponse<ip>:INPut:USER:FLISt<fli>:INSert....830
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[SENSe:]PMETer:MATH:SUBTrahend 606
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[SENSe:]PMETer<p>:MTIMe 602
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