R&S®SMM100A
Vector Signal Generator
User Manual

1179134102
Version 14

ROHDE&SCHWARZ
Make ideas real

This document describes the R&S®SMM100A, stock no. 1440.8002.02 and the following options:

- R&S®SMM-B1006/-B1007/-B1012/-B1020/-B1031/-B1044/-B1044N/-B1044O
- R&S®SMM-B9
- R&S®SMM-B709
- R&S®SMM-B90
- R&S®SMM-K17
- R&S®SMM-K22/-K23/-K24
- R&S®SMM-K61/-K62
- R&S®SMM-K200
- R&S®SMM-K511/-K512/-K513/-K520/-K523/-K524/-K525/-K527/-K575
- R&S®SMM-K703/-K704/-K720
- R&S®SMM-K811
- R&S®SMM-K980

This manual describes firmware version FW 5.50.042.60 and later of the R&S®SMM100A.

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

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1 Welcome to the R&S SMM100A

The R&S SMM100A is a new signal generator developed to meet demanding customer requirements. Offering excellent signal characteristic and straightforward and intuitive operation, the signal generator makes signal generation fast and easy.

1.1 Key features

Outstanding key features of the R&S SMM100A are:

- Frequency range from 100 kHz to 44 GHz
- Up to 1 GHz I/Q modulation bandwidth (in RF) with internal baseband
- Support of important digital standards such as 5G NR, LTE incl. eMTC/NB-IoT, HRP-UWB 802.15.4, WLAN IEEE 802.11a/b/g/n/ac/ax/be, LoRa
- Excellent signal quality for high accuracy in spectral and modulation measurements
- Intuitive operation via touchscreen with block diagram as key element
- Graphical signal monitoring at practically every point in the signal flow
- SCPI macro recorder and code generator for generating executable remote control code from manual operating steps (for MATLAB®, CVI, etc.)

For more information, refer to the specifications document.

1.2 What's new

This manual describes firmware version FW 5.50.042.60 and later of the R&S®SMM100A.

Compared to the previous version, it provides the new features listed below:

- RF bandwidth extension to 2 GHz with option R&S SMM-K527, see Section 7.1, "Required options", on page 309.
- Information on optimizing I/Q modulation:
  - R&S SMM-K575: On-mode added for linearizing the RF signal over the whole dynamic range, see "Linearize RF" on page 305.
  - R&S SMM-K575: To linearize the RF signal automatically using the "Auto" mode and "On" mode, see "To linearize the RF signal automatically" on page 293.
  - To apply an automatic carrier offset added, see "To reduce LO leakage via an automatic carrier offset" on page 293.
- Editorial changes

1.3 Documentation overview

This section provides an overview of the R&S SMM100A user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/smm100a

1.3.1 Getting started manual

Introduces the R&S SMM100A 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.

1.3.2 User manuals and help

Separate manuals for the base unit and the software options are provided for download:

- 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.
- Software option manual
  Contains the description of the specific functions of an option. Basic information on operating the R&S SMM100A is not included.

The contents of the user manuals are available as help in the R&S SMM100A. The help offers quick, context-sensitive access to the complete information for the base unit and the software options.

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

1.3.3 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):

https://gloris.rohde-schwarz.com

1.3.4 Instrument security procedures

Deals with security issues when working with the R&S SMM100A in secure areas. It is available for download on the internet.

1.3.5 Printed safety instructions

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

1.3.6 Specifications and product brochures

The specifications document, also known as the data sheet, contains the technical specifications of the R&S SMM100A. 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 www.rohde-schwarz.com/brochure-datasheet/smm100a

1.3.7 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.

1.3.8 Release notes and open source acknowledgment

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.

www.rohde-schwarz.com/firmware/smm100a

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

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

For some application sheets, see also:

www.rohde-schwarz.com/application/smm100a

1.3.10 Videos

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

2 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. It generates radio frequency (RF) signals for test setups 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, technicians, operators, administrators and maintenance personnel. 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 2.1, "Safety instructions", on page 20. 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.

2.1 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.

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.

2.2 Labels on R&S SMM100A

Labels on the casing inform about:

- Personal safety, see "Connecting to power" on page 22.
- Product and environment safety, see "Labels regarding product and environment safety" on page 23.
- Identification of the product, see the serial number on the rear panel.

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.

2.3 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.

DANGER

Imminently hazardous situation. Will result in death or serious injury if not avoided.

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.

2.4 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/smm100a

2.5 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

3 Getting started

3.1 Preparing for use

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

3.1.1 Lifting and carrying

For safety information, see "Lifting and carrying the product" on page 21.

Use the handles for lifting and carrying the R&S SMM100A.

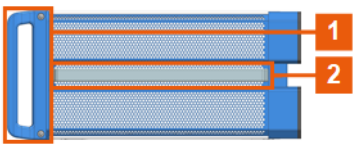


Figure 3-1: Instrument side view with front handles (1) and side handles (2)

3.1.2 Unpacking and checking

1. Unpack the R&S SMM100A carefully.
2. Retain the original packing material. Use it to protect the control elements and connectors when transporting or shipping the R&S SMM100A later.
   See also Section 15, "Transporting", on page 1114.
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.

3.1.3 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 21.

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.

3.1.4 Setting up the R&S SMM100A

See also:

- "Setting up the product" on page 21
- "Intended use" on page 20

3.1.4.1 Placing the R&S SMM100A on a bench top

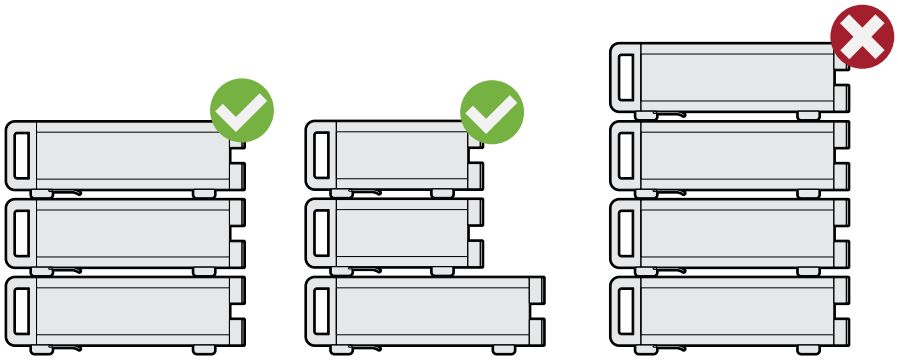
To place the product on a bench top

1. Place the product on a stable, flat and level surface. Ensure that the surface can support the weight of the product. For information on the weight, see the specifications document.
2. **CAUTION!** Foldable feet can collapse. For safety information, see "Setting up the product" on page 21.

   Always fold the feet completely in or out. With folded-out feet, do not place anything on top or underneath the product.
3. **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.

   Stack as follows:

   - If the products have foldable feet, fold them in completely.
   - It is best if all products have the same dimensions (width and length). If the products have different dimensions, stack according to size and place the smallest product on top.
   - Do not exceed the permissible total load placed on the product at the bottom of the stack:
     - 50 kg when stacking products of identical dimensions (left figure).
     - 25 kg when stacking smaller products on top (middle figure).



Left = Stacked correctly, same dimensions
Middle = Stacked correctly, different dimensions
Right = Stacked incorrectly, too many products

4. **NOTICE!** Overheating can damage the product.
   Prevent overheating as follows:
   - 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.

3.1.4.2 Mounting the product in a rack

To prepare the rack

1. Observe the requirements and instructions in "Setting up the product" on page 21.
2. **NOTICE!** Insufficient airflow can cause overheating and damage the product.
   Design and implement an efficient ventilation concept for the rack.

To mount the product in a rack

1. Use an adapter kit that fits the dimensions of the R&S SMM100A to prepare the instrument for rack mounting.
   a) Order the rack adapter kit designed for the R&S SMM100A.
      For more information, refer to the specifications document.
   b) Mount the adapter kit. Follow the assembly instructions provided with the adapter kit.
2. **WARNING!** The product is heavy. For safety information, see "Lifting and carrying the product" on page 21.
   Lift the product to shelf height.
3. Grab the handles at the front.
4. Push the R&S SMM100A onto the shelf until the rack brackets fit closely to the rack.

5. Tighten all screws at the rack brackets with a tightening torque of 1.2 Nm to secure the R&S SMM100A in the rack.

To unmount the product from a rack

1. Loosen the screws at the rack brackets.
2. **WARNING!** The product is heavy. For safety information, see "Lifting and carrying the product" on page 21.

   Bring the lifting equipment to shelf height.
3. Remove the R&S SMM100A from the rack.
4. If placing the R&S SMM100A on a bench top again, unmount the adapter kit from the R&S SMM100A. Follow the instructions provided with the adapter kit.

3.1.5 Considerations for test setup

For safety information, see "Connecting the product" on page 22.

Cable selection to minimize electromagnetic interference

Electromagnetic interference (EMI) can affect the measurement results.

To suppress electromagnetic radiation during operation:

- Use high-quality shielded cables, for example, double-shielded RF, LAN and USB cables.
- Always terminate open cable ends.
- Ensure that connected external devices comply with EMC regulations.
- Use cables of the same type and equal length for connection to the I/Q and I/Q Bar interfaces of the instrument.
- Use the cable R&S SMU-Z6 for connection to the Dig I/Q interfaces of the instrument. The cable is available under order number 1415.0201.02.
- Use the cable R&S DIGIQ-HS for connection to the HS Dig I/Q interfaces of the instrument. The cable is available under order number 3641.2948.03.
  How to: Section 3.1.13, "Connecting to HS Dig I/Q", on page 33

Signal input and output levels

Keep the signal levels within the specified ranges to avoid damage to the R&S SMM100A and connected devices.

For more information, refer to the specifications document.

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.

3.1.6 Connecting to power

For safety information, see "Connecting to power" on page 22.

1. Plug the AC power cable into the AC power connector on the rear panel. Only use the AC power cable delivered with the R&S SMM100A.
2. Plug the AC power cable into a power outlet with ground contact.

   The required ratings are listed next to the AC power connector.

For more information, refer to the specifications document.

3.1.7 Connecting to LAN

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.

To connect to LAN

► Connect the LAN socket on the rear panel via an RJ-45 cable to the LAN.

Using DHCP (dynamic host configuration protocol), the R&S SMM100A assigns the IP address automatically.

If connected to the LAN, the R&S SMM100A displays the IP address and the host name at the left bottom of the block diagram.

1 = IP address
2 = Hostname

If disconnected from the LAN, the R&S SMM100A displays the IP address *0.0.0.0*.

See also Section 12.8, "Setting up remote control", on page 669.

3.1.8 Connecting USB devices

You can connect or disconnect all USB devices from the R&S SMM100A during operation.

To connect USB storage devices

USB storage devices, such as memory sticks, allow data transfer from or to the R&S SMM100A. You can also use them for firmware updates.

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

To connect USB devices with an external power supply

1. **NOTICE!** Connected devices with external power supply can feed back current into the 5 V power supply of the USB interface and thus damage the R&S SMM100A.

   Ensure that there is no connection between the positive pole of the power supply and the +5 V power pin of the USB interface (VBUS).

2. Connect the USB device to any of the USB connectors.

To connect a keyboard

► Connect the keyboard to any of the USB connectors.

When connected, the R&S SMM100A detects the keyboard automatically. A detected keyboard has the default layout English – US.

To connect a mouse

► Connect the mouse to any of the USB connectors.

When connected, the R&S SMM100A detects the mouse automatically.

To connect power sensors

Connect the power sensors of the R&S NRP families to any of the USB connectors.

See Section 7.12.4, "Using power sensors", on page 418.

3.1.9 Connecting to RF coaxial connectors

Here, you find information on how to prepare and to connect to RF coaxial connectors of the R&S SMM100A. Use these RF connectors, for example, for output of the RF signal or for input of an external reference signal.

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. **NOTICE!** DC voltage at the RF connector can damage the instrument. Never apply DC voltage to the RF input connectors.

   Make sure that the values are within the DC limits given in the specifications document.

3. If your test setup has a DC component at the RF input, insert a DC blocker.

4. Use a high-quality RF cable that matches the RF connector type. See also "Cable selection to minimize electromagnetic interference" on page 28.

5. You can connect to two kinds of connectors:
   - "To connect to screwable connectors" on page 31
   - "To connect to pluggable connectors" on page 32

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 you couple the connectors firmly.

4. **NOTICE!** Excessive tightening can damage the connectors.

   Using a calibrated torque wrench torque the nut to the limit as in the table below. Hold the opposite connector part stationary with a spanner.

The R&S SMM100A provides screwable RF connectors as in Table 3-1.

Table 3-1: Connector name, type, size, torque limit and nut opening

Connector		Torque limit		Nut opening	
Type	Name	lb-Inch	Nm	Inch	mm
N	RF*)	13.3	1.5	3/4	20
SMA	LO In LO Out Ref In 1 GHz Ref Out 1 GHz	5	0.56	5/16	8
2.92 mm	RF*)	8	0.9	5/16	8
1.85 mm	RF*)	8	0.9	5/16	8

*) maximum frequency f_{max} depends on the connector type: f_{max}(N) ≤ 7 GHz, f_{max}(2.92 mm) ≤ 40 GHz, f_{max}(1.85 mm) ≤ 67 GHz

To connect to pluggable connectors

The R&S SMM100A 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.

For more information on handling and maintaining coaxial RF connectors, see the application note 1MA99.

For information on mounting test port adapters onto the RF connector, see the application note 1MA100.

3.1.10 Connecting to RF

1. Before connecting, disable the RF output:
   In the block diagram, switch off the RF block.
2. For connection, use the connector "RF" on the front panel.
   See "To connect to screwable connectors" on page 31.

To prevent RF output switch-off

► **NOTICE!** High reflected powers can force the R&S SMM100A to switch off the RF output.

Connect a load with sufficient return loss.
For more information, refer to the specifications document.

3.1.11 Connecting to LO In/Out

For connection, the R&S SMM100A provides SMA connectors on the rear panel. See "To connect to screwable connectors" on page 31.

See also Section 7.9, "Local oscillator coupling", on page 329.

3.1.12 Connecting to Ref In/Ref Out

For connection, the R&S SMM100A provides BNC connectors or SMA connectors on the rear panel. See "To connect to pluggable connectors" on page 32 and "To connect to screwable connectors" on page 31.

3.1.13 Connecting to HS Dig I/Q

To connect to the QSFP+ interface

1. For connection, use the cable R&S DIGIQ-HS.
   See "Cable selection to minimize electromagnetic interference" on page 28.
2. Hold the QSFP+ plug of the cable by its panes.
3. Turn the QSFP+ cable, so that the release tab shows upwards.
4. Insert and push the QSFP+ plug into the QSFP+ cage.

   If you hear a clicking sound, the plug engaged correctly with the cage and the cable is connected to the interface.

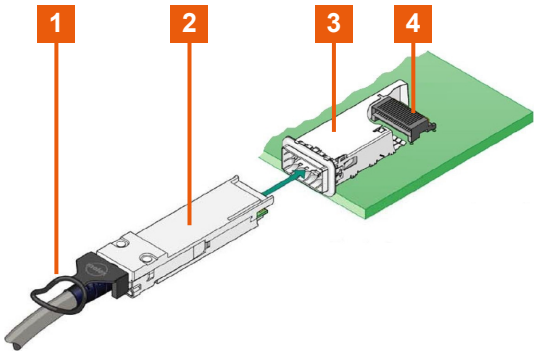
To disconnect from the QSFP+ interface

1. **NOTICE!** Pulling a connected QSFP cable can damage the cable and the QSFP connector.

   Pull the release tab.
2. Pull the QSFP+ plug out of the QSFP+ cage.

About the QSFP+ interface

The "HS Dig I/Q" connector is a QSFP+ (quad small form factor pluggable) interface or QSFP28 interface. The connector socket has two components: a QSFP+ cage and a QSFP+ connector. The QSFP+ cable is equipped with the QSFP+ plug. The interface supports a maximum bandwidth of up to 50 Gsample/s with active optical cables.



1 = Release tab
2 = QSFP+ plug
3 = QSFP+ cage
4 = QSFP+ connector

See also:

- Section 9.6, "Digital baseband input settings", on page 506

3.1.14 Switching on or off

The following table provides an overview of power states, LEDs and positions of the power switch.

Table 3-2: Overview of power states

State	LED	Position of power switch
Off	gray	[0]
Standby	orange	[I]
Ready	green	[I]

To switch on the R&S SMM100A

The R&S SMM100A is off but connected to power. See Section 3.1.6, "Connecting to power", on page 29.

1. Set the switch on the power supply to position [I] on the rear panel.

   The LED of the [On/Standby] key on the front panel is orange.

2. Wait until the oven-controlled oscillator (OCXO) warms up.
   For more information, refer to the specifications document.

3. Press the [On/Standby] key on the front panel.

   The LED changes to green. The R&S SMM100A boots.

   After booting, the R&S SMM100A starts up displaying the block diagram on the screen on the front panel.

To check startup functions

When starting for the first time, the R&S SMM100A starts with the default settings. When restarting, the R&S SMM100A recalls the instrument configuration before shut-down.

See Section 10.5.2, "Saving and recalling instrument settings", on page 533.

When switched on, the R&S SMM100A monitors the main functions and logs erroneous functions. See the following:

See Section 14.4, "Querying notifications", on page 1103.

To shut down the product

The product is in the ready state.

► Press the [On/Standby] key.

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

In the standby state, the power switch circuits and the OCXO are active. To deactivate them, disconnect the instrument from the power supply.

To disconnect from power

The R&S SMM100A 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 toggle switch on the power supply to position [0].

   The LED of the [On/Standby] key is switched off.

2. Disconnect the R&S SMM100A from the power source.

3.2 Instrument tour

This section explains the control elements and the connectors of the R&S SMM100A. The views of the front panel and the rear panel help you to get familiar with the instrument and to perform the first steps. For specifications of the interfaces, see the specifications document.

The meanings of the labels on the R&S SMM100A are described in Section 2.2, "Labels on R&S SMM100A", on page 23.

3.2.1 Front panel tour

This section provides an overview of the control elements and connectors on the front panel of the R&S SMM100A. On the rear panel, you find all further connectors.

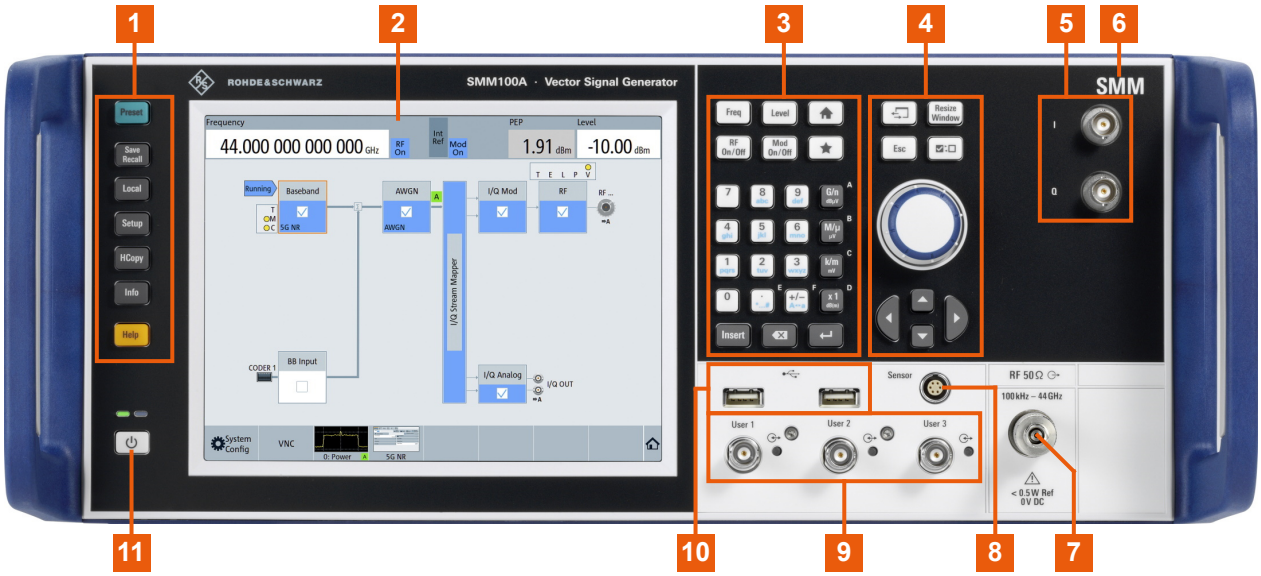


Figure 3-2: Front panel view of R&S SMM100A (R&S SMM-B1044)

1 = Utility keys
2 = Touchscreen
3 = Keypad and Function keys
4 = Navigation controls

5 = I/Q
6 = Product family name
7 = RF
8 = Sensor
9 = User x
10 = USB
11 = On/Standby key

3.2.1.1 Touchscreen

The block diagram and the most important settings are displayed on the screen on the front panel. Also, the screen display provides status and setting information and allows you to quickly reconfigure the signal flow. The screen is touch-sensitive, offering an alternative means of user interaction for quick and easy handling of the instrument.

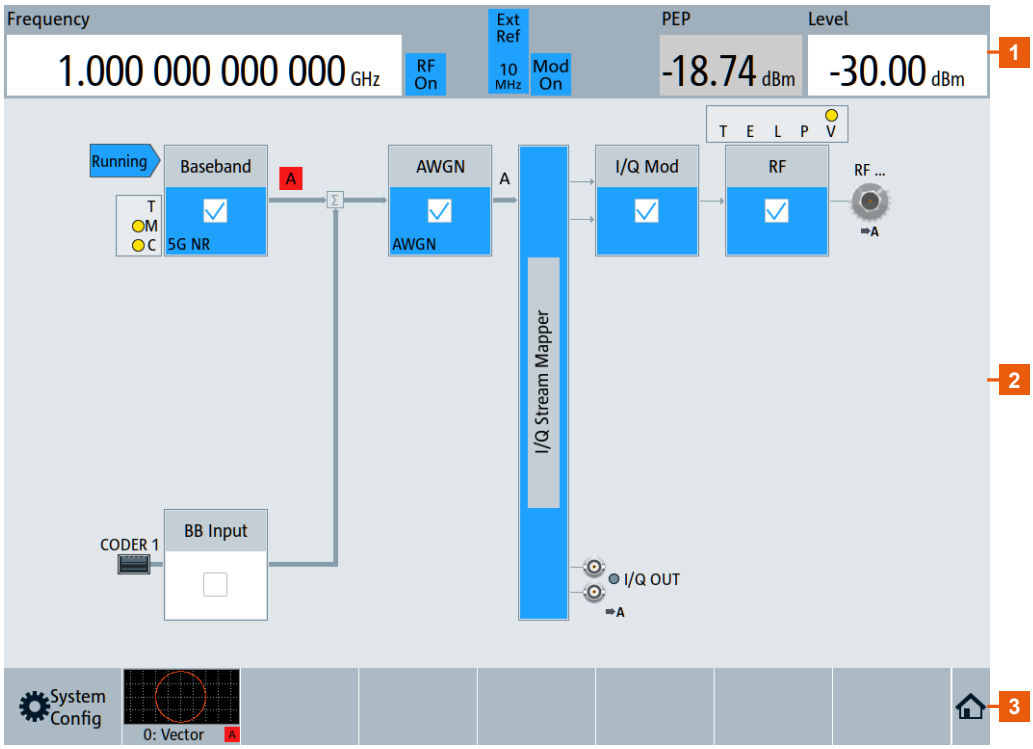


Figure 3-3: Touchscreen elements

1 = Status bar (frequency and level display)
2 = Block diagram
3 = Taskbar/softkey bar

A touchscreen is a screen that is touch-sensitive. It reacts in a specified way when a particular element on the screen is tapped by a finger. Any user interface element that can be clicked by a mouse pointer can also be tapped on the screen to trigger the same behavior.

Using the touchscreen, the following tasks (among others) can be performed by the tap of your finger:

- Changing a setting

- Selecting new settings
- Scrolling through the list of parameters
- Saving or recalling settings
- Opening and closing dialogs

See also:

- Section 3.5, "Operating the instrument", on page 69, for operating the touchscreen.
- Section 16.1, "Cleaning", on page 1115, for cleaning the screen.

3.2.1.2 Keys

Utility keys

The utility keys set the instrument to a defined state, provide information on the instrument and assist.

For more information, see Section 11, "General instrument functions", on page 557.

Table 3-3: Utility keys

Utility key	Assigned functions
[Preset]	Sets the instrument to a defined state
[Save/Rcl]	Saves and loads instrument setting Accesses the file manager
[Local]	Switches from remote control to local (manual) control
[Setup]	Accesses the general instrument settings
[HCOPY]	Opens the "Hardcopy" dialog for storing the current display in a file
[Info]	Displays status messages, error messages, and warnings
[Help]	Displays context-sensitive help text

On/Standby key

The [On/Standby] key switches the instrument from the standby to the ready state or vice versa.

The LED above the [On/Standby] key indicates the instrument state, see Section 3.1.14, "Switching on or off", on page 34.

Function keys

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

A detailed description of the corresponding functions is provided in the user manual.

Table 3-4: Function keys

Function key	Assigned functions
[Freq]	Activates frequency entry.
[Level]	Activates level entry.
[Diagram]	Brings the block diagram to the foreground. Active dialogs are minimized.
[RF on/off]	Switches the RF output on and off.
[Mod on/off]	Switches the modulations on and off.
[★ (User)]	Key with a customizable function. You can define the action to be executed.
Function execution (in navigation controls area)	
[On/Off Toggle]	• Switches highlighted elements or a function block on and off. • Switches between two or more settings, e.g. items of selection lists. At the end of a list, the cursor is set on the first entry again.

Keypad

The keypad is used to enter alphanumeric parameters, including the corresponding units. It contains the following keys:

Table 3-5: Keys on the keypad

Type of key	Description
Alphanumeric keys	Enter numbers and (special) characters in edit dialog boxes.
Decimal point	Inserts a decimal point "." at the cursor position.
Sign key	Changes the sign of a numeric parameter. For an alphanumeric parameter, inserts a "-" at the cursor position.
Unit keys (G/n dBµV, M/µ µV, k/m mV and x1 dB(m))	These keys add the selected unit to the entered numeric value and complete the entry. For level entries (e.g. in dB) or dimensionless values, all units have the value "1" as the multiplying factor. Thus, they have the same function as the [Enter] key.
[INSERT] key	Toggles between insert and overwrite mode
[Esc] key	Closes all kinds of dialog boxes, if the edit mode is not active. Quits the edit mode, if the edit mode is active. Closes dialog boxes that contain a "Cancel" button. For "Edit" dialog boxes, the following applies: • If a data entry has been started, it retains the original value and closes the dialog box. • If data entry has not been started or has been completed, it closes the dialog box.

Type of key	Description
[Backspace] key	If an alphanumeric entry has already been started, this key deletes the character to the left of the cursor.
[Enter] key	It has the same effect as pressing the rotary knob • Concludes the entry of dimensionless entries. The new value is accepted. • With other entries, this key can be used instead of the default unit key. • In a dialog box, selects the default or focused element. • Calls the next dialog level. • Confirms and closes open input windows.

Navigation controls

The navigation controls include a rotary knob, navigation keys, and the display keys. They allow you to navigate within the display or within dialog boxes.

Rotary knob

The rotary knob has several functions:

- Increments (clockwise direction) or decrements (counterclockwise direction) numeric instrument parameters at a defined step size.
- Moves the selection, e.g. to a function block in the block diagram
- Shifts the selection bar within focused areas (e.g. lists).
- Behaves the same as the [Enter] key when it is pressed.

Navigation keys

The navigation keys can be used alternatively to the rotary knob to navigate through dialog boxes, diagrams, or tables.

Table 3-6: Navigation keys

Type of key	Description
[Up/Down] Key	The [Up] and the [Down] key does the following: • In a numeric edit dialog box, increase or decrease the instrument parameter. • In a list, scroll forward and backward through the list entries. • In a table, move the selection bar vertically. • In windows or dialog boxes with vertical scrollbar, move the scroll-bar.
[Left/Right] Key	The [Left] and the [Right] key does the following: • In an alphanumeric edit dialog box, 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 dialog boxes with horizontal scrollbar, move the scrollbar.

Display keys

The display keys arrange different windows on the display.

Table 3-7: Display keys

Display key	Assigned functions
[Next window]	Toggles between the active dialogs
[Resize window]	Adjusts the size of the active dialog to use the whole height of the display.
[Esc]	Closes all kinds of dialog boxes, if the edit mode is not active. Quits the edit mode, if the edit mode is active. Equals selecting the "Cancel" button in dialogs, if provided. For "Edit" dialog boxes, the following applies: • If a data entry has been started, it retains the original value and closes the dialog box. • If data entry has not been started or has been completed, it closes the dialog box.

3.2.1.3 Connectors

The RF connector and various other interface connectors are on the front panel.

I/Q
BNC connectors for input of external I/Q signals for analog modulation. The signals are fed directly into the I/Q modulator.

RF
Female connector for output of the RF signal.

The connector type depends on the maximum frequency f_{max}, see table below.

Table 3-8: Frequency options and RF connector types

Frequency option	Connector type	Frequency range
R&S SMM-B1003/-B1006/-B1007	N female	$f_{max} \leq 7.5$ GHz
R&S SMM-B1012/-B1020/-B1031	PC 2.92 mm female Instrument equipped with interchangeable PC 2.92 mm test port adapter.	$f_{max} \leq 40$ GHz
R&S SMM-B1044/-B1044N/-B1044O	PC 1.85 mm female Instrument equipped with PC 1.85 mm interchangeable female/female wear and tear adapter.	$f_{max} \leq 44$ GHz

Note: The PC 1.85 mm male connector for up to 44 GHz comes with a protective 1.85 mm female adapter to prevent the sensitive connector from damage. It is available as a spare part, and can be replaced if damaged. Contact Rohde & Schwarz customer support.

How to: Section 3.1.10, "Connecting to RF", on page 32

Sensor
Connector for R&S NRP power sensors.

To work with these sensors, use the R&S SMM100A applications power viewer, power control, sensor configuration and sensor mapping.

See also:
- Section 7.12.4, "Using power sensors", on page 418
- Section 7.12.3, "User correction", on page 406

User x
BNC multipurpose connectors for defining input signals and output signals.

The Table 3-9 lists the signals assigned to the User x connectors in the default instrument state.

Table 3-9: Default configuration of the User x connectors

User connector	Direction	Default assigned signal
1	Output	"Baseband Marker 1"
2	Output	"Baseband Marker 2"
3	Input	"Global Trigger 1"

A dedicated LED indicates the connector status:
- green: an input connector
- yellow: an output connector
- no light / gray: the connector is not active

See also Section 11.2, "Configuring local and global connectors", on page 563.

USB
Two female USB (universal serial bus) 2.0 connectors of type A (host USB). You can connect, for example, a keyboard, a mouse or a USB memory stick.

Further USB connectors of type A (host USB) and type B (USB Device) are available on the rear panel.

How to: Section 3.1.8, "Connecting USB devices", on page 30

3.2.2 Rear panel tour

This section provides an overview of the connectors on the rear panel of the instrument. For technical data of the connectors, refer to the specifications document.

Figure 3-4: Rear panel view of R&S SMM100A

1 = Connectors for multipurpose RF signals and remote control
2 = Processing board connectors and power supply
3 = Instrument board

Figure 3-5: Connectors for multipurpose RF signals and remote control

1 = Connectors for use in a rack: I/Q, page 43 and RF, page 43
2, 3 = Ref In/Ref Out, page 44
4 = Inst Trig, page 46
5 = User x, page 44
6 = EFC, page 44
7 = Serial number (six digits in the string 1440.8002.02-<serial number>-<checksum>)
8 = LO In/LO Out, page 44
9 = IEC 625/IEEE 488, page 44

Figure 3-6: Processing board connectors and power supply

1 = System drive (SSD)
2 = AC power supply connector and switch
3 = USB/USB Device
4 = LAN
5, 6 = Display Port, HDMI

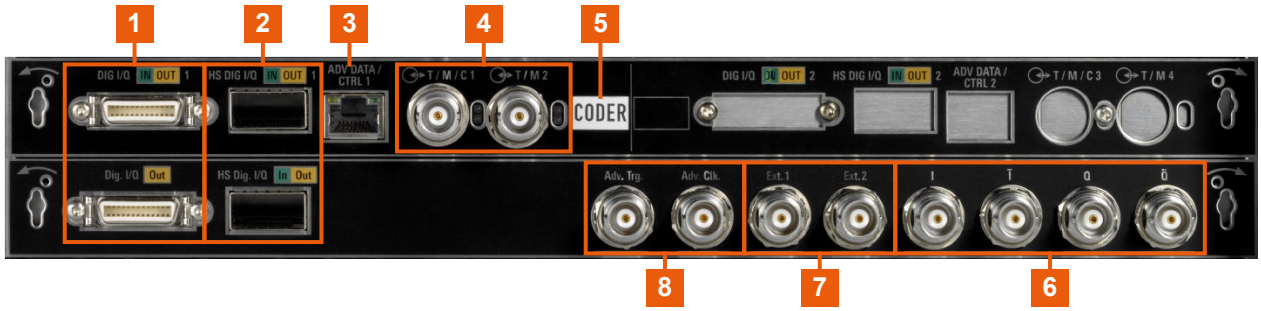


Figure 3-7: Instrument board

1 = Dig I/Q
2 = HS Dig I/Q
3 = Adv Data/Ctrl
4 = T/M/C
5 = Board designation (CODER)
6 = I/Q, I/Q Bar
7 = Mod Ext 1/2
8 = Adv. Trg., Adv. Clk.

3.2.2.1 Connectors

I/Q
Rear panel I/Q input connectors for use of the instrument in a 19" rack. See "I/Q" on page 40.

How to: Section 3.1.4.2, "Mounting the product in a rack", on page 27

RF
Rear panel RF output connectors for use of the instrument in a 19" rack. See "RF" on page 40.

How to:
- Section 3.1.4.2, "Mounting the product in a rack", on page 27
- Section 3.1.10, "Connecting to RF", on page 32

Ref In/Ref Out
Input/output for external reference signal.

BNC connectors for reference signals from 1 MHz to 100 MHz.

SMA connectors for 1 GHz reference signals.

How to: Section 3.1.12, "Connecting to Ref In/Ref Out", on page 32

User x
BNC multipurpose connectors for defining input signals and output signals.

Table 3-10 lists the signals assigned to the User x connectors in the default instrument state.

Table 3-10: Default configuration of the User x connectors

Connector	Direction	Default assigned signal
"User 4"	"Input"	"Global Trigger 2"
"User 5"	"Output"	"Signal Valid"
"User 6"	"Not used"	"None"

A dedicated LED indicates the connector status:
- green: an input connector
- yellow: an output connector
- no light / gray: the connector is not active

See also Section 11.2, "Configuring local and global connectors", on page 563.

EFC
BNC connector for input of an EFC (external frequency control) signal for electronic tuning of the internal reference frequency.

See Section 7.8, "Reference oscillator", on page 321.

LO In/LO Out
Option: R&S SMM-B90

SMA connector for local oscillator input and output for phase-coherent RF signal:
- LO In: Input of phase coherence signal
- LO Out: Output of phase coherence signal

How to: Section 3.1.11, "Connecting to LO In/Out", on page 32

IEC 625/IEEE 488
General purpose interface bus (GPIB) interface for remote control of the instrument. The interface complies with the standards IEC 625, IEEE 488 and SCPI.

Use this interface to connect a computer for remote control of the R&S SMM100A. See also the following sections:
- Section 12.2.3, "GPIB interface (IEC/IEEE bus interface)", on page 631
- Section 12.5.3, "GPIB address settings", on page 643

- Section D.2, "GPIB interface", on page 1147

System drive (SSD)
Solid-state drive (hard disk).

For security reasons, the hard disk is bound to the specific R&S SMM100A. You can remove it from the instrument, but you cannot use it in other instruments.

See also "To remove the system drive" on page 529.

AC power supply connector and switch
Mains power switch for performing the following tasks:
- Connecting the internal power supply to the power source
- Disconnecting the internal power supply from the power source

How to: Section 3.1.6, "Connecting to power", on page 29.

USB/USB Device
- Two female USB (universal serial bus) 3.1 connectors of type A (host USB), to connect devices like a keyboard, a mouse, a memory stick, or the R&S NRP-Z3/Z4 cable for the R&S NRP power sensors.
- Female USB 3.0 connector of type B (USB Device), for example, for remote control.

How to: Section 3.1.8, "Connecting USB devices", on page 30

LAN
RJ-45 connector to connect the R&S SMM100A to a LAN for remote control, remote operation, and data transfer.

How to: Section 3.1.7, "Connecting to LAN", on page 29

Display Port, HDMI
Provided for future use.

Dig I/Q
Connectors for the input of a digital I/Q signal from a Rohde & Schwarz instrument, like a signal generator.

The table below provides an overview.

Table 3-11: Overview of the instrument boards, Dig I/Q interfaces and options

Board	Connector	GUI designation	Required options
CODER	"Dig I/Q IN/OUT 1/2"	"CODER 1 In"	R&S SMM-B9

For more information, refer to the specifications document.

HS Dig I/Q
Connectors for the input or output of high-speed digital I/Q signals, for example, from and to Rohde & Schwarz instruments.

The table below provides an overview.

Table 3-12: Overview of the instrument boards, HS Dig I/Q interfaces and options

Board	Connector	GUI designation	Required options
CODER	"HS Dig I/Q IN/OUT 1"	"CODER 1 In"	R&S SMM-B9

*) for the output of digital I/Q signals.

The interface is a QSFP+ (Quad Small Form-factor Pluggable) module. It supports a maximum bandwidth of 50 Gsample/s with optical active cables.

How to: Section 3.1.13, "Connecting to HS Dig I/Q", on page 33

For more information, refer to the specifications document.

T/M/C
BNC multipurpose input/output trigger/marker/clock connectors.

There is one T/M/C and one T/M connector.

Define the input/output signal first. Table 3-13 lists the configuration of the local connectors in the default instrument state.

Table 3-13: Default configuration of the T/M/C connectors

Connector	Direction	Default signal	Remark
T/M/C	Output	Clock	Symbol clock A
T/M	Input	Marker	Baseband marker 2

A dedicated LED indicates the connector status:
- green: an input connector
- yellow: an output connector
- no light / gray: the connector is not active

See also the following sections:
- Section 4.4.1.1, "About data signals", on page 86
- Section 11.2, "Configuring local and global connectors", on page 563

Inst Trig
BNC connector for input of external trigger signals. The signals trigger sweeps and list mode.

See Section 7.10.1, "Signal generation and triggering in the sweep and list modes", on page 336.

Mod Ext 1/2
BNC connectors for input of external analog modulation signals.

Section 7.11, "Analog modulations", on page 370

Adv Data/Ctrl
Interface for exchanging of external data and control signals.

Adv. Trg., Adv. Clk.
Input and output for synchronization signal in multi-instrument setups.

See also Section 9, "Multi-instrument setups", on page 475.

I/Q, I/Q Bar
BNC connector for output of direct (single-ended) or differential analog I/Q signals.

Note: The R&S SMM100A also assigns the internal signal of the LF generator to the I output connector.
Therefore, consider that you cannot output the analog I/Q signal and the internal LF signal at the same physical connector simultaneously.

See the data sheet and in the user manual, section Section 7.11, "Analog modulations", on page 370.

Use the connectors for connections as follows:
- I/Q connectors: Direct (single-ended) or positive differential output of analog I/Q signals
- I/Q Bar connectors: Negative differential output of analog I/Q signals

3.3 Trying out the instrument

This section provides step-by-step instructions to introduce the most important functions and settings of the R&S SMM100A.

Prerequisites

- The R&S SMM100A is equipped with its base unit configuration.
- The R&S SMM100A is connected to the power supply and started up.
  See Section 3.1.6, "Connecting to power", on page 29.
- The R&S SMM100A has its default configuration after an instrument preset.
  See also "Overview of the characteristics of the preset functions" on page 524.

Instrument equipment and screenshots

In this description, the screenshots show a fully equipped instrument. Consider that some settings in the block diagram or in the configuration dialogs can differ from the settings of your instrument.

For the first signal generation tasks, you use the internal baseband and reference signal, so you do not need any additional signal source. More complex signal generation tasks require an instrument equipped with additional options or external signals.

The following sections provide introductory step-by-step instructions using the touchscreen. Each instruction lists the prerequisites to execute the instruction. Try out the following:

- Generating an unmodulated carrier 48
- Generating a digitally modulated signal 50
- Triggering the instrument externally 51
- Working with marker signals 56
- Visualizing the generated signal 57
- Saving and recalling settings 60
- Generating an EUTRA/LTE signal 62

3.3.1 Generating an unmodulated carrier

The step-by-step instructions in this section explain how to generate and measure an unmodulated RF continuous wave (CW) signal. The R&S SMM100A base unit generates an RF signal that is sufficient for generic RF receiver testing, for example for testing chipsets.

To generate a CW signal

1. Connect the RF connector of the R&S SMM100A to the RF input connector of the DUT.
   See "To connect to screwable connectors" on page 31.
2. To check the generated signal, you can optionally connect a signal analyzer.
   See "To connect to a signal analyzer" on page 49.
3. Configure the RF signal:
   a) In the status bar, select the "Frequency" field to enter a frequency value.
   b) Using the on-screen keypad, enter for example *1.955g* to set a frequency value of 1.955 GHz.
   c) Select the "Level" field to enter a level value.
   For example, enter *20* to set a level value of 20 dBm.
4. In the block diagram, set the block "RF" > "On" to enable the output of the generated RF signal.

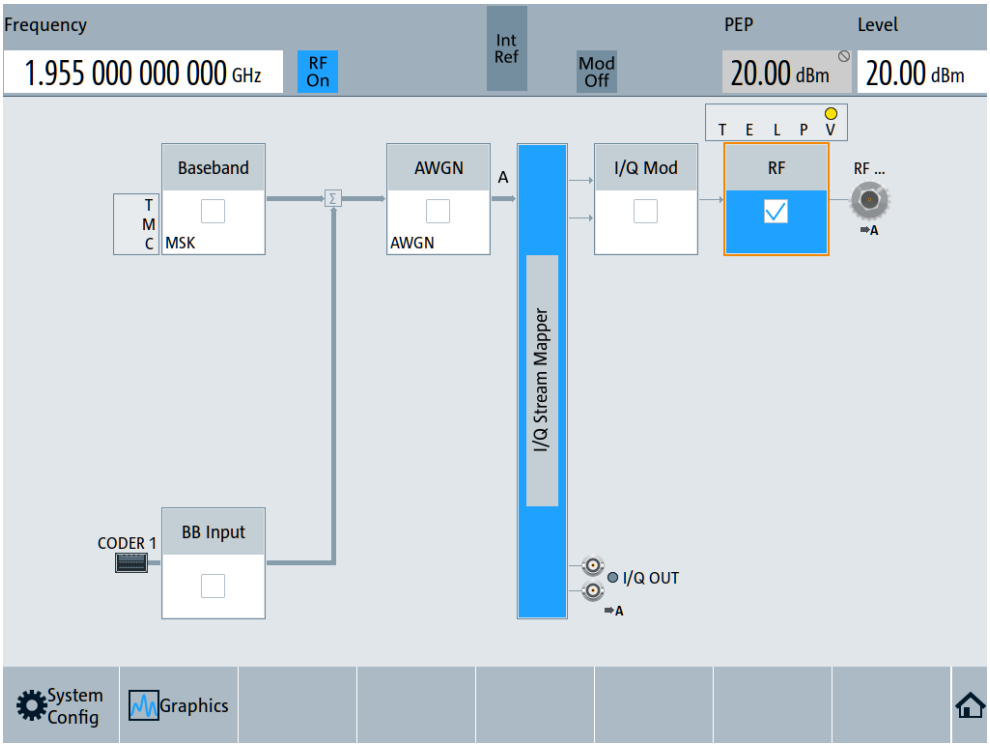


Figure 3-8: Block diagram: Generating an unmodulated signal

The "RF" connector on the front panel of the R&S SMM100A is output for the 1.955 GHz signal.

To connect to a signal analyzer

To display the generated CW, you can connect to a signal analyzer.

► Connect the "RF" connector of the R&S SMM100A, for example to an FSW.

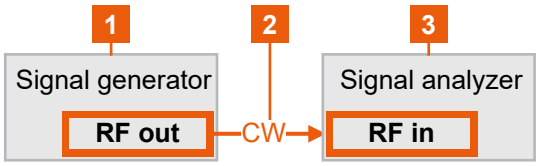


Figure 3-9: Test setup for measuring a CW

1 = Signal generator: R&S SMM100A
2 = RF output signal: CW signal
3 = Signal analyzer, for example the FSW

Table 3-14: Signal types and connections

Signal	Signal generator	Signal analyzer
RF (CW)	RF out: "RF"	RF in: "RF INPUT 50 Ω"

For the required settings at the signal analyzer, refer to the documentation of the signal analyzer.

3.3.2 Generating a digitally modulated signal

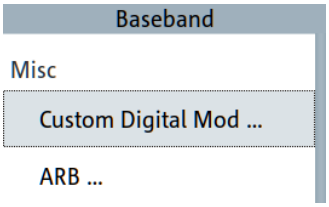
This example shows you how to generate a simple WCDMA-3GPP (QPSK 45° offset) signal. The minimum requirement for R&S SMM100A in this example is a base unit.

The minimum requirement for R&S SMM100A in this example is a base unit equipped with:

- Option baseband generator R&S SMM-B9
- Option custom digital modulation R&S SMM-K520
- Option frequency R&S SMM-B1006.

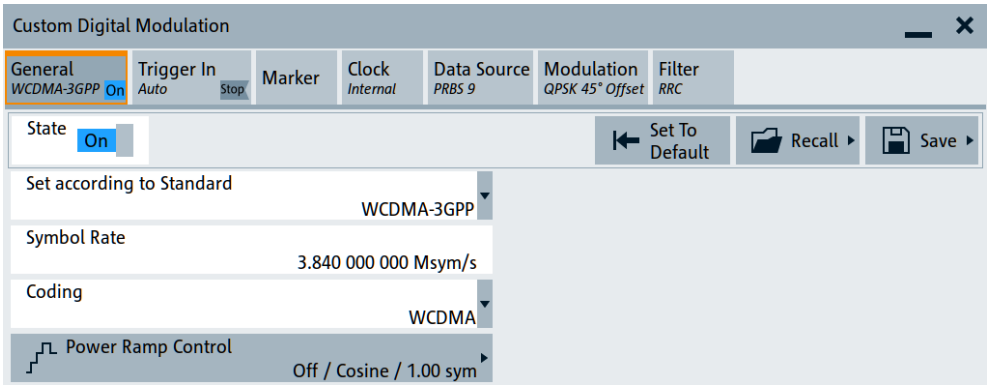
The initial situation is not the instrument's preset state but rather the configuration described in Section 3.3.1, "Generating an unmodulated carrier", on page 48.

1. In the block diagram, select "Baseband" to navigate to the section "Misc" > "Custom Digital Mod".



   The "Custom Digital Modulation" dialog opens.

2. Select "General" > "Set according to Standard" > "WCDMA-3GPP".
3. Select "State" > "On" to enable baseband signal generation.



4. Select the "Modulation" tab to check the "Modulation Type".

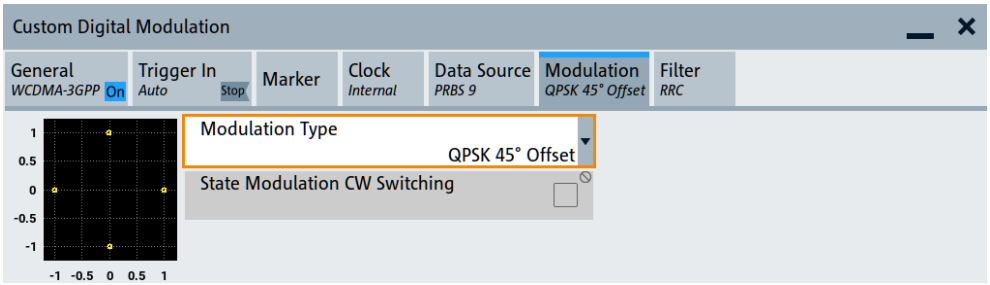


Figure 3-10: Modulation type of the WCDMA-3GPP signal

The instrument enables the I/Q modulator automatically ("I/Q Mod" > "On"). Also, it uses an internal trigger signal and clock signal and generates the WCDMA-3GPP signal.

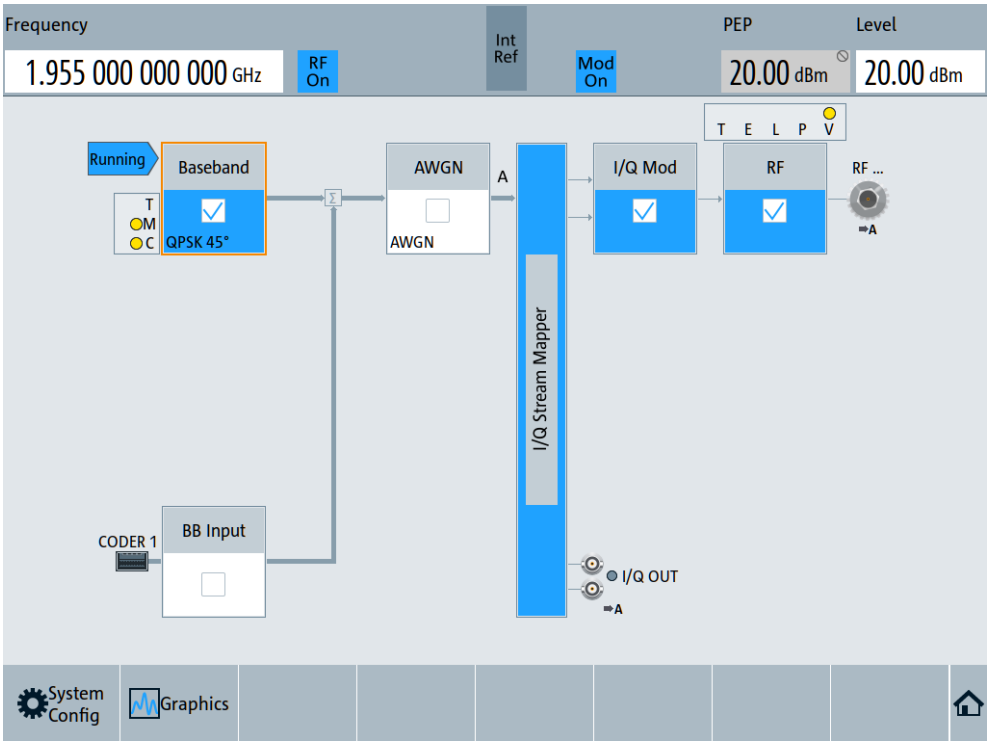


Figure 3-11: Block diagram: Generating a digitally modulated signal

3.3.3 Triggering the instrument externally

The example configurations are rather theoretical cases, because you rarely use the R&S SMM100A as a stand-alone instrument. Usually, you connect the instrument to a device under test (DUT) or other measurement equipment. As a rule, whenever a test setup requires two or more devices, provide them with a common reference frequency.

Some test setups require control of the signal generation start and an exact generation start time. A defined trigger event starts the signal generation, for example when triggering the instrument internally or externally from the DUT.

This example illustrates the general principle of external triggering and extends the configuration of Section 3.3.2, "Generating a digitally modulated signal", on page 50 by the configuration of the required trigger signal and connector settings.

The test setup requires a signal analyzer, for example the FSW, as additional equipment.

To trigger signal generation with an external global trigger signal

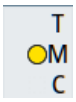
The configuration requires three main steps with the following goals:

1. Define an input connector for the external global trigger signal.
   See "To verify the current connector configuration" on page 52
2. Configure the baseband to use this external global trigger signal as the trigger source.
   See "To reconfigure the trigger settings" on page 53.
3. Connect the instrument and the external trigger source.
   See "To connect the instrument and the external trigger source" on page 54.

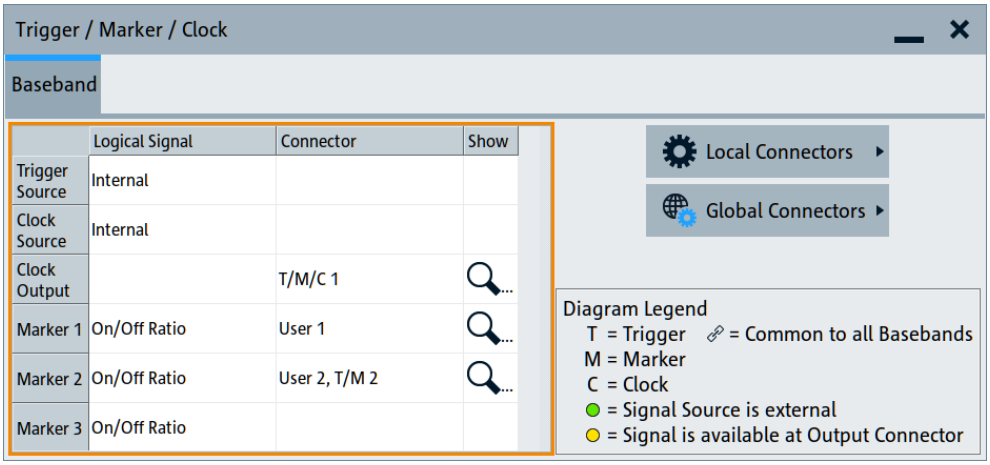
To verify the current connector configuration

The R&S SMM100A is equipped with multipurpose bi-directional User connectors. Because the signal direction, input or output, and the signal mapping are configurable, we recommend that you check the current configuration before cabling or further instrument's configurations.

1. To display the current mapping of the logical signals to the connectors, select the "TMC" status LEDs on the left side of the "Baseband" block.

   The "Trigger Marker Clock" dialog opens.

   The instrument uses its internal trigger and clock signals, and the default mapping of the marker signals to the connectors.

2. To open the related connector settings, select "Global Connectors".

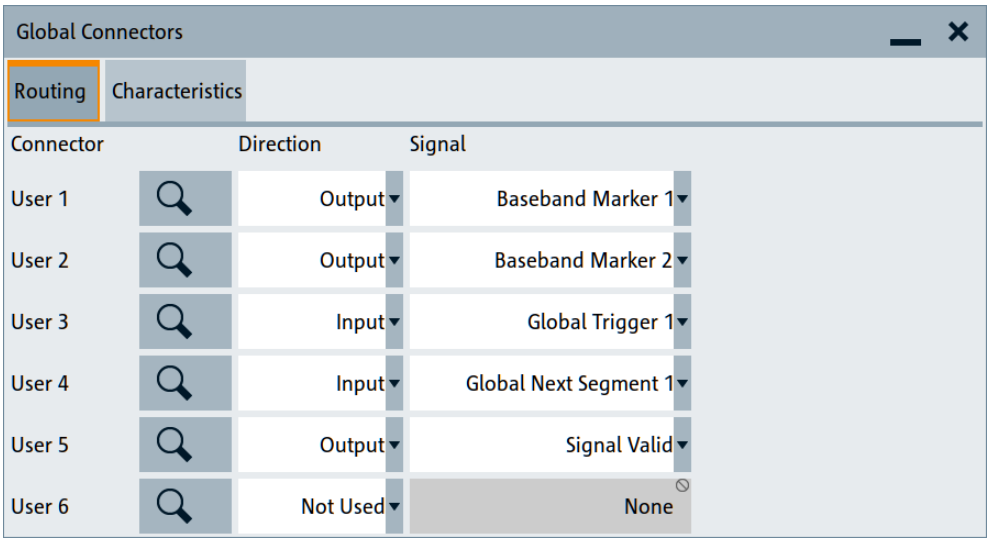


Figure 3-12: Global connectors and signal mapping

The "Global Connectors" dialog displays the current connector configuration. In this example we use the default signal mapping of the global connectors.

The three global connectors "User 1" to "User 3" are on the front panel and are mapped as follows:

- "User 1" and "User 2" connectors are output for the marker signals "Baseband Marker 1" and "Baseband Marker 2".
- The "User 3" connector is an input for the trigger signal "Global Trigger 1".

Check the front panel of the R&S SMM100A. The LEDs next to the "User 1" and "User 2" connectors are yellow. The LED next to the "User 3" connector is green.

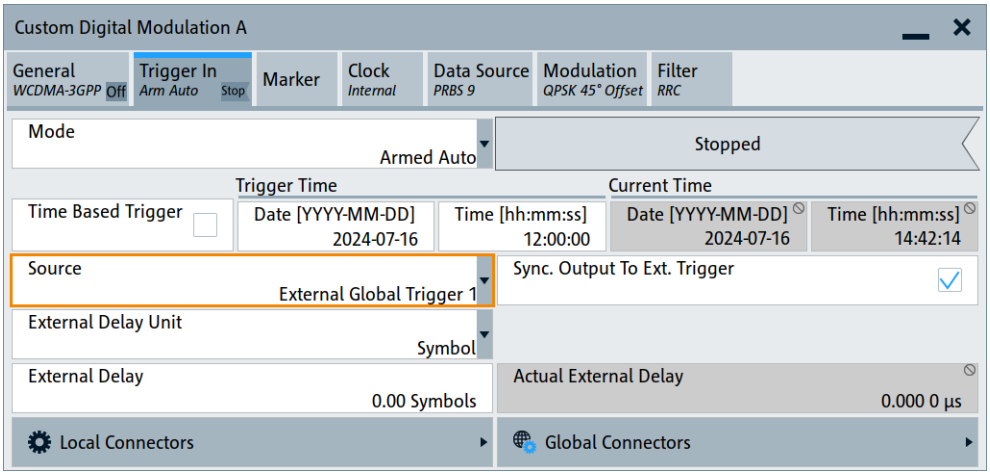
To find the location of a connector

Use the built-in "Show" function to display the location of the selected connector. A blinking rectangle on the front panel or rear panel indicates the selected connector.

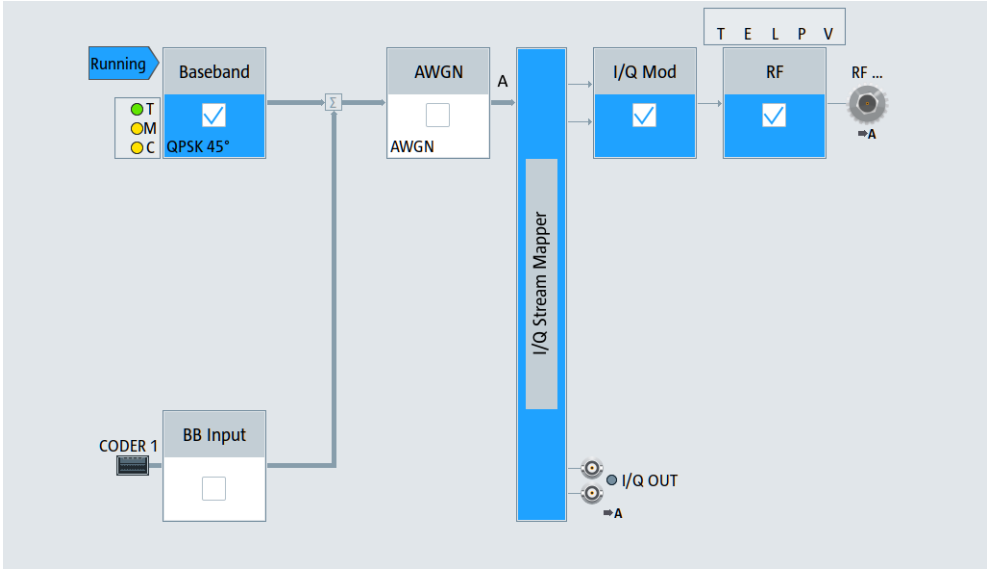
To reconfigure the trigger settings

We assume that the instrument generates a digital modulated signal, see Section 3.3.2, "Generating a digitally modulated signal", on page 50. Also we assume the default global connector mapping, see Figure 3-12.

1. In the block diagram, select "Baseband" > "Misc" > "Custom Digital Mod".
2. Configure for an external trigger event:
   a) Select "Trigger In" > "Mode" > "Armed Auto".
   b) Select "Source" > "External Global Trigger 1".



The instrument expects an external global trigger event. In the block diagram, the "TMC" status LED confirms that an external trigger signal is available that triggers the signal generation.



To connect the instrument and the external trigger source

Use suitable cables for connection, see "Cable selection to minimize electromagnetic interference" on page 28.

1. Connect the external trigger source to the "User 3" connector of the R&S SMM100A and to the signal analyzer.

2. Connect the output connectors for the RF signal and for the reference signal of the R&S SMM100A to the signal analyzer.

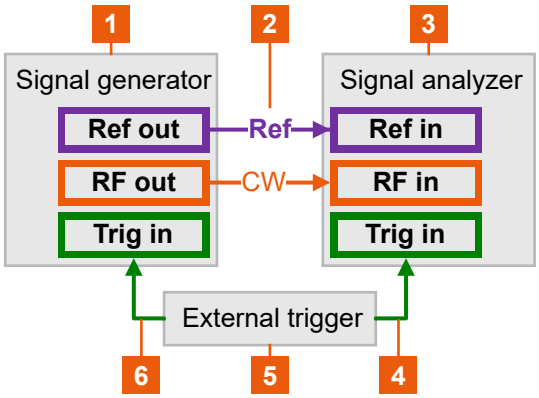


Figure 3-13: Test setup for external triggering

1 = Signal generator: R&S SMM100A
2 = Output signals: reference output signal and RF output signal
3 = Signal analyzer, for example the FSW
4, 6 = External trigger signal for the signal generator and signal analyzer
5 = External trigger source that provides an external trigger signal

Table 3-15: Signal types and connections

Signal	Signal generator	Signal analyzer
Reference	Ref out: "Ref Out"	Ref in: "REF INPUT"
RF	RF out: "RF"	RF in: "RF INPUT 50 Ω"
Trigger	Trig in: "User 3"	Trig in: "TRIGGER 1 INPUT"

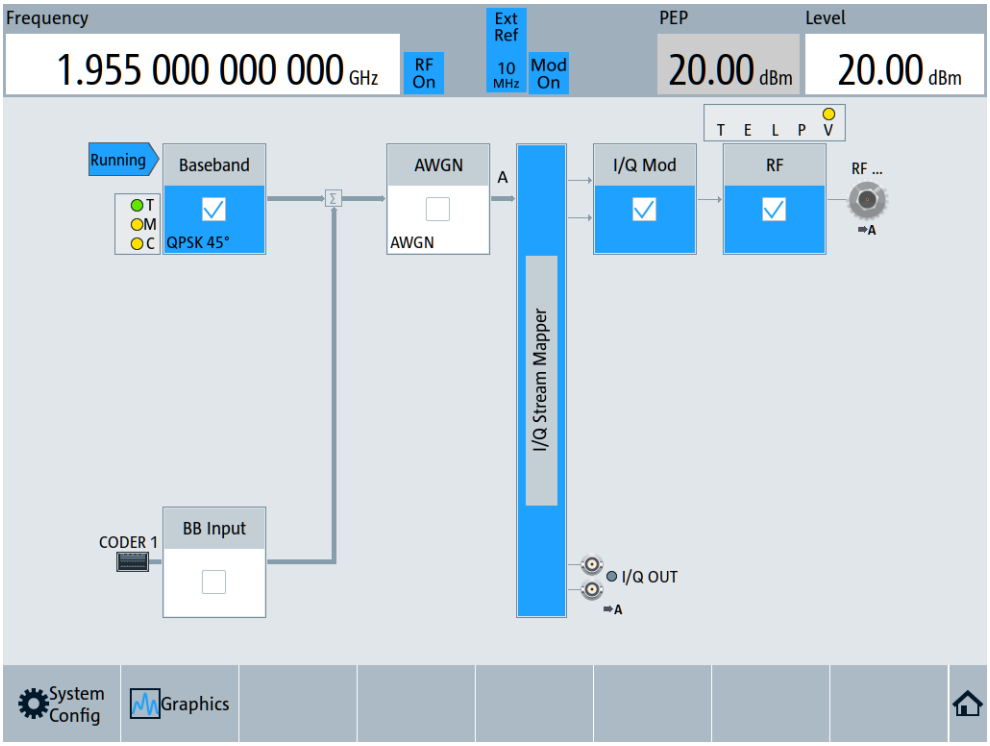
In practice, the signal analyzer is the DUT, for example a base station. Also, the DUT can be the source for the reference signal. Instead of an external trigger source, the DUT can send, for example, a frame trigger signal to the R&S SMM100A. The R&S SMM100A remains the signal generation source.

To generate an RF signal with an external trigger

1. Set "Baseband" > "On" to trigger signal generation.

   If the R&S SMM100A receives the external trigger event, it starts continuous signal generation. Arming the trigger stops the signal generation until the next trigger event restarts the signal generation.

2. Select "RF" > "On".



The R&S SMM100A generates the RF output signal and transmits the signal to the signal analyzer.

For more information see the following sections:

- Section 4.4.1.5, "About trigger signals", on page 92
- Section 11.2, "Configuring local and global connectors", on page 563

3.3.4 Working with marker signals

About marker signals

Test setups often require that an external device is synchronized to the generated data stream. For this purpose, the R&S SMM100A provides marker output signals also additional to the generated signal. There are several generic marker signals and specific marker signals of a firmware option. With suitable marker settings for instance, you can mark slot or frame boundaries or mark the start of a particular modulation symbol.

To connect an oscilloscope

You can monitor marker output signals, for example with an oscilloscope like the R&S RTO. Use suitable cables for connection, see "Cable selection to minimize electromagnetic interference" on page 28.

1. Connect the "User 1" connector of the R&S SMM100A to the oscilloscope.
2. Connect the "I" connector of the R&S SMM100A to the oscilloscope.

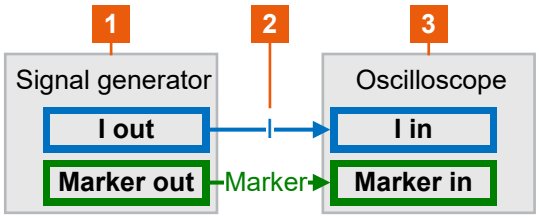


Figure 3-14: Test setup for a marker and I output signal

1 = Signal generator: R&S SMM100A
2 = Output signals: I-component of the I/Q output signal and marker output signal
3 = Oscilloscope, for example the R&S RTO

Table 3-16: Signal types and connections

Signal	Signal generator	Oscilloscope
I (I/Q signal component)	I out: "I"	I in: "Ch 2"
Marker	Marker out: "User 1"	Marker in: "Ch 3"

To configure the marker output signal

This step-by-step instruction uses a digital baseband signal and the default global connector mapping. See Section 3.3.2, "Generating a digitally modulated signal", on page 50 and see Figure 3-12.

1. In the block diagram, select "Baseband" > "Misc" > "Custom Digital Mod".
2. Configure a periodic marker signal for marker 1:
   a) Select "Marker" > "Marker 1" > "Mode" > "Pulse".
   b) Select "Divider" = "32".

   The instrument generates a periodic marker signal with a frequency of 120 kHz. The instrument outputs the signal at the "User 1" connector.

For more information, see Section 4.4.1.4, "About marker signals", on page 90.

3.3.5 Visualizing the generated signal

You can visualize the generated signal graphically, before you enable the RF output of the instrument. The R&S SMM100A provides a build-in function to represent the generated signal on a graphical signal display. We demonstrate this feature by showing the

characteristics at one particular point of the signal processing chain. You can, however, display the signal characteristics at other different stages.

This step-by-step instruction shows how to use the graphical display to verify the generated signal. We use the generated signal as described in Section 3.3.4, "Working with marker signals", on page 56.

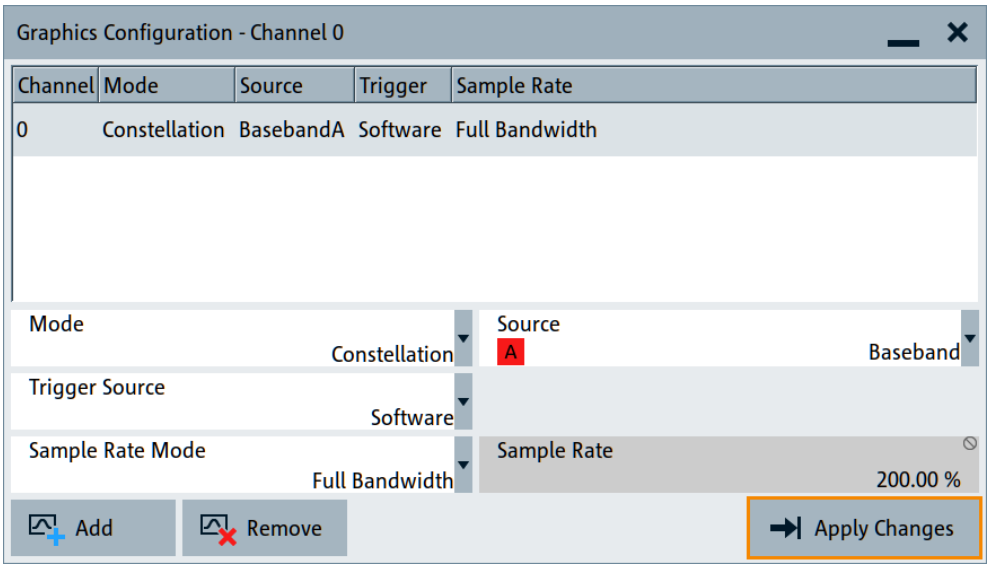
To open the graphics dialog

► On the taskbar, select the graphics icon.

The "Graphics Configuration" dialog opens.

To visualize the signal

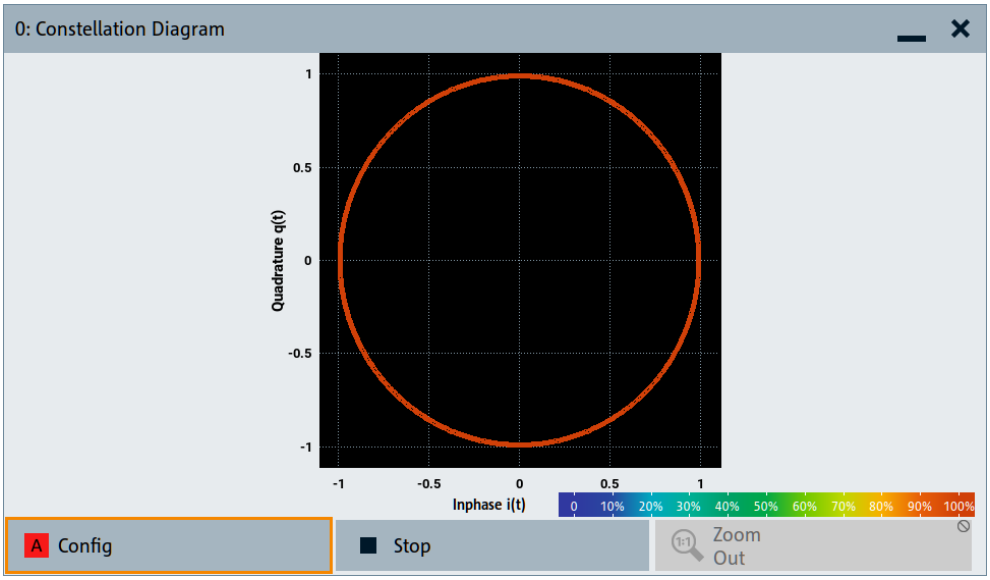
1. In the "Graphics Configuration" dialog, select "Mode" > "Constellation".
2. Select "Source" > "Baseband".
3. Select "Add" to enable signal display.



A new thumbnail appears in the taskbar and displays the constellation diagram.

4. Press the thumbnail graphic.

   The graphic enlarges and the diagram is displayed in a normal size.

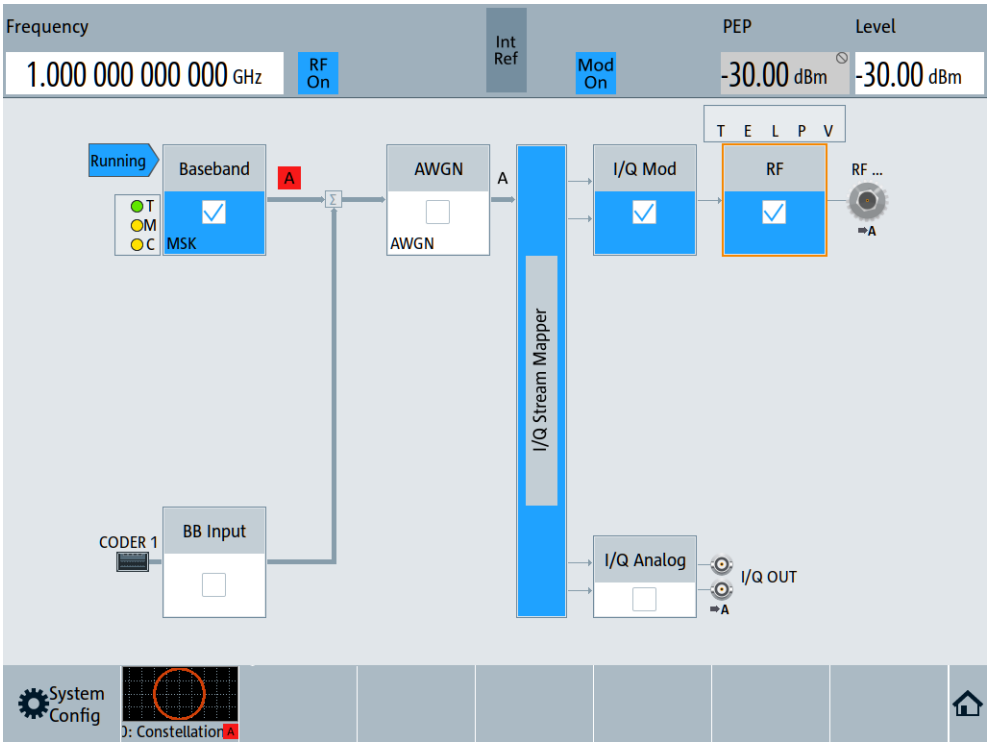


The "Constellation Diagram" displays the WCDMA-3GPP signal.

5. Zoom into the spectrum. The zoom in function works like the two-finger pinching for magnifying images on your mobile phone.
6. Select "Config" to return to the "Graphics Configuration" dialog.

   You can close the dialog. Closing the dialog has no effect on the configured graphics but on the dialog itself.

   The block diagram displays the current signal routing. It indicates that frequency and power offsets are enabled and displays the acquisition points for the real-time diagrams minimized in the "Taskbar".



The block diagram displays the current signal routing. It displays the acquisition points for the real-time diagrams minimized in the taskbar.

For more information, see Section 8, "Monitoring baseband signal characteristics", on page 454.

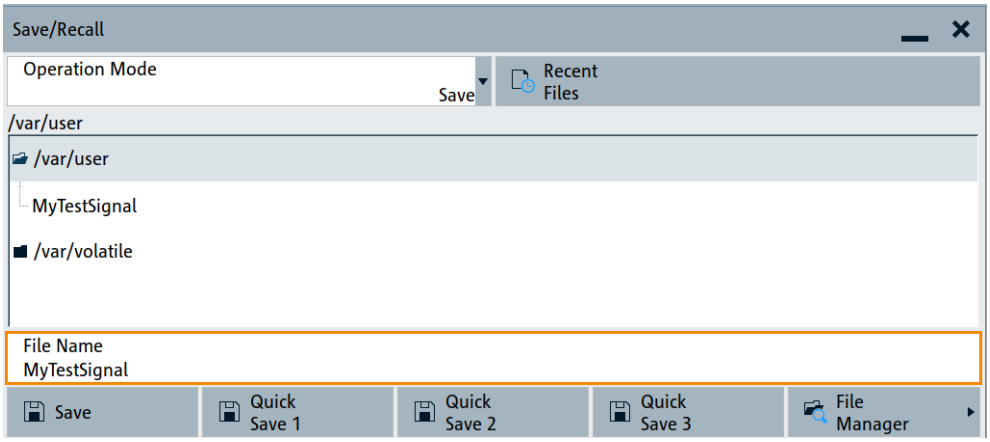
3.3.6 Saving and recalling settings

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

To save the instrument settings to a file

We assume a test configuration as described in Section 3.3.4, "Working with marker signals", on page 56.

1. Press the [Save/Rcl] key on the front panel.
2. In the "Save/Recall" dialog, save the settings of the test configuration:
   a) Select "Operation Mode" > "Save".
   b) Use the on-screen keyboard to enter *MyTestSignal* for the "File Name".



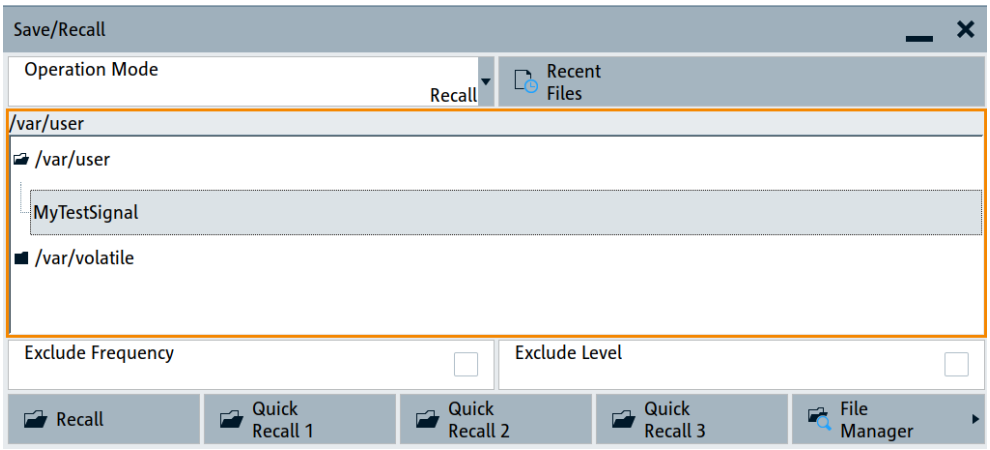
3. Tap the "Save" button.

   The instrument saves the settings in the file `MyTestSignal.savrcltxt` to the default directory `/var/user`.

To load saved instrument settings

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

1. Press the [Preset] button to restore the default instrument settings.
2. Press the [Save/Rcl] key.
3. In the "Save/Recall" dialog, select "Recall" operation.
4. Select the file `MyTestSignal` in the directory.



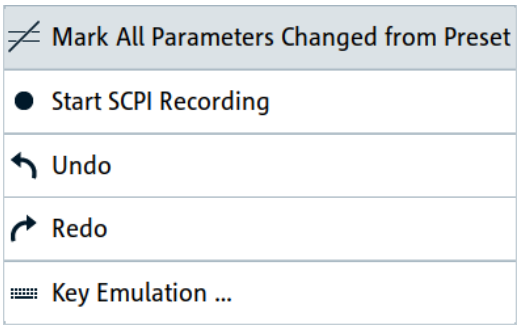
5. Tap the "Recall" button.

   All instrument settings are restored.

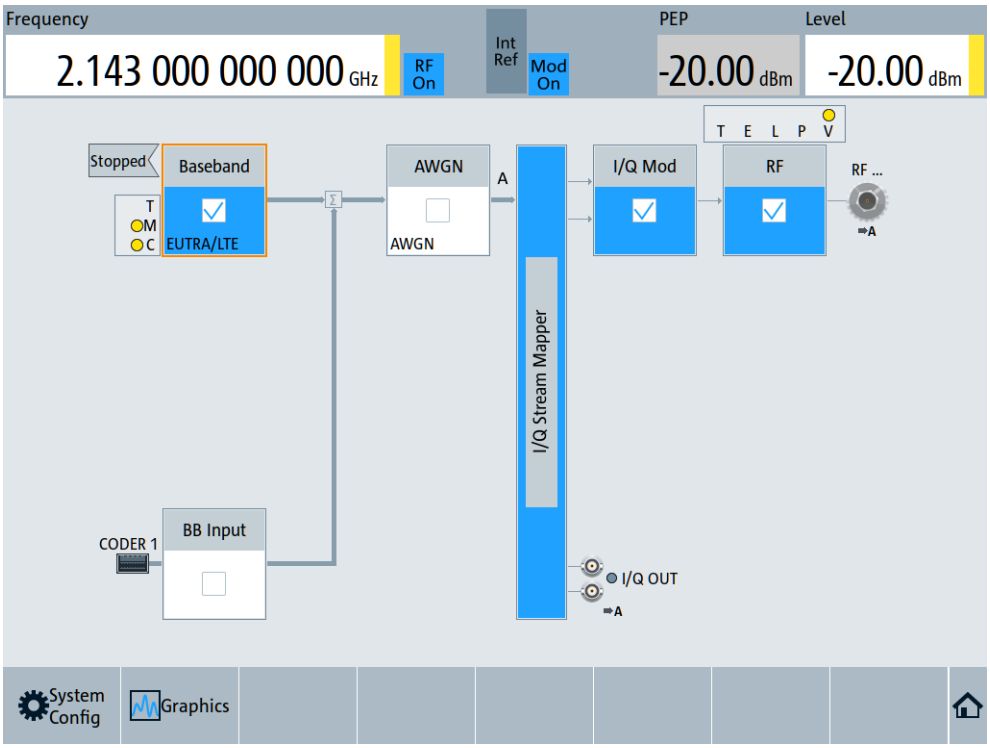
To display variations from preset values

When you load a file to your instrument, you can mark the changed settings. The user interface can visualize all parameters that differ from their default state.

1. Tap and hold on an empty space in the block diagram to open the context-sensitive menu.
2. Select "Mark All Parameters Changed from Preset".



All changed parameters are highlighted.



3.3.7 Generating an EUTRA/LTE signal

The main application field of the R&S SMM100A is the generation of digital signals in accordance with several telecommunication and wireless standards, like WCDMA, EUTRA/LTE or WLAN, to name a few. This example uses the digital standard

EUTRA/LTE to introduce the way you can access and interact with the instrument and experience the advantages provided by the additional options.

The minimum requirement for R&S SMM100A in this example is a base unit equipped with:

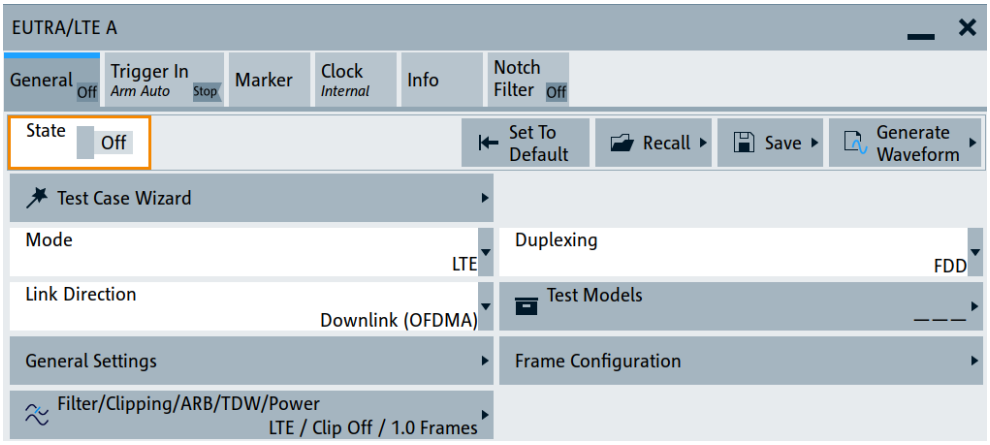
- Option baseband generator R&S SMM-B9
- Option EUTRA/LTE R&S SMM-K55
- Option frequency R&S SMM-B1006

To generate a downlink test signal

The main focus of the following example is not on the R&S SMM100A capabilities and the features provided by the firmware option. The example aims rather to help you get familiar with the settings and configuration principles common for the digital standards.

We use one of the provided EUTRA test models (E-TM) to show how to generate a test signal upon a quick selection.

1. On the R&S SMM100A front panel, press the Preset key to start out in a defined instrument configuration.
2. In the block diagram, select "Baseband" > "EUTRA/LTE".



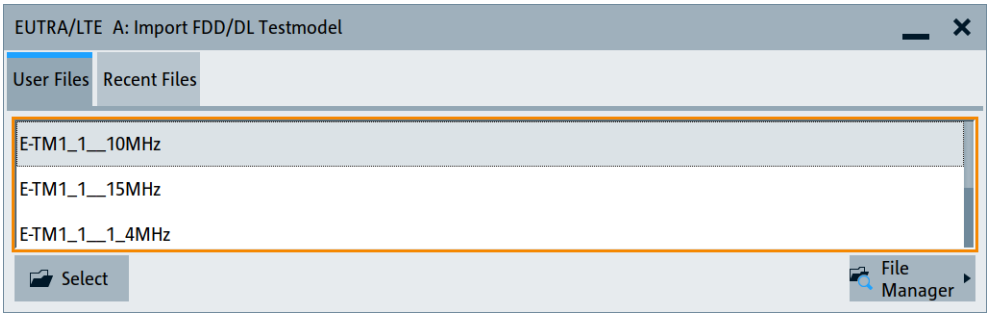
As in the user interfaces of all digital standards, the "EUTRA/LTE" dialog is divided into several tabs. The "General" tab provides general LTE settings and saving and recalling settings. Also, it provides functions to open further dialogs, for example, the baseband filter settings. The "Trigger In", "Marker" and "Clock" tabs provide settings to configure these functions.

More complex digital standard configurations provide a more complex dialog and tab structure. For all digital standards the dialog structure at the beginning has the following tabs: "General", "Trigger In", "Marker" and "Clock".

Tip: To display the dialog in its maximal height, press the [Resize window] key on the front panel.

3. In the "General" tab, select "Test Models".

   The test models conform with various EUTRA test models (E-TM). A standard "File Select" dialog enables you to select from a list of files with predefined settings.



Tip: On the front panel, press the [Help] key to obtain detailed information on the contents of the predefined files.

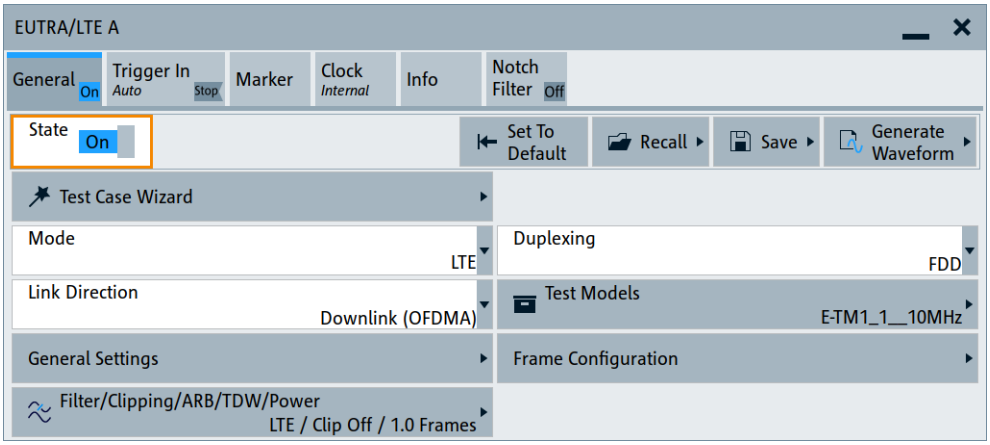
4. Navigate to a file, for example to the file `E-TM1_1__10MHz`.

   The file uses an E-TM1.1 test model with 10 MHz channel bandwidth.

5. Confirm with "Select".

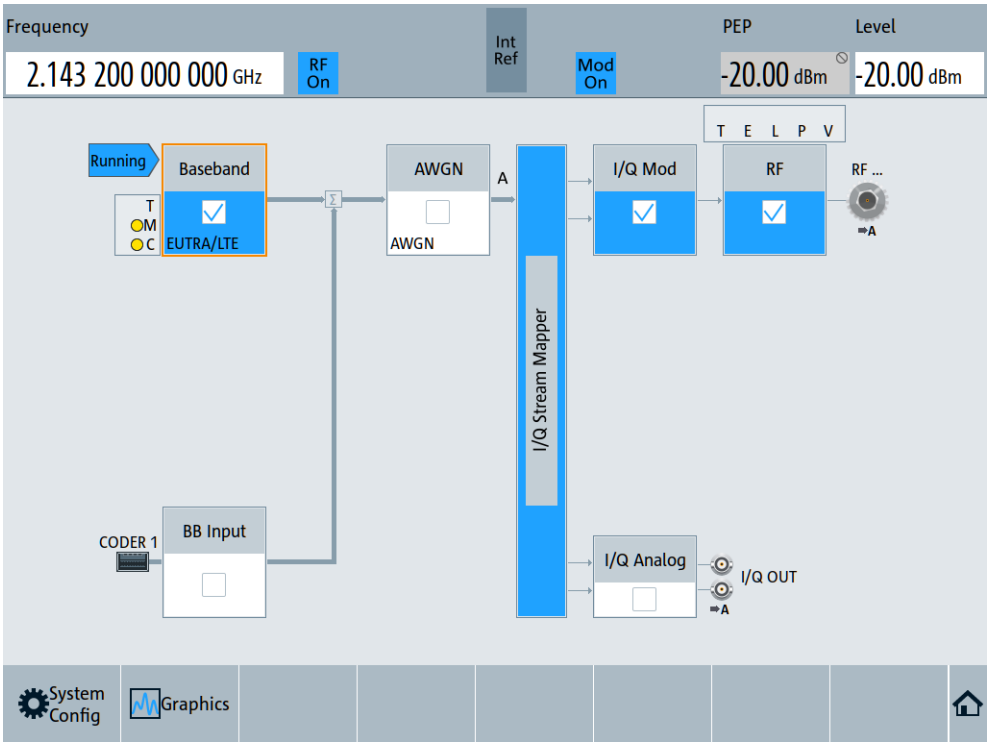
   The dialog closes and the "Test Models" button displays "E-TM1_1__10MHz".

6. Set "State" > "On" to enable baseband signal generation.



7. On the status bar, set the "Freq" = "2.143 GHz".
8. Set "Lev" = "-20 dBm"

9. Set "RF" > "On" to enable RF signal generation.



The instrument generates an EUTRA/LTE test signal with the configured channel bandwidth, frequency and level.

For more information, see the "R&S SMM100A EUTRA/LTE" user manual.

3.4 System overview

This section helps you to get familiar with the R&S SMM100A. It provides an introduction to the general concept of the instrument. This section also introduces the main blocks in the signal generation flow.

For information on how to access functions and interact with the R&S SMM100A, refer to Section 3.5, "Operating the instrument", on page 69.

3.4.1 Brief concept of the instrument

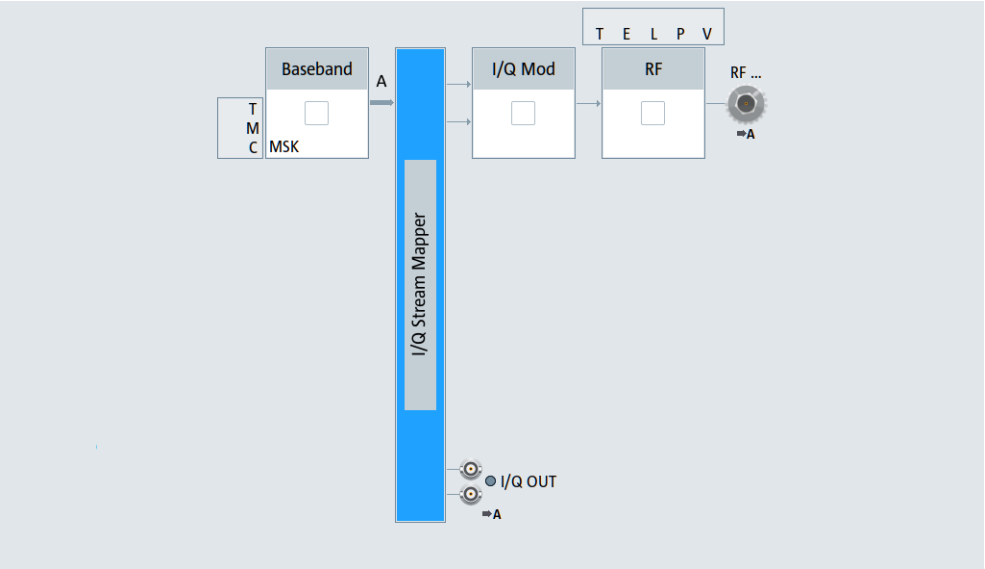
The R&S SMM100A offers excellent RF and baseband characteristics. The baseband section of the R&S SMM100A is fully digital. It contains the hardware for generating and processing I/Q signals in real time or generating signals with an arbitrary waveform generator.

3.4.1.1 Signal flow at a glance

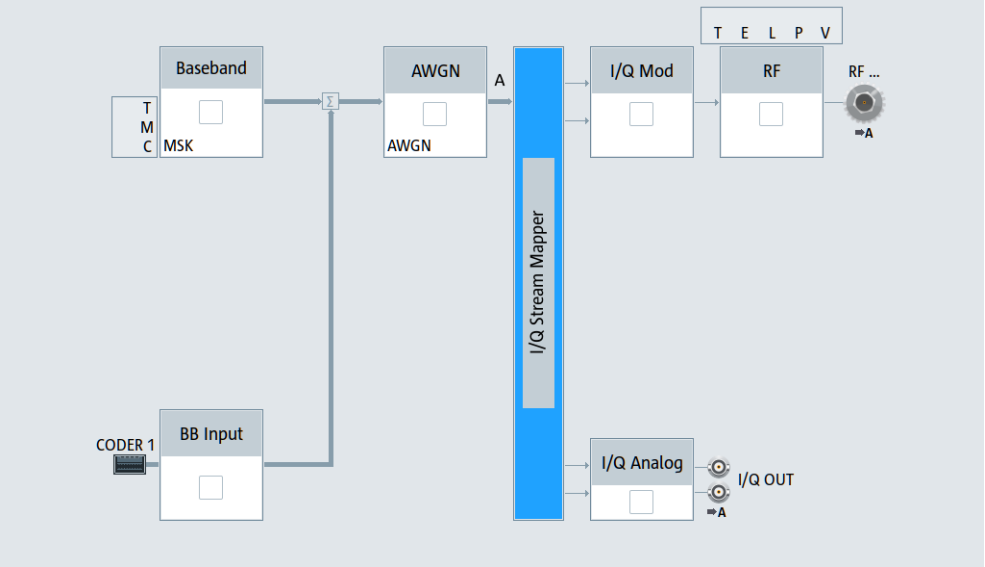
The R&S SMM100A is equipped with a large touchscreen that displays a block diagram. The block diagram represents the signal flow and the general stages that the signal generation goes through. Depending on the options the R&S SMM100A is equipped with, the appearance of the block diagram changes.

The following examples do not cover all possible cases but aim to introduce the way the block diagram depicts the installed options.

- An example of a base unit equipped with R&S SMM-B1006.



- An example of a fully equipped instrument.
  The block diagram displays all blocks for that the required hardware and software options are fitted. The block diagram shows the signal flow as it is.



Installed options and displayed settings

The table Table 3-17 lists the options to display a functional block in the block diagram for a base unit.

Table 3-17: Functional block and required options per functional block (excerpt)

Functional block	Required option
"Baseband"	R&S SMM-B9
"BB Input"	-
"AWGN"	R&S SMM-K62
"I/Q Stream Mapper"	-
"I/Q Mod"	For example, R&S SMM-B1006
"I/Q Analog"	For example, R&S SMM-B1006
"I/Q Digital"	-
"RF"	For example, R&S SMM-B1006

For more information, refer to the specifications document.

3.4.1.2 Internal baseband source (Baseband block)

The "Baseband" block represents the source of the baseband signals (basebands).

This functional block is the access point to:

- *The internal baseband generator*
  The baseband generator contains modules for real-time signal generation (Custom Digital Modulation) and an arbitrary waveform generator (ARB).
- *The available digital standards*
  Generation of digital signals in accordance with the supported standards requires additional software options. For example, option R&S SMM-K55 generates signals according to the EUTRA/LTE standard.
- *The baseband offsets function*
  Signals from the baseband generator can be shifted in frequency and phase, or boosted in power.

3.4.1.3 Digital I/Q input (BB Input block)

The "BB Input" block is the access point to the settings of:

- *The external digital I/Q signals*
  The external digital I/Q signals are further processed in the baseband section
- *The baseband offsets function*
  The external and internal baseband signals can be shifted in frequency and phase, or boosted in power.

3.4.1.4 Additional white Gaussian noise (AWGN block)

Displaying the "AWGN" block requires option R&S SMM-K62. This block controls the additional white Gaussian noise generator (AWGN). An additive white noise is required for measurements of base stations.

3.4.1.5 I/Q stream mapper (I/Q Stream Mapper block)

The "I/Q Stream Mapper" block opens settings to configure the distribution and mapping of the generated I/Q streams. You can route these streams to the RF connectors or the analog I/Q output connectors.

3.4.1.6 I/Q modulator (I/Q Mod block)

The "I/Q Mod" block represents the I/Q modulator.

This functional block is the access point to:

- The I/Q modulation of the internal baseband signal
- The I/Q modulation of an external single-ended analog wideband signal
- The analog I/Q impairments

3.4.1.7 Analog I/Q output (I/Q Analog block)

The "I/Q Analog" block represents the analog I/Q output connectors.

This block is the access point to the settings of:

- The analog I/Q output signals
  The generated signal can be output as a single-ended or differential analog signal.
- The analog I/Q impairments

3.4.1.8 RF and analog modulations (RF block)

The "RF" block represents the RF settings of the instrument.

This block is the access point to:

- RF frequency and level settings, the reference frequency, local oscillator, user correction, etc.
- The analog modulations
- The list and sweep modes

3.4.2 Applications examples of the R&S SMM100A

The R&S SMM100A can be optimally adapted to the requirements of different applications:

- Generation of digitally modulated signal

The main field of application of the R&S SMM100A is the generation of digitally modulated signals. The R&S SMM100A generates a digitally modulated signal in several ways: using the internal baseband generator, using the externally applied digital baseband signals or in an analog wideband I/Q operation.

- Generation of a wanted signal or an interference signal for receiver tests
- Generation of signals with up to 500 MHz signal bandwidth

3.5 Operating the instrument

This section provides an overview on basic operating tasks. There are three ways to operate the R&S SMM100A.

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.

This way of operation is described in Section 12.1, "Overview of remote access modes", on page 626.

Remote operation

For remote monitoring and operation of the instrument, a VNC server is installed on the R&S SMM100A. You need a LAN connection to the computer, and a VNC client or browser to connect to the instrument.

This way of operation is described in Section 12.1, "Overview of remote access modes", on page 626.

The following sections show how to operate the instrument manually.

- Means of manual interaction....69
- Understanding the display information....70
- Accessing the functionality....75
- Entering data....76
- Undo and redo actions....77
- Getting information and help....78

3.5.1 Means of manual interaction

For the manual interaction with the R&S SMM100A, you have several methods that you can use as an alternative to perform a task:

- 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 dialog boxes, enter data, scroll within a dialog etc., as if you work 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 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 cell phone

- Function keys and rotary knob:
  The front panel provides nearly all functions and controls to operate the instrument in the classic way, without touchscreen.
- Optional mouse and/or keyboard:
  These devices work like known from PCs. The navigation keys on the front panel correspond to the keys on the keyboard.

This manual describes the 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 it deviates from the standard operating procedures. The usage of the touchscreen and navigation keys is described in Section 3.5.3, "Accessing the functionality", on page 75.

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

3.5.2 Understanding the display information

The block diagram of the R&S SMM100A displays all main settings and generator states, divided into main operation areas.

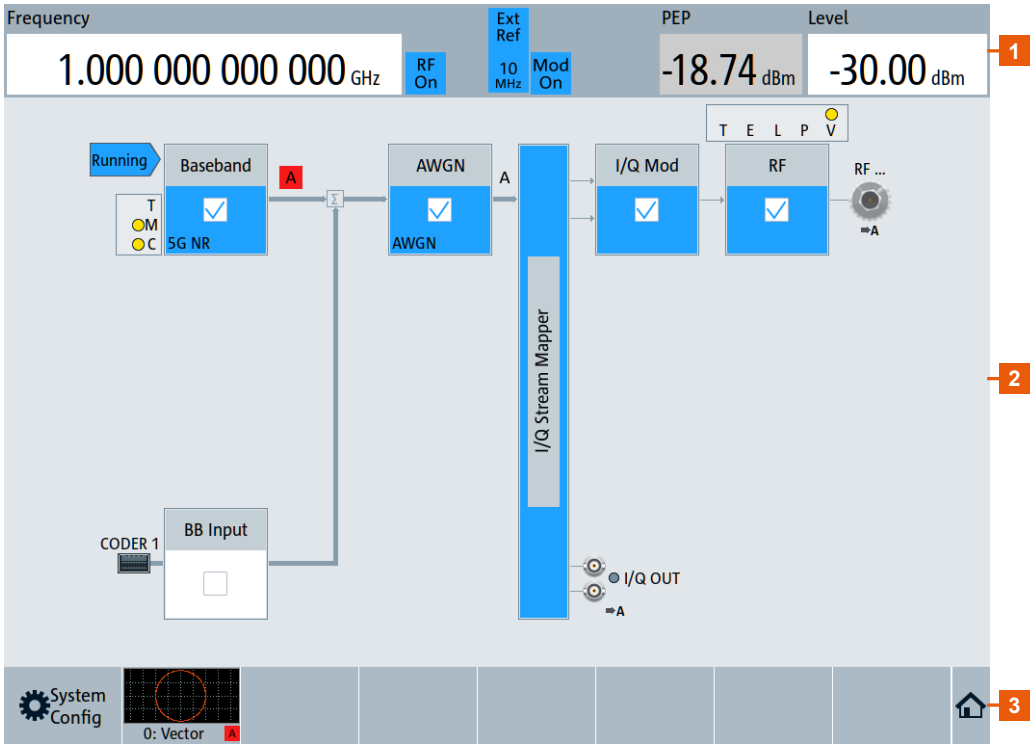


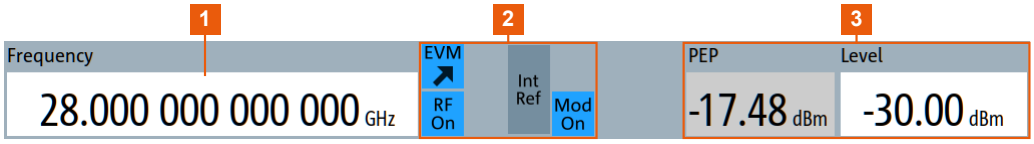
Figure 3-15: Block diagram

1 = Status bar
2 = Block diagram
3 = Taskbar/softkey bar

- Status bar 71
- Block diagram 72
- Taskbar 73
- Additional display characteristics 74

3.5.2.1 Status bar

The status bar at the top of the screen indicates the RF frequency and the level of the output signal provided to the DUT. You can set both parameters directly here.

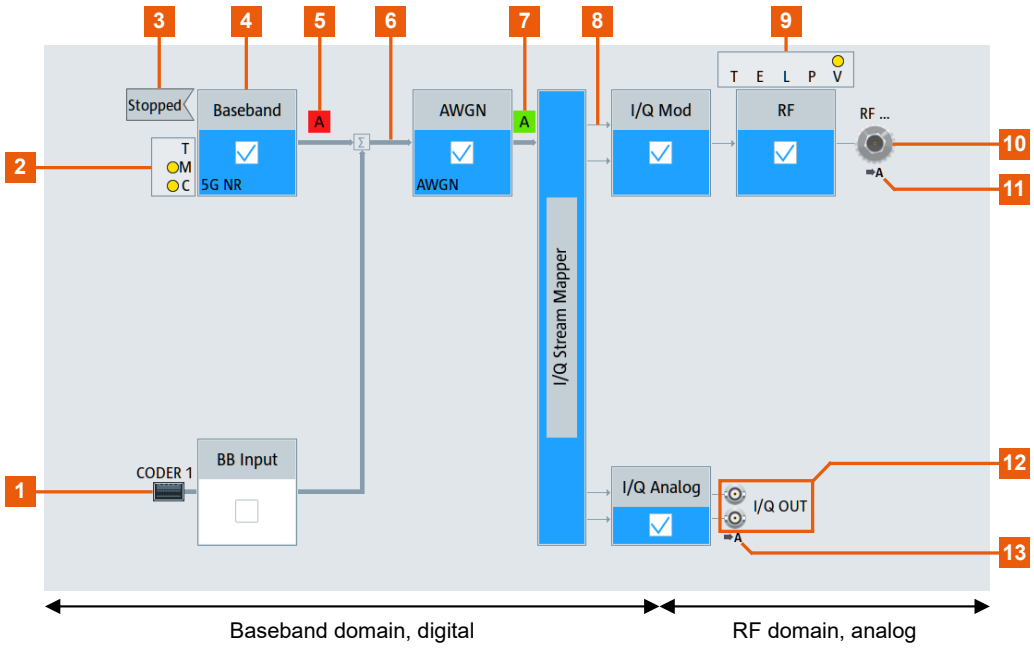


1 = Frequency display
2 = Status buttons
3 = Level display

The status buttons indicate key parameters that are set for the output signal. Most of the status buttons are virtual keys that you can use to open a corresponding menu or dialog.

3.5.2.2 Block diagram

The block diagram shows the current configuration and the signal flow in the generator with the aid of function blocks, connected by signal lines.



1, 10, 12 = Connector icons (RF, analog, digital)
2, 9 = Control signal block
3 = Status indicator
4 = Functional block
5, 7 = Graphics indicator
6 = Signal line (digital)
8 = Signal line (analog)
11, 13 = Stream indicator

Starting from the left up to the "I/Q Stream Mapper", you can see the functional blocks provided in the baseband domain. After the stream mapper, the analog section contains the digital to analog conversion and modulation to RF.

Legend	Item	Description
1 10 12	Connector icons	Represent the interfaces for signal input and output: • Digital I/Q signal connector input (1) • RF signal connector output (10) Icons vary depending on the frequency. • Analog I/Q signal connector output (12)
2 9	Control signal block	Indicates information on the control signals like signal content, input or output and provides quick access to the corresponding configuration dialog. A dedicated control block is displayed to the left of the baseband block (2) and above the RF block (9).
3	Status indicator	Indicates whether the signal is running or waiting for a trigger.

Legend	Item	Description
4	Functional block	Represents a basic task in signal generation. The push button provides access to any number of associated actions to accomplish the task. "On/Off" (checkbox) and the block label quickly enables the basic task.
5 7	Graphics indicator	Denotes that the signal is displayed graphically: Baseband signal (5), stream signal (7)
6, 8	Signal line • digital • analog	Shows the currently configured signal flow: • Thick lines represent digital I/Q streams (6). • Thin lines represent analog signals (8).
11 13	Stream indicators	Indicates the output stream "A" that is routed to the RF connector (11) or analog I/Q out connector (13)

3.5.2.3 Taskbar

The "Taskbar" contains labeled softkeys and minimized views (thumbnails) of active graphics and dialogs.

Initially, it shows the permanently assigned softkeys. The softkey with the sine wave denotes that no signal is enabled for graphical representation.

Figure 3-16: Taskbar in default state

Whenever you open a settings or graphics dialog, it is automatically assigned to the "Taskbar". The softkeys shown in the following figure represent the variants.

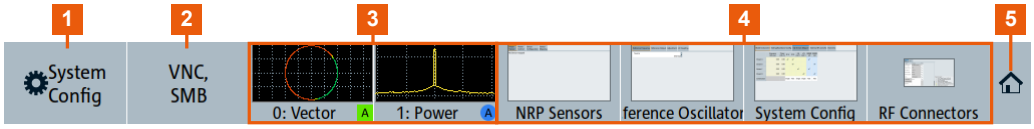


Figure 3-17: Taskbar with thumbnails

1 = System configuration
2 = Remote control connections
3 = Graphics
4 = Dialogs
5 = Homescreen or more thumbnails

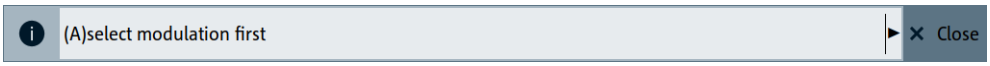
1	System Config	Provides access to general system configurations like setup, display, or remote.
2	Remote	Shows the established remote connections when the instrument is remotely controlled. **Tip:** An indicator in the status bar shows the current remote control status.
3	Graphics	Shows that a signal is represented graphically.

4	Dialogs	Shows a dialog as a thumbnail, the dialog name, and the name of the signal channel.
5	Diagram / more	The diagram icon as shown in Figure 3-16 minimizes all dialogs indicated on the screen. The block diagram is in the foreground. The "More" softkey indicates that more dialogs are open than can be displayed in the taskbar. Use this softkey to open a selection list with the remaining active dialogs, and the "Diagram" function.

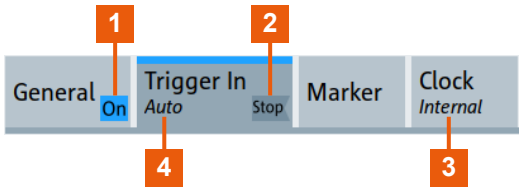
3.5.2.4 Additional display characteristics

The following section provides a short insight on the indication of the screen in general, and significant elements that you see under specific modes, in dialogs or settings.

- **Appearance of active elements**
  - *Active* elements like On/Off switches, state buttons have a **blue** background.
  - *Selected* elements are framed or highlighted **orange**.
  - *Inactive* elements are **gray**.
- **On-screen keypads**
  Either a numerical or alphanumerical on-screen keypad appears when you enable an entry field, see Section 3.5.4, "Entering data", on page 76.
- **Info line**
  The "Info line" shows brief status information and error messages. It appears when an event generates a message. If selected, the R&S SMM100A shows information on static errors and the error history.



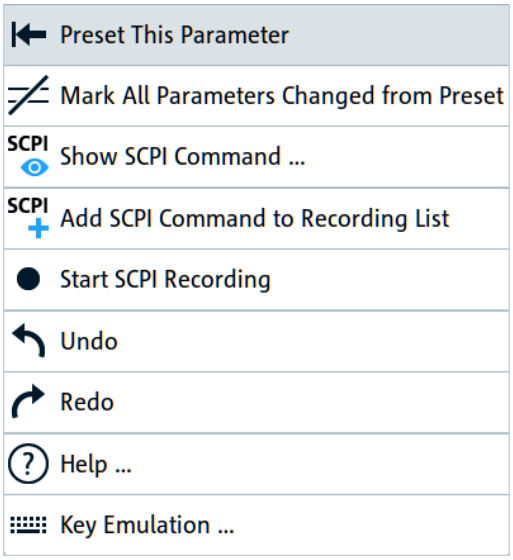
- **Key parameters indicated in tab labels**
  Most dialogs are divided into tabs with logically grouped parameters. The tab label expresses the content and can also contain status indicators or the set value of a key parameter.



1, 2 = Status indicators
3, 4 = Key parameter values

- **Scrollbar handle**
  An arrow icon that appears when you touch a scrollbar helps you to scroll in a dialog or list.
- **Progress indicators**
  A busy icon indicates a currently running process. If a process takes some time, a progress bar shows the current state.
- **Context-sensitive menus**

Within the entire screen display, including single parameters, you can access context-sensitive menus that provide some additional functions.



3.5.3 Accessing the functionality

All functionalities are provided in dialog boxes as known from computer programs. You can control the instrument intuitively with the touchscreen. This section provides an overview of the accessing methods.

The instrument's functions and settings can be accessed by selecting one of the following elements:

- System and function keys on the front panel of the instrument
- Taskbar/softkeys on the touchscreen
- Context-sensitive menus for specific elements on the touchscreen
- Elements on the status bar in the touchscreen
- Displayed setting on the touchscreen that means block diagram and all settings available in dialogs.

To open a dialog box

► Perform one of the following actions:

- Select the required block, and then the menu entry.
- Select the minimized view (thumbnail) on the taskbar.

Some of the utility keys access a dedicated dialog, too.

To minimize a dialog box

► Select the "Minimize" icon in the upper right corner.

To close a dialog box

To close a dialog box, you have the same controls as you know from computers or devices with touchscreen.

► Perform one of the following actions:

- Select the "Close" icon in the upper right corner.
- Select the [Esc] key on the front panel.
- Drag and drop a minimized dialog from the taskbar to the block diagram.

To select an option in a dialog box

► Select the required option.

To select an option in a list

If you can select many options, these options are provided in a list. The current selection is shown on the list button.

1. Select in the list.
2. To navigate through the list, try out the following:
   - Using a mouse, scroll in the list to select the required option.
   - Use the rotary knob.
   - Use [On/Off Toggle] key to select the succeeding option
   - Use the front panel keys:

   a) Select the [Left/Right] arrow keys to navigate to the list button.
   b) Select the [Enter] key to open the list.
   c) Select the [Up/Down] keys to navigate to the required option in the list.
   d) Select the [Enter] key to select the marked option.

3.5.4 Entering data

Some parameters have their own key on the front panel. For data input in dialog boxes, the instrument provides on-screen keypads for entering numeric and alphanumeric values. You can always set the parameters via the touchscreen, the front panel or an external keyboard.

To enter numeric values with the on-screen keypad

For numeric settings, the instrument displays the numeric keypad. The units specified correspond to the units of the parameter.

1. Enter the numeric value.

   Tip: For a quick entry, you can enter a value in an exponential representation, for example *1e7* for *10000000*.

2. Tap the unit button to complete the entry.

   The unit is added to the entry.

Tip: For a quick unit change, you can enter shortcuts, for example for a frequency value *1e8h* for *100 MHz*.
For an overview of shortcuts supported by the R&S SMM100A, see Section C, "Unit shortcuts", on page 1140.

3. If the parameter does not require a unit, confirm the entered value by pressing "Enter".

To enter numeric values with the front panel controls

1. Change the currently used parameter value by using the rotary knob or the [Up/Down] keys.
2. If the parameter does not require a unit, confirm the entered value by pressing the [Enter] key or any of the unit keys.
   The instrument highlights the editing line to confirm the entry.

If you edit numeric data in tables, enable edit mode first. Press [Enter] or press the rotary knob.

To enter alphanumeric values

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

To complete an entry

► Press the [Enter] key or the rotary knob.

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.
3. Deletes the entry to the left of the cursor.
4. Enter your correction.

To abort an entry

► Press the [Esc] key.
The dialog box closes without changing the settings.

3.5.5 Undo and redo actions

Accessed via the context-sensitive menus, "Undo" allows you to restore one or more actions on the instrument. Depending on the available memory, the "Undo" steps can restore all actions.

Undo

Redo

"Redo" restores a previously undone action.

3.5.6 Getting information and help

In some dialog boxes, graphics are included to explain the way a setting works.

For further information, you can use the following sources:

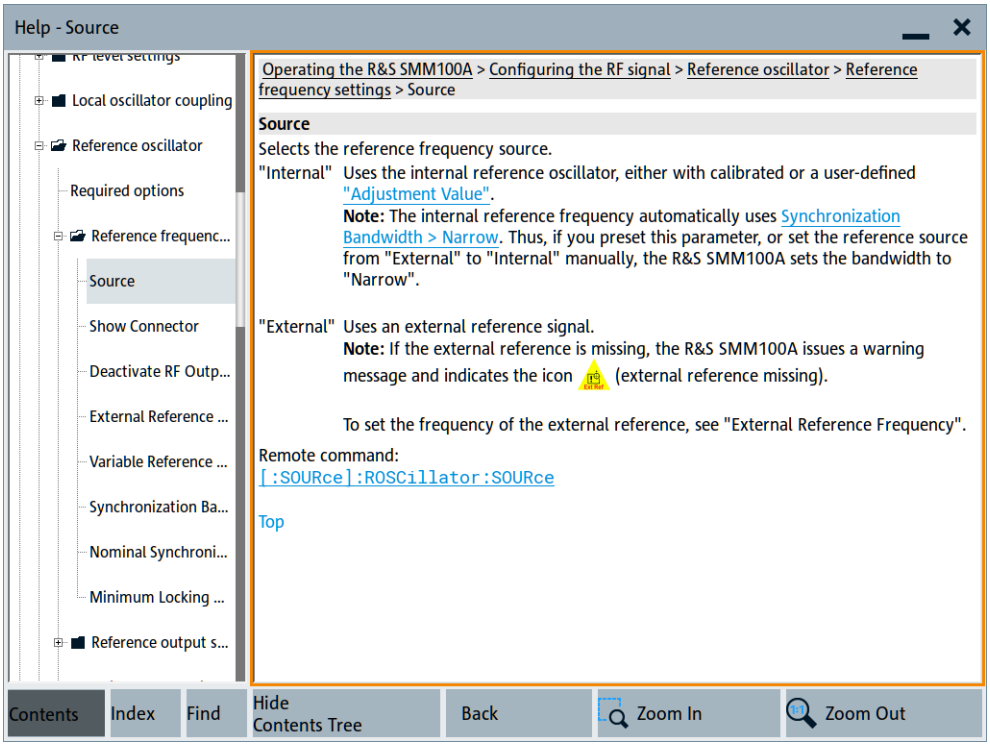
- Tooltips give the value range of the parameter.
- The context help provides a functional description on a setting.
- The general help explains a dialog box, provides instructions, and general information.

To display context help

► To access a help topic, perform one of the following:

a) Tap and hold the parameter for which you need information.
b) In the opening context menu, tap "Help".
c) Tap the parameter.
d) Press the [Help] key.

The "Help" dialog opens. You can browse the help for further information.



Contents of the help dialog box

The help dialog box covers two main areas:

- "Contents" - contains a table of help contents
- "Topic" - contains a specific help topic

The help system also provides an "Index" and a "Find" area, and "Zoom" functions that are accessed via the corresponding buttons.

To open general help

► Press the yellow [Help] key on the front panel.

If a dialog box is opened, the help topic for the current tab is shown. Otherwise the "Contents" page appears.

Navigating in the table of contents and in the help topics

1. To move through the displayed content entries, tap on an entry.
   Entries with a plus sign contain further entries.
2. To display a help topic, tap on the topic name.
3. To follow a cross-reference, tap on the link text.
4. To return to the previous page, select "Back".
   This function scrolls back all steps that you have performed before.
5. Use the "scroll bars" to shift the visible section of content shown.
6. To maximize the "Topics" area, tap the "Hide Contents Tree" button to hide the contents tree.

Using the index

1. Select the "Index" button.
2. Enter the first characters of the topic that you are interested in.

   The entries starting with these characters are displayed.
3. Tap on the index entry.

   The corresponding help topic is displayed.

4 Configuring the internal baseband source

The R&S SMM100A is a vector signal generator with internal signal generation and real-time functionality and with integrated arbitrary waveform generator.

The instrument enables you to generate various digital modulation signals in accordance with the definitions in the corresponding specifications or with user-definable characteristics. Signals are generated in realtime or played from a data store with external and internal data. The instrument provides an interface for the loading of externally computed modulation signals in form of waveform files.

This section covvers the following topics:

- Overview of the signal generation modes....80
- Accessing the functions in the baseband domain....81
- Generating signals according to digital standards....82
- Common characteristics of the baseband domain....85
- Generating custom digital modulation signals....117
- Using the arbitrary waveform generator (ARB)....149
- Generating notched signals....197
- Reducing the crest factor....203
- Generating multi-segment waveform files....204
- Generating multicarrier waveform signals....234
- Generating multicarrier continuous wave signals....251
- Shifting the baseband signal....261

4.1 Overview of the signal generation modes

The R&S SMM100A can generate the signal in the following ways:

- Generating digital standard signals
- Generating a real-time signal
- Playing a waveform

Generating digital standard signals

Provided the instrument is equipped with the required digital standard options, the instrument can generate digital standards in accordance with the corresponding specifications.

The required options are specified in the description of the respective digital standard (see the corresponding user manual).

See also Section 4.3, "Generating signals according to digital standards", on page 82.

Generating a real-time signal

- While utilizing the *internal* signal generator, the R&S SMM100A generates the digital modulation signals with user-definable characteristics in real time.
  See also Section 4.5, "Generating custom digital modulation signals", on page 117.

- If the required options are installed, *externally supplied real-time* baseband signals can be added to the internally generated signals.
  See also Section 9.6, "Digital baseband input settings", on page 506.

Playing a waveform

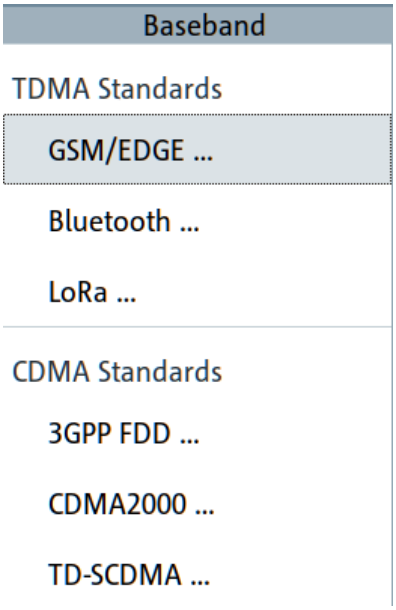
The R&S SMM100A is equipped with an arbitrary waveform generator (ARB) used to generate test signals and to process waveform files. Waveforms are files with settings provided for repeatable tests with the same test signal. Irrespectively of the way these waveform files are generated, they are always played from the instrument. That is, the signal calculation is performed in advance and the instrument reacts as a player.

- Externally computed waveform files can be loaded in the instrument over the LAN, USB, or the GPIB interface.
  Create waveforms, for example, with the signal generation software R&S WinIQSIM2 or the R&S®Pulse Sequencer software.
- The instrument provides different functions to generate waveforms *internally*.
  - Some of the digital standards firmware options provide the possibility to store the current signal settings into a waveform file. These waveform files can be loaded in and processed as multi-carrier or multi-segment signal by the ARB generator.
    See also Section 4.6, "Using the arbitrary waveform generator (ARB)", on page 149.
  - Multi-carrier waveforms consisting of carriers modulated by different baseband signals can be configured and created internally. Such multi-carrier waveform files are required to simulate complex multi-carrier scenarios with different baseband signals, e.g. CDMA2000, 3GPP FDD, or signals in accordance with the LTE-Advanced specifications.
    See also Section 4.10, "Generating multicarrier waveform signals", on page 234.
  - Provided the instrument is equipped with the corresponding option, it is also possible to generate multi-carrier waveforms consisting of unmodulated carriers
    See also Section 4.11, "Generating multicarrier continuous wave signals", on page 251.

4.2 Accessing the functions in the baseband domain

1. In the block diagram, select the "Baseband" block.

2. Navigate through the context menu.



The "Baseband" block provides all functions and settings to configure the baseband signal. The functions and settings include all generation modes as described in the Section 4.1, "Overview of the signal generation modes", on page 80.

3. By default, baseband signal generation is off.
   To activate the baseband generator, in the block diagram, select the "Baseband" block and set "Baseband > On".

   A short designation indicates the digital standard or modulation currently selected.

   For information, see:
   - Section 4.5, "Generating custom digital modulation signals", on page 117
   - Section 4.6, "Using the arbitrary waveform generator (ARB)", on page 149
   - Section 4.11, "Generating multicarrier continuous wave signals", on page 251
   - The description of the digital standards
   - Section 4.12, "Shifting the baseband signal", on page 261

4.3 Generating signals according to digital standards

The R&S SMM100A generates digital signals in accordance with the specifications of the main communication and radio standards only if the corresponding firmware options are installed.

GSM/EDGE, EDGE Evolution

This digital standard requires an instrument equipped with the GSM/EDGE and EDGE Evolution options R&S SMM-K40/-K41.

The GSM/EDGE, EDGE Evolution options provide functionality to generate signals in accordance with the GSM/EDGE standard. GSM/EDGE signals comprise GMSK and 8PSK modulation and higher order modulations that are in accordance with the EDGE Evolution standard.

For details, see the R&S SMM100A GSM/EDGE user manual.

Bluetooth® BR/EDR/LE/Channel Sounding

This digital standard requires an instrument equipped with the Bluetooth® options R&S SMM-K60/-K117/-K178.

The Bluetooth® options provide functionality to generate signals in accordance with the Bluetooth® core specification for Bluetooth® Classic and Bluetooth® 5.x Low Energy operation. For the latest version, see the latest Bluetooth® core specification document.

For details, see the R&S SMM100A Bluetooth® Signal Generation user manual.

LoRa

This digital standard requires an instrument equipped with the LoRa option R&S SMM-K131.

The LoRa option provides functionality to generate signals in accordance with the Semtech Corporation, Camarillo California, USA proprietary standard.

For details, see the R&S SMM100A LoRa user manual.

3GPP FDD incl. enhanced MS/BS tests, HSPA, HSPA+

This digital standard requires an instrument equipped with the 3GPP FDD incl. enhanced MS/BS tests, HSPA, HSPA+ options R&S SMM-K42/-K83.

These options provide functionality to generate signals in accordance with the WCDMA standard 3GPP FDD.

For details, see the R&S SMM100A 3GPP FDD user manual.

CDMA2000®

This digital standard requires an instrument equipped with the CDMA2000 option R&S SMM-K46.

The CDMA2000 option provides functionality to generate signals in accordance with the CDMA2000 standard 3GPP2 C.S0002-C, version 1.0 (release C).

For details, see the R&S SMM100A CDMA2000 user manual.

TD-SCDMA and TD-SCDMA enhanced features

This digital standard requires an instrument equipped with the TD-SCDMA and TD-SCDMA enhanced features options R&S SMM-K50/-K51.

The TD-SCDMA options provide functionality to generate signals in accordance with the TD-SCDMA (3GPP TDD LCR) standard.

For details, see the R&S SMM100A TD-SCDMA user manual.

1xEV-DO Rev. A and Rev. B

This digital standard requires an instrument equipped with the 1xEV-DO Rev. A and Rev. B options R&S SMM-K47/-K87.

The 1xEV-DO options provide functionality to generate signals in accordance with the CDMA2000 1xEV-DO (Evolution-Data Optimized), Rev. A and Rev. B standard.

For details, see the R&S SMM100A 1xEV-DO Rev. A Rev. B user manual.

IEEE 802.11a/b/g/n/p/j, IEEE 802.11ac, IEEE 802.11ax, IEEE 802.11be

These digital standards require an instrument equipped with the WLAN options R&S SMM-K54/-K86/-K142/-K147.

These options provide functionality to generate signals in accordance with the WLAN standards IEEE 802.11a/b/g/n/ac/p/j/ax/be.

For details, see the R&S SMM100A IEEE 802.11 WLAN user manual.

HRP UWB 802.15.4

This functionality requires an instrument equipped with the HRP UWB 802.15.4 option R&S SMM-K149.

This option provides functionality to generate signals in accordance with the HRP UWB standard.

For details, see the R&S SMM100A HRP UWB 802.15.4 user manual.

EUTRA/LTE Rel. 8, Rel. 9, Rel. 10, Rel. 11, Rel. 12, Rel. 13/14, Cellular IoT, incl. Enhancements

This digital standard requires an instrument equipped with the EUTRA/LTE options R&S SMM-K55/-K69/-K81/-K84/-K85/-K112/-K113/-K115/-K119/-K143.

These options provide functionality to generate signals in accordance with the 3GPP standard EUTRA/LTE Rel. 8, Rel. 9, Rel. 10, Rel. 11, Rel. 12 and Rel. 13/14.

5G NR

This functionality requires an instrument equipped with the 5G NR option R&S SMM-K144.

This option provides functionality to generate signals in accordance with the 3GPP standard release 17.

For details, see the R&S SMM100A 5G NR user manual.

OFDM Signal Generation

This functionality requires an instrument equipped with the OFDM Signal Generation option R&S SMM-K114.

This option provides functionality to generate OFDM signals and signals according to predefined OFDM modulation schemes.

For details, see the R&S SMM100A OFDM Signal Generation user manual.

NFC/EMV

This digital standard requires an instrument equipped with the NFC/EMV option R&S SMM-K89.

The NFC/EVM option provides functionality to generate signals in accordance with the short-range wireless connectivity technology NFC-A/B/F and the EMV standard.

For details, see the R&S SMM100ANFC A/B/F user manual.

4.4 Common characteristics of the baseband domain

This section describes characteristics that are common to many baseband signal generation tasks. These characteristics are independent from the selected baseband signal source, for example, the selected digital standard.

For specific signal generation tasks, there can be specific settings that can deviate from common baseband signal generation settings. For example, a specific signal generation task is to generate a signal according to a digital standard.

4.4.1 About common baseband characteristics

This section provides general information on common baseband signals including signal sources and signal types, modulation formats and coding schemes and baseband filtering and clipping.

Signal sources

In the baseband domain, you can generate internal signals or input external signal. Control signals however are always generated internally.

Depending on the current configuration, the internally generated data and marker signals are output on one or several connectors. The output capabilities of the instrument and the required connectors are configurable.

Signal types

For the generation of modulation signals, the instrument uses the following input signals:

- "Internal modulation data" on page 86
- Section 4.4.1.3, "About control signals", on page 88

See also Section 11.2, "Configuring local and global connectors", on page 563.

This section describes common characteristics of the signals used for generating the baseband signal for all standards. Common characteristics do not depend on the generation mode.

The selection in the dialogs at any given time depends on the parameter and standard concerned. It is clear from the selection list offered in the dialog. Some parameters are

therefore not available in certain cases. Characteristics specific to particular standards are described in the corresponding user manual.

- About data signals....86
- Clock signals....87
- About control signals....88
- About marker signals....90
- About trigger signals....92
- Supported modulation signals....99
- Supported coding schemes....100
- Supported baseband filters....101
- Methods for optimizing the crest factor....103

4.4.1.1 About data signals

For the generation of modulation signals, the instrument uses the following input signals:

- "Internal modulation data" on page 86
- Section 4.4.1.3, "About control signals", on page 88

Internal modulation data

The R&S SMM100A uses the following internal modulation data sources:

- **Data lists**
  Data lists are externally or internally created binary lists with modulation data.
  The instrument provides a standard file select function for loading of existing data lists, creating internally new data lists or editing an existing one. Internally, data lists are created in the dedicated "Data List" editor (see Section 4.5.3.7, "Data list editor", on page 130). A separate file is created for each list and saved on the instrument's internal memory (hard disk). The filename is user-defined; the file extension is `*.dm_iqd`.
  The maximum length of a data list is determined by the size of the data list memory. There is no restriction on the number of lists that can be saved.
  Settings for file handling, like transferring external data lists to the instrument, or renaming of folders and files, are accessed via the standard "File Manger" function. (See also Section 10, "File and data management", on page 519).
- **Data patterns**
  Simple data patterns such as binary 0 ("All 0") strings or 1 ("All 1") strings or variable bit strings with a maximum length of 64 bits can be used as internal modulation data.
- **PRBS data**
  The PRBS generators deliver pseudo random binary sequences of differing length and duration. They are known as maximum length sequences. PRBS sequences are generated with the aid of ring shift registers with feedback points determined by the polynomial.
  The pseudo-random sequence from a PRBS generator is uniquely defined by the register number and the feedback. The Table 4-1 describes the available PRBS generators.

For PRBS15 and PRBS23, a CCITT V.52-compliant data inversion is performed in the feedback path automatically.

For more information, refer to the specifications document.

Table 4-1: Overview of PRBS generators

PRBS generator	Sequence length /bit	Feedback to	GUI selection
9-bit	2^9 - 1 = 511	Registers 4, 0	"PRBS 9"/"PN9"
11-bit	2^{11} - 1 = 2047	Registers 2, 0	"PRBS 11"/"PN11"
15-bit	2^{15} - 1 = 32767	Registers 1, 0	"PRBS 15"/"PN15"
16-bit	2^{16} - 1 = 65535	Registers 5, 3, 2, 0	"PRBS 16"/"PN16"
20-bit	2^{20} - 1 = 1048575	Registers 3, 0	"PRBS 20"/"PN20"
21-bit	2^{21} - 1 = 2097151	Registers 2, 0	"PRBS 21"/"PN21"
23-bit	2^{23} - 1 = 8388607	Registers 5, 0	"PRBS 23"/"PN23"

Example:

By way of example, the diagram on A 9-bit PRBS generator shows a 9-bit generator with feedback to registers 4 and 0 (output). The generated serial data is converted internally, e.g 2 Bit/Symbol if QPSK is used.

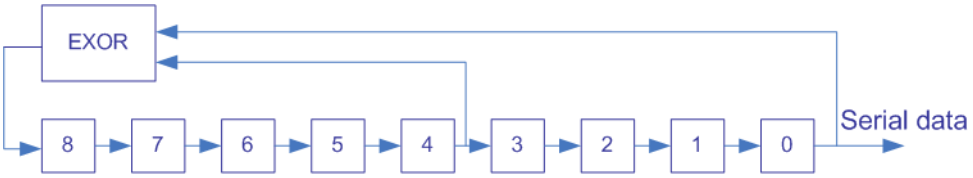


Figure 4-1: A 9-bit PRBS generator

Related settings:

- Section 4.5.3.3, "Data source settings", on page 122
- Section 4.5.3.7, "Data list editor", on page 130
- Section 4.5.3.8, "Control and marker lists editor", on page 132
- "Data Source" selection in the dialogs of the firmware options

4.4.1.2 Clock signals

The instrument requires a clock reference for generating the timing pulse and uses its internal clock reference for that purpose.

The internally generated symbol clock signal can be output at the User x connectors. The Table 4-2 gives an overview.

Table 4-2: Output connectors for the reference clock signal

Connector	Location	GUI selection
T/M/C	Front and rear panel	To configure the connector: • "Custom. Dig. Mod/Digital Standard > Clock Settings > Global Connectors > Direction > Input > Global Clock 1/2" • "Custom. Dig. Mod/Digital Standard > Clock Settings > Local Connectors > Signal > Symbol Clock A" To enable the clock source • "Custom. Dig. Mod/Digital Standard > Clock Settings > Clock Source > Internal"

Synchronizing data signals and clock signals

The synchronization is always based on the positive edge of the clock.

Related settings:

- Section 4.4.2.3, "Clock settings", on page 113
- Section 11.2, "Configuring local and global connectors", on page 563
- Clock settings in the dialogs of the firmware options

4.4.1.3 About control signals

The following control signals are processed in the R&S SMM100A:

- "Burst Gate" for power ramping
- "Level Attenuation" for power ramping
- "CW/Mod" for controlling the CW (continuous wave) mode

A dedicated internal "Control Data Editor" is provided for defining the control signals. Refer to Section 4.5.3.8, "Control and marker lists editor", on page 132 for a description on the provided settings.

Continuous wave mode

The "CW" signal turns off digital modulation. The signal is output in unmodulated form.

Power ramping and level attenuation

The R&S SMM100A uses the two control signals "Burst Gate" and "Lev_Att" to trigger the power ramping and level attenuation functions.

The instrument internally generates control signals as configured in Section 4.5.3.8, "Control and marker lists editor", on page 132; the signals can be output on the T/M connectors.

- *Burst gate control signal*
  The "Burst Gate" signal is a rectangular pulse signal with variable low and high periods. Signal generation is restricted to the gate high periods. If the power ramping function is enabled, each transition between two gate periods of the "Burst Gate" signal triggers the generation of a ramp. Further settings define the form and

the steepness of this ramp, see "Impact of the power ramping settings on the generated signal" on page 89.

- *Level attenuation control signal*
  The "Lev_Att" signal is a rectangular pulse signal with variable low and high periods. Level attenuation is applied if the "Lev_Att" signal is high. If level attenuation is enabled, the modulation signal level is attenuated by a defined value.

Related settings:

- Section 4.5.3.6, "Power ramp control settings", on page 128

Possible applications

- Use the "Level Attenuation" function to simulate radio stations located at various distances.
- Use the "Power Ramp" function if it is necessary to control the RF output signal envelope synchronously, e.g. by the generation of TDMA signals.

Both the GSM/EDGE and the TD-SCDMA firmware options are equipped with an embedded power ramping function. In the GSM/EDGE standard, for example, a maximum of 7 different level attenuation values can be defined and allocated separately to the 8 slots independently of one another.

Impact of the power ramping settings on the generated signal

The Figure 4-2 explains the power ramping function in principle. The "Burst Gate" signal defines the start of the rising and falling edges of the envelope of the output signal, and the "Lev Att" signal defines the start and end of level attenuation. The signal level during the attenuation period is a configurable value.

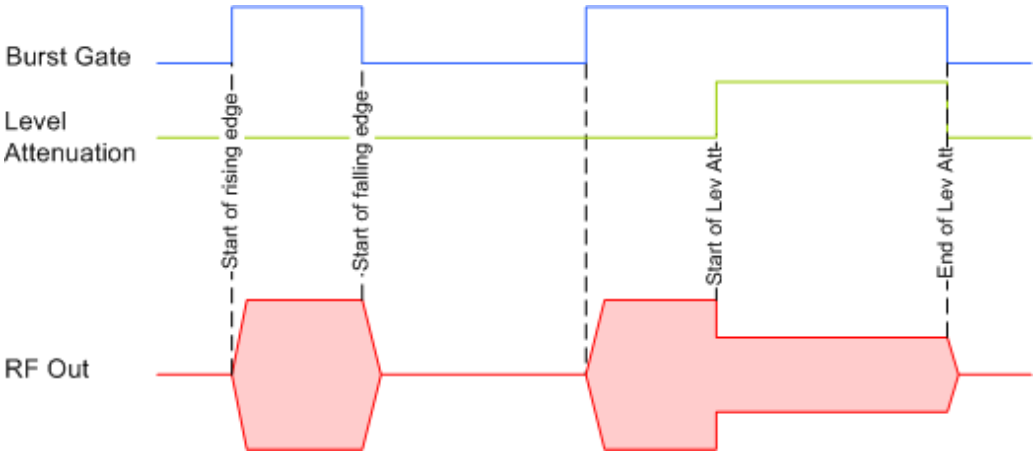


Figure 4-2: Signal behavior when power ramping and level attenuation are enabled

Several parameters are provided for precise definition of the form and the steepness of ramp. The Figure 4-3 depicts the impact of the provided settings.

- Ramp function: defines the shape of the rising and falling edges
- Ramp time: defines the duration of the rising and the falling ramp
- Rise/fall delay: offsets the falling edge of the envelope at the beginning/end of a burst

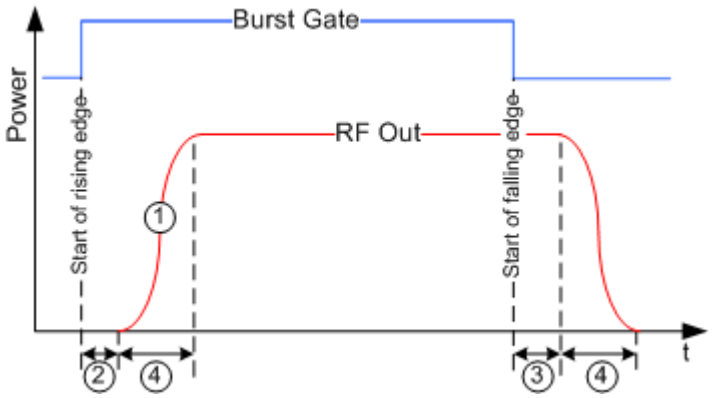


Figure 4-3: Impact of the ramp settings

1 = "Ramp Function"
2, 3 = "Rise Delay", "Fall Delay"
4 = "Ramp Time"

4.4.1.4 About marker signals

The R&S SMM100A can add additional signals to the generated signal. Marker signals (or markers) are digital signals to synchronize external devices to the generated data stream. For example, with suitable marker settings, you can select a slot clock or frame clock, or mark the start of a particular modulation symbol.

Number of marker signals and marker output

Three marker output signals are available; they can be output at the User x connectors or at the T/M 1/2 connectors.

Related settings

- Section 4.4.2.2, "Marker settings", on page 111
- Section 11.2, "Configuring local and global connectors", on page 563
- Marker settings in the dialogs of the firmware options

Marker modes

Marker mode restart

The generated marker signal is a single "On" pulse. The rising edge of this pulse is generated at the signal generation start and at each subsequent signal restart time. This marker can be used to monitor the effects of the selected trigger, e.g. trigger causing restarts of the signal generation.

Marker mode pulse

Periodic marker with consecutive on periods and off periods of equal length. The first on period starts at the beginning of the first generated sample/symbol. The marker frequency is defined by a "Divider". The frequency is derived as follows:

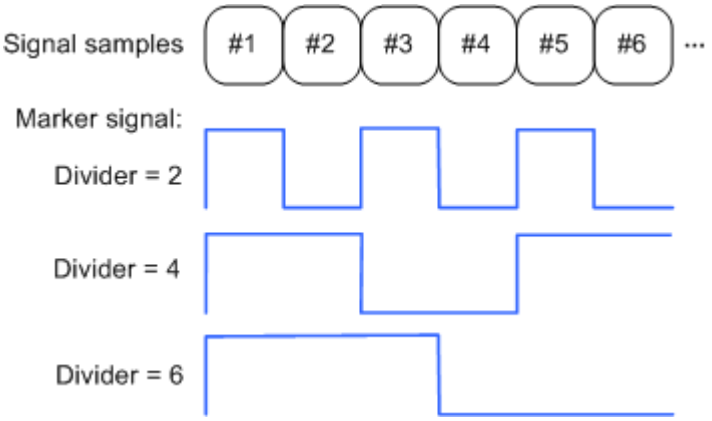
<Frequency> = "Symbol Rate"/"Sample Rate" / "Divider", respectively.

<Frequency> = "Sampling Frequency" / "Divider".

Example:

"Symbol Rate" = "1 Msym/s", "Divider" = "2"

The marker frequency is 500 kHz, corresponding to a marker period of 2 us. Each on and off period has a length of 1 us, corresponding to one symbol period. With a divider of 4 (6, 8 ...), the length of each on and off period is increased to 2 (3, 4, ...) symbol periods.

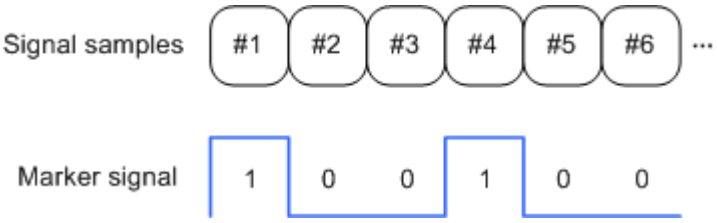


Marker mode pattern

Periodic marker where each period is defined by a bit pattern with a maximum length of 64 bits. A "1" ("0") in the pattern denotes an on (off) signal segment with a duration of one sample/symbol period.

Example:

In the following example, the marker signal is defined by a pattern *100100...*.

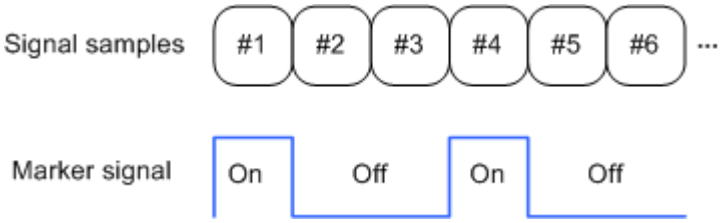


Marker mode On/Off Ratio

Similar to "Pulse" but with independent lengths of the on periods and off periods. The length of the periods is entered as several symbols/sample periods.

Example:

In the following example, the marker signal is defined by an "On Time" = "1 sym" and "Off Time" = "2 sym".



Delaying marker signals

In all the examples listed in "Marker modes" on page 90, the marker starts at the beginning of the first generated sample/symbol (sample/symbol no. 1). It is possible though to delay the start of the marker by an integer number of symbol periods or sample periods.

4.4.1.5 About trigger signals

The R&S SMM100A provides several trigger modes, different trigger sources, and some additional trigger settings to suppress or delay the trigger events. This section provides an overview of the provided baseband trigger settings and the impact of the trigger settings on the signal generation.

The current signal generation status ("Running" or "Stopped") is continuously displayed in the corresponding dialog, indicated in the header of the tab and in the block diagram of the instrument. This indication is important when an external trigger is applied.

For information on the trigger signals used in the RF domain, see Section 7.10.1, "Signal generation and triggering in the sweep and list modes", on page 336.

Trigger

The trigger signals are internally generated or externally supplied signals, which start signal generation at a particular point in time. However, signal generation can also take place without triggering. In this case, the signal generation stars immediately after the modulation is enabled.

Trigger event

A trigger event is caused by the received trigger signal. Another possibility to provoke a trigger event is to execute the trigger manually. The "Arm" function stops the signal generation until a following trigger event occurs.

- Trigger sources 93
- About trigger modes 93
- Impact of additional trigger settings 96
- Receiving and providing trigger signals 99

Trigger sources

The provided trigger sources are divided into two main groups, internally generated or externally supplied trigger signals.

- Internal ("Internal")
  Internal trigger signals are generated by the instrument itself.
- External ("External Global Trigger")
  External trigger signal is generated by an external trigger source.
  The instrument expects the trigger signal at one of the T/M/C or User x connectors.
  Refer to Configuring local and global connectors for information on how to configure the required settings.
- External ("Baseband Sync In")
  In primary-secondary instrument mode, secondary instruments are triggered by the active edge of the synchronization signal.
  This trigger source is selected automatically and cannot be changed.
  See Section 9.2.1, "Connecting multiple instruments in primary-secondary instrument mode", on page 476.

The trigger mode setting, the selection of the trigger source and the setting of a delay and trigger suppression in the case of external triggering are carried out independently.

However, the polarity and impedance characteristics of the external signals are identical for all basebands using this signal.

A signal which marks the trigger event can be output at the T/M/C connectors.

Related settings:

- Section 4.4.2.1, "Trigger settings", on page 106
- Section 11.2.5, "Global connectors settings", on page 570
- Trigger settings in the dialogs of the firmware options

About trigger modes

A trigger event defines the signal generation and depends on the trigger mode. The Table 4-3 provides an overview of the trigger modes and their impact on the signal generation start.

Table 4-3: Impact of the trigger events on the generated signal

"Trigger Mode"	Signal generation mode[1)]	1st Trigger event "Exec. Trigger" or "External" trigger signal	Subsequent trigger event "Exec. Trigger" or "External" trigger signal	Trigger event "Arm"
"Auto" See Figure 4-5	Continuous	-	-	-
"Retrigger" See Figure 4-6	Continuous	Initial start	Restart	-
"Armed_auto" See Figure 4-7	Continuous	Initial start	Restart (only after previous "Arm")	Stop

"Trigger Mode"	Signal generation mode[1)]	1st Trigger event "Exec. Trigger" or "External" trigger signal	Subsequent trigger event "Exec. Trigger" or "External" trigger signal	Trigger event "Arm"
"Armed_retrigger" See Figure 4-8	Continuous	Initial start	Restart	Stop
"Single" See Figure 4-4	Single length determined by "Trigger Signal Duration"	Initial start	Restart	-

[1)] the instrument generates a continuous signal or a single signal.

- Single signal generation means that the signal generation stops after one cycle. That is, after the signal with signal length determined by the "Trigger Signal Duration" has been generated.
- Continuous transmission means that the signal is generated repeatedly without delay and until the data generation is stopped explicitly.
  However, any parameter change within the processing chain (baseband, fading simulator, or stream mapping) causes a signal generation restart.

The following is a list of the trigger modes together with their short description. An example of their impact on the generated signal is given. The provided examples are intended to show the triggering mechanism in principle. To simplify the description, an internal trigger event ("Execute Trigger") is used. An external trigger event has the same effect on the signal generation. In the examples on the figures bellow, the instrument's processing time is ignored.

- Single
  The instrument starts the signal generation only when a trigger event occurs. The signal is generated once. Its signal length is set with the parameter "Trigger Signal Duration".
  Every subsequent trigger event causes a restart.

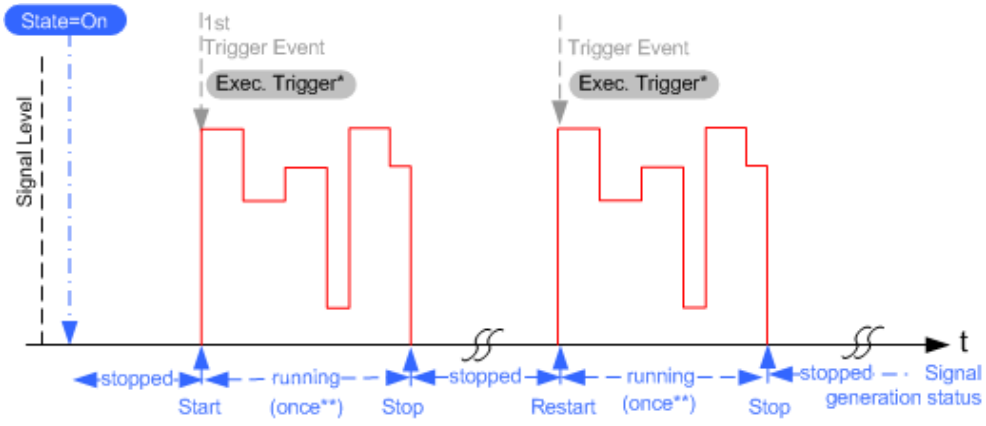


Figure 4-4: Trigger mode single

* = Internal trigger event (to simplify the description)
** = The signal is generated once to the length specified with "Trigger Signal Duration"

- Auto
  In auto trigger mode, the instrument generates a continuous signal.

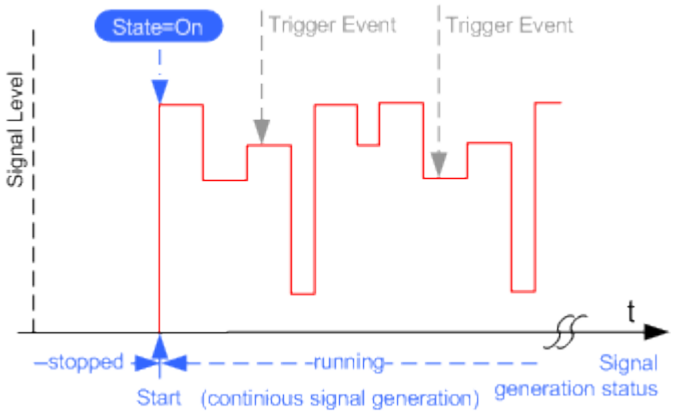


Figure 4-5: Trigger mode auto

- Retrigger
  The instrument generates a continuous signal. With enabled retrigger, a new trigger event aborts the current generation cycle and restarts the signal generation from the beginning.

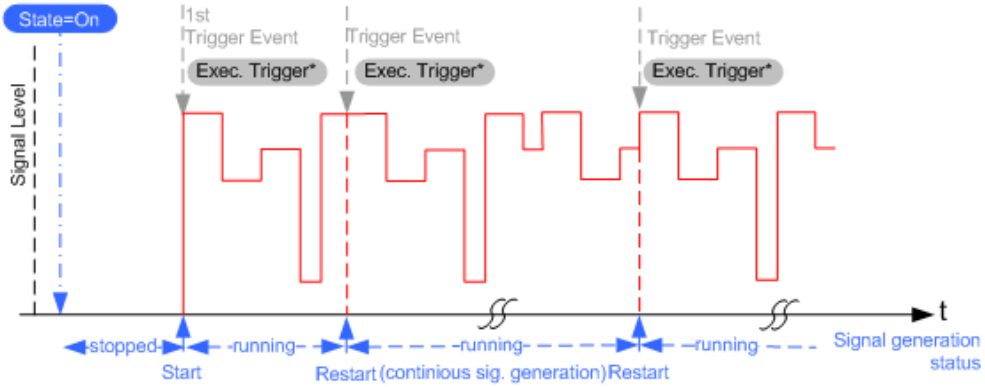


Figure 4-6: Trigger mode retrigger

* = Internal trigger event (to simplify the description)

Compare the shape and the length of the red curve in single mode and in retrigger mode. The first part of the curve in retrigger mode is shorter. The signal generation is interrupted due to the subsequent trigger event.

- Armed auto
  The instrument starts the signal generation only when a trigger event occurs and then generates a continuous signal. An "Arm" stops signal generation. A subsequent trigger event causes a restart of the signal generation.

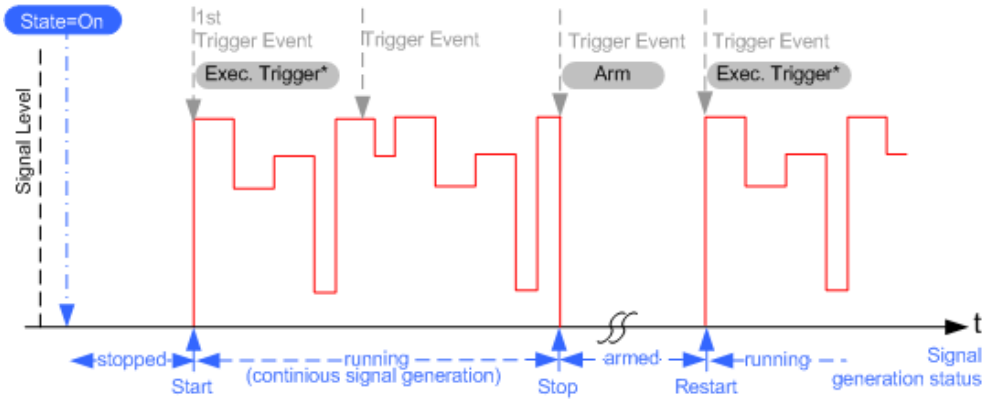


Figure 4-7: Trigger mode armed auto

* = Internal trigger event (to simplify the description)

- Armed retrigger
  The instrument starts the signal generation only when a trigger event occurs and then generates a continuous signal. Every subsequent trigger event causes a restart of the signal generation.
  An "Arm" stops the signal generation. A subsequent trigger event causes a restart.

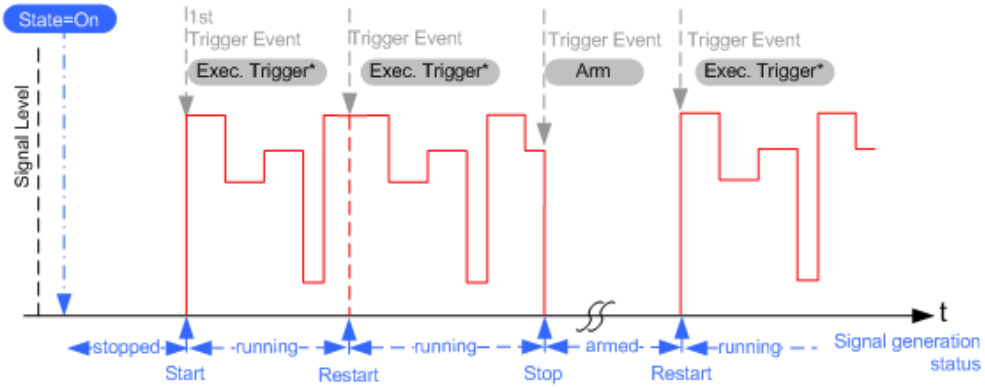


Figure 4-8: Trigger mode armed retrigger

* = Internal trigger event (to simplify the description)

Impact of additional trigger settings

The R&S SMM100A provides a set of settings to configure the behavior upon receiving of a trigger signal. For example:

- Suppressing trigger events
- Delaying the instrument's response on trigger events
- Adjusting the signal calculation start time in relation to the trigger event.

Avoiding accidental trigger events

The following trigger settings enhance the flexibility of the trigger system and can help to avoid accidental trigger events.

- "Threshold Trigger Input"

Defines the voltage level of the trigger signal where the R&S SMM100A generates a trigger event. Trigger signals below the trigger threshold are ignored.

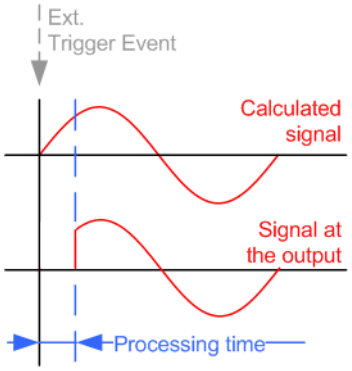
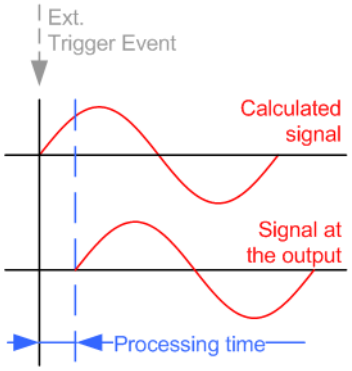
- "Trigger Input Slope"
  Specifies the edge (rising or falling edge) of the trigger signal that is to provide the trigger event.
- "Impedance Trigger Input"
  Specifies the input impedance of the trigger signal.

Starting the signal generation with the first sample

By default, the instrument starts the signal calculation simultaneously with the receiving of the external trigger event. Because of the signal propagation time and the instrument's processing time, the first samples are cut off and no signal is output.

This default behavior, however, can cause problems if short signal sequences are generated. To overcome this problem, the instrument provides the special parameter "Sync. Output to (External) Trigger". If this parameter is disabled, the signal output begins after elapsing of the processing time and starts with sample 0. That is, the complete signal is output (compare both figures in Table 4-4).

Table 4-4: Impact of the parameter Sync. Output to (External) Trigger

"Sync. Output to (External) Trigger = On"	"Sync. Output to (External) Trigger = Off"
	
Suitable for long signal sequences The output signal is synchronous to the trigger event after elapsing of the internal processing time.	Suitable for triggering of short signal sequences with signal duration comparable with the processing time of the instrument

Suppressing and delaying trigger events

The main focus of the following features is the mobile communication standards.

- "External Delay"/"Trigger Delay"
  You can apply a definable number of symbols to delay the start trigger event of an externally supplied trigger signal.

  This feature is useful to:
  - Simulate the time delay between a base station signal and a user equipment signal, for example during base station tests
  - Compensate for known propagation delays or a timing offset in the test setups.
- "External Inhibit"/"Trigger Inhibit"

You can suppress the effect of a restarted trigger signal in the "Retrigger" trigger mode for a definable number of symbols.
During base station tests, for example, this feature enables the trigger suppression for a definable number of frames and yet the signal can still be generated synchronously. In each frame, the base station generates a trigger event that restarts the signal generation every time but for the suppression.

Example:

A trigger delay of 1000 samples means that after a trigger event, any subsequent trigger signal is ignored for the space of 1000 samples.

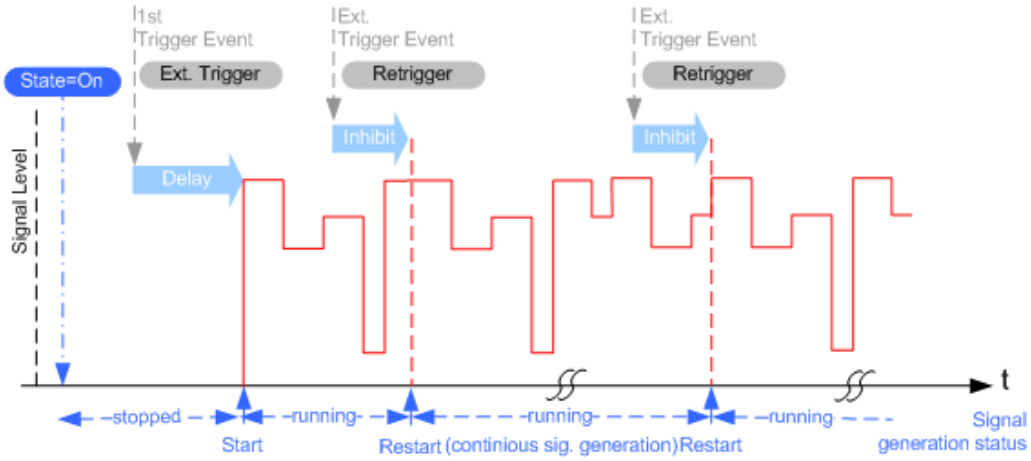


Figure 4-9: Trigger delay and trigger inhibit in trigger mode retrigger

To set delay and inhibit values

Trigger delay and inhibit values have the same unit as the generated baseband signal, for example samples or symbols. Sometimes, you can also set the delay or inhibit period as a time value, for example in seconds.

Trigger delay values t_{delay} depend on the instrument hardware, in particular the sample rate r_s. The table below illustrates an exemplary instrument configuration and related t_{delay} values in samples, symbols and in seconds.

Option	Max. r_s / MHz	t_{delay} / samples	t_{delay} / s
R&S SMM-B9	2400	0 to t_{delay_max} t_{delay_max} depends on r_s.	0 to 458.1

For more information, refer to the specifications document.

Example: ARB clock frequency and trigger delay

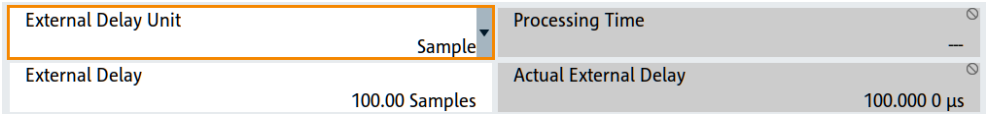
This example describes an ARB signal with 1 MHz clock frequency. It illustrates the relation between the ARB clock frequency and the configurable trigger delay.

1. Select "Baseband" > "ARB" > "Clock Frequency" = "1 MHz".

2. Configure an external, for example, for an armed auto trigger mode.

   a) Select "ARB" > "Trigger In" > "Mode" > "Armed Auto"
   b) Select "Source" > "External Global Trigger 1".
   c) Select "External Delay Unit" > "Samples".
   d) Set "External Delay" = "100 Samples".

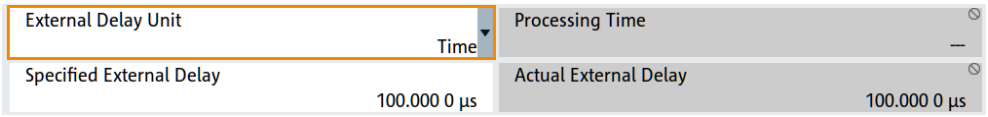
   The parameter "Actual External Delay" = "100 us" displays the actual delay in time units.



3. Set the delay in time units.

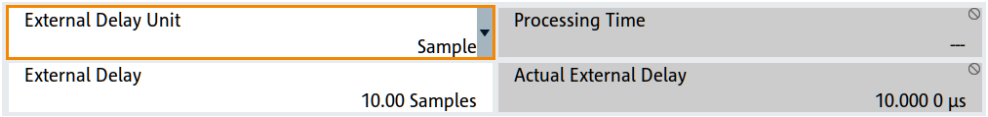
   a) Select "External Delay Unit" > "Time".
   b) Select "Specified External Delay" > "10 µs".

   The "Actual External Delay" changes to 10 us.



4. To check again the delay in samples, select "External Delay Unit" > "Samples".

   The external dealy and actual delay is 10 samples.



Receiving and providing trigger signals

In test setups that combine the signal of two or more instruments it is often required that:

- The signal generation starts at a defined moment
- The signal generation starts simultaneously (or with an exactly defined delay) in all involved instruments.

For information on simultaneous signal generation start in multiple instruments, see Section 9.2, "Generating time-aligned baseband signals", on page 475.

4.4.1.6 Supported modulation signals

The R&S SMM100A supports a range of predefined digital and analog modulation signals. This section focuses on the possibility to digitally modulate the baseband signal.

In communication techniques, commonly used digital modulation schemes are based on keying. From the several existing keying techniques, this instrument supports ASK (amplitude shift keying), FSK (frequency shift keying), PSK (phase shift keying), and QAM (quadrature amplitude modulation).

The digital modulation procedure is described by mapping. That is, by the assignment of I and Q values (PSK and QAM) or frequency shifts (FSK) to every modulation symbol. The resulting modulated signal is graphically represented by a constellation diagram, in that each possible symbol is represented by a discrete point on a complex plane. The number of bits per symbol is a modulation parameter. The exact position of the symbols on the constellation diagram is determined by the used coding scheme. You can also change the symbol position by applying rotation.

Most of the provided modulation schemes are implemented according to a communication standard. The QAM procedures 16QAM, 32QAM, 64QAM, for instance, have been produced in accordance with ETSI standard ETS 300429 for digital video broadcasting (DVB). The QAM procedures 256QAM and 1024QAM are not specified in this standard, but have been produced according to the same basic principles.

For all FSK procedures, you can set the symbol rate f_{SYMB} up to a maximum value. The frequency deviation (FSK deviation) of the MSK modulation is permanently set to ¼ of the symbol rate. Also a variable FSK modulation with definable deviation per symbol is available and for even greater flexibility. A user-defined modulation mapping can be applied, see "User mapping" on page 100.

For more information, refer to the specifications document.

User mapping

A user-defined modulation-mapping file can also be selected as a modulation-mapping source. Valid files have the extension `*.vam` and can be created with the Rohde & Schwarz software tool-mapping wizard. The mapping wizard "mapwiz" is a tool from Rohde & Schwarz designed for editing modulation schemes (for example QPSK, 32QAM).

The main purpose of "mapwiz" is the assignment of logical symbol numbers to constellation points and the selection of modulation-specific parameters. Also, the tool supports the creation of nearly any arbitrarily chosen constellation diagram. The output of "mapwiz" is a mapping file (`*.vam`) that can be imported into a R&S SMM100A. The program was developed on a 32-bit Microsoft Windows platform under MATLAB.

For more information, see "Introduction to "mapwiz" Mapping Editor" at the Rohde & Schwarz webpage.

The remote commands required to define the modulation settings are described in Section 13.17.5.2, "SOURce:BB:DM subsystem", on page 845.

Related settings:

- Section 4.5.3.4, "Modulation settings", on page 124

4.4.1.7 Supported coding schemes

Coding is a technique used to improve the signal properties and signal reception and is required only when using some types of modulation. In general, the coding schemes are applied before modulation. The modulation symbols are coded directly before I and Q values or frequency shifts are assigned. The applied coding is directly related to the selected modulation scheme. The relation implies that coding schemes are not freely combinable with the modulation scheme.

See section Section 4.5.5.1, "Default settings and predefined configurations", on page 139 for an overview on the available coding combinations. This section also defines the modulation formats for which the various coding procedures can be used.

Related settings:

- "Coding" on page 121

4.4.1.8 Supported baseband filters

In the wireless transmission technique, filters are applied to shape the baseband signal before it is modulated on the RF. The selected baseband filter type and shape affect the output stream, especially while generating broadband signals. If the filter is too narrow, it cuts the signal. If the filter is too wide, the signal could be distorted by some unwanted signals.

To fulfill wide range of requirements, the R&S SMM100A offers a wide selection of predefined baseband filters. The predefined filters are designed for the special spectrum characteristics of the different communication standards. However, depending on the selected filter form one or more filter parameters are provided for even more precise adjustment of the filter characteristic. You can select, for example, steeper edges or change the transition bandwidth. For more information on the provided settings, see "Impact of the filter parameters" on page 102.

The selection of user-defined filters offers even more flexibility. Use these filters if you need to filter with filters of complex or proprietary form are required. For more information, refer to "User filter" on page 101.

Predefined baseband filters

See Section 4.5.5.3, "Predefined baseband filters", on page 144 for an overview of available baseband filters.

User filter

The user filter file must have an extension `*.vaf` and can be created with the Rohde & Schwarz software tool filter wizard.

The filter wizard (filtwiz) is a tool from Rohde & Schwarz designed for creating filter files that can be imported on a R&S SMM100A. Its main purpose is the conversion of user-defined finite impulse response (FIR) filters into the filter format (`*.vaf`). Beyond this filtwiz provides designs for standard filters, e.g. root raised cosine (RRC), Gaussian.

The program was developed on a 32-bit Microsoft Windows platform under MATLAB.

For more information, see "Introduction to "filtwiz" Filter Editor" at the Rohde & Schwarz webpage.

The remote commands required to define the filter settings are described in Section 13.17.5.2, "SOURce:BB:DM subsystem", on page 845 and the corresponding section in the user manual of each firmware option.

Related settings:

- Section 4.5.3.5, "Filter settings", on page 126

- Filter settings in the dialogs of the firmware options

Impact of the filter parameters

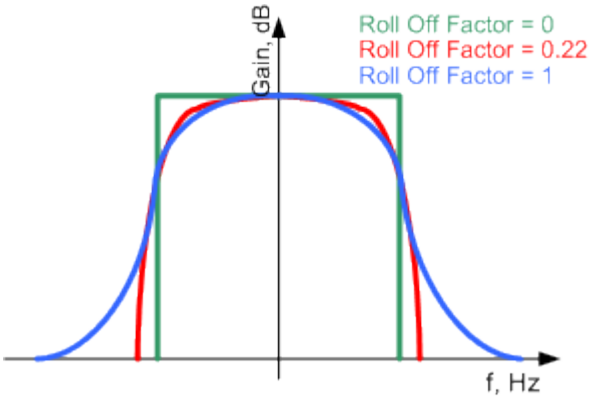
The following is a simple description of the filter parameters and the way they affect the main filter characteristics. Changing filter parameters is an effective way to ensure that the entire bandwidth of the desired signal is allowed to pass and adjust the filter form to reach the spectrum mask requirements.

Cut Off Frequency

The cut-off frequency or corner frequency is a filter characteristic that defines the frequency at the 3 dB down point. This frequency is bound to the transition band; here the filter characteristic changes form the passband to the stopband, where the signal is suppressed.

Rolloff Factor

The rolloff factor is a measure for the excess bandwidth compared to the ideal bandwidth of a "brick like" filter. The roll off factor affects the steepness of the filter flanks. A "Rolloff Factor" = 0 would result in the steepest theoretically possible flanks ; values near to 1 make the flanks more flat.



Passband

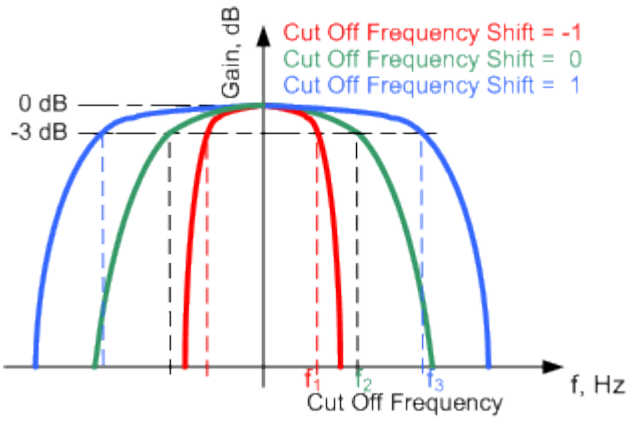
The passband describes the frequency span that the filter passes unchanged. The total passband of a filter is given as follows:

```
Bandwidth = (1 + "Roll Off Factor") * "Symbol Rate"
```

Cut Off Frequency Shift

The "Cut Off Frequency Shift" affects the cut-off frequency in the way that the filter flanks are "moved" and the passband increases by "Cut Off Frequency Shift"*"Sample Rate":

```
Cut Off Frequency = (1 + "Cut Off Frequency Shift") * "Sample Rate"
```



- A "Cut Off Frequency Shift" = -1 results in a very narrow-band filter
- Increasing the value up to 1 makes the filter more broad-band
- By "Cut Off Frequency Shift" = 0, the -3 dB point is at the frequency determined by the half of the selected "Sample Rate".

4.4.1.9 Methods for optimizing the crest factor

Communication standards utilizing higher-order modulation techniques or using multiple carriers and complex signals consisting of the signals of more than one digital standard can feature a high crest factor. The signals of some digital standards can have high crest factors also particularly with many channels and long sequences.

About the crest factor

The crest factor represents the ratio of the peak voltage value to the RMS voltage value, i.e. the peak to average ratio (PAR). The higher the crest factor and the resulting dynamics of a signal, the greater the requirement for a power amplifier fed by the signal to be linear.

A high crest factor arises, for example, when in a multicarrier signal the carriers feature an identical start phase. Multicarrier signals imply periodically superimposed signals with high peak voltages in relation to the RMS voltage values.

High crest factors entail two basic problems:

- The nonlinearity of the power amplifier (compression) causes intermodulation which expands the spectrum (spectral regrowth).
- Since the level of the D/A converter is relative to the maximum value, the average value is converted with a relatively low resolution. This low resolution leads to a high quantization noise.

Both effects increase the adjacent-channel power.

Direct crest factor reduction

At the individual signal generation stages, the R&S SMM100A offers different direct approaches to reduce the crest factor. While the corresponding parameters are enabled, the implemented algorithms ensure minimizing the crest factor or achieving of predefined target crest factor by applying of automatic settings. Methods of reducing

the crest factor differ regarding both the optimization achievable and the time required for computation.

The provided crest factor reduction methods include:

- Internal calculation of optimized carrier phases for the individual carriers in a multi-carrier signal
- Automatic calculation of the carrier start phases in a multi-carrier continuous wave signal

Applying clipping and filtering

Another common and simple approach for achieving a lower PAR is the combination of clipping and filtering. In several of the firmware options, like 3GPP FDD or CDMA2000, the instrument provides baseband clipping. Also, you can select the baseband filter and adjust the filter characteristics.

- Clipping is a method that applies a wanted distortion to the signal, see Example "Vector clipping and crest factor" on page 104.
  This method includes specifying a level limit, finding out the signal peaks and clipping off the peaks that exceed the limit. The level limit is a percentage of the highest peak value. Clipping does not influence the spectrum but the error vector magnitude (EVM) increases.

  The instrument offers two clipping modes:

  – Vector clipping: | I + q |
    The clipping limit is related to the amplitude | I + q |. This mode maps the I and Q components together and retains the angle between the vectors.
  – Scalar clipping | I | + | q |
    The clipping limit is related to the absolute maximum of all the I and Q values | I | + | q | . This mode maps the I and Q components separately, the angle changes between the vectors.

  Signal clipping not only changes the peak value but also the average value and the effect on the crest factor is unpredictable.
- Filtering is a method after clipping. The filters are able to filter out the distortion.

Example: Vector clipping and crest factor

The following figures display constellation diagrams that demonstrate the effect of the clipping on the crest factor for typical scenarios.

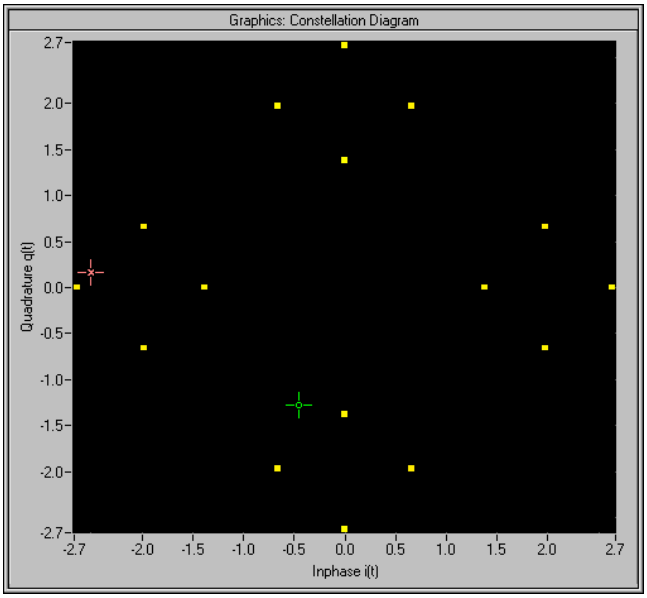


Figure 4-10: I/Q constellation without clipping

The clipping mode in figure Figure 4-11 is vector | I + q | mode and the I/Q signal configuration has two active channels. The circle visualizes the changed constellation points.

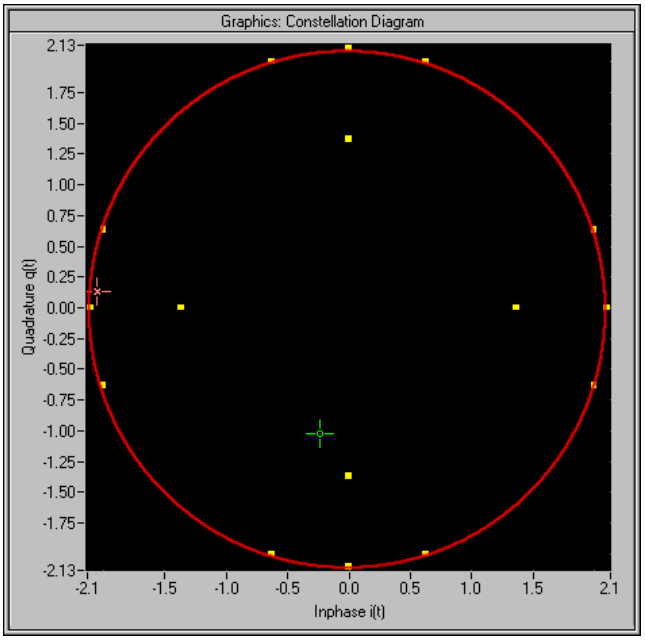


Figure 4-11: I/Q constellation with vector clipping and clipping level 80 %

4.4.2 Common baseband settings

The main baseband dialog for a digital standard follows a repeating dialog structure including the tabs "General", "Trigger In", "Marker" and "Clock".

The "General" tab comprises the primary settings of the standard, the functions for storing and recalling settings. It also provides access to further functions and dialogs, like the "Filter" settings.

The "Trigger In", "Marker" and "Clock" tabs comprise the settings related to the corresponding function.

In the following, we use the "Custom Digital Mod" dialog to explain the provided common settings. The related remote control commands are listed in the order "Custom Digital Mod", "ARB", "Multi Carrier CW".

About trigger marker clock signals

For background information on these signals, see the following sections:

- Section 4.4.1.5, "About trigger signals", on page 92
- Section 4.4.1.4, "About marker signals", on page 90
- Section 4.4.1.2, "Clock signals", on page 87

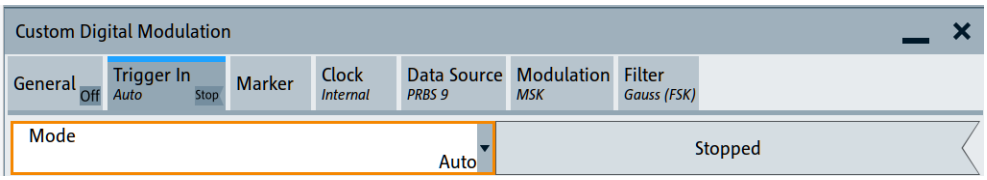
Settings:

- Trigger settings 106
- Marker settings 111
- Clock settings 113
- Local and global connectors settings 114

4.4.2.1 Trigger settings

Access:

► Select "Baseband" > "Custom Digital Mod" > "Trigger In".



This tab provides settings to select and configure the trigger, like trigger source, trigger mode and trigger delays, and to arm or trigger an internal trigger manually. The header of the tab displays the status of the trigger signal and trigger mode. As in the tabs "Marker" and "Clock", this tab also provides access to the settings of the related connectors.

Routing and enabling a trigger signal

1. Select "Trigger In" > "Mode" to set the trigger mode.
   The mode determines the effect of a trigger event on the signal generation.
2. Select "Source" to set the trigger signal source. For example, set the internal baseband signal or an external trigger signal.

3. For external trigger signals, configure the connector for the signal input. See Section 4.4.2.4, "Local and global connectors settings", on page 114.
   You can map trigger signals to one or more User x or T/M connectors.

   Local and global connectors settings allow you to configure the signal mapping, the polarity, the trigger threshold and the input impedance of the input connectors.

4. Enable baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMM100A starts baseband signal generation after receiving the configured trigger event.

About baseband trigger signals

This section focuses on the available settings.

For detailed information, see Section 4.4.1, "About common baseband characteristics", on page 85.

Settings:

Mode 107
Running/Stopped 107
Time Based Trigger 108
Trigger Time 108
Arm 108
Execute Trigger 109
Source 109
Sync. Output to Ext. Trigger/Sync. Output to Trigger 109
External Inhibit/Trigger Inhibit 109
External Delay Unit/Delay Unit 110
(Specified) External Delay/(Specified) Trigger Delay 110
Actual Trigger Delay/Actual External Delay 110
Signal Duration 111

Mode
Selects the trigger mode. The mode determines the effect of a trigger event on the signal generation.

See also "About trigger modes" on page 93.

Remote command:
`[:SOURce<hw>]:BB:DM[:TRIGger]:SEQuence` on page 860
`[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence` on page 917
`[:SOURce<hw>]:BB:MCCW[:TRIGger]:SEQuence` on page 939

Running/Stopped
With enabled modulation, displays the status of signal generation for all trigger modes.

- "Running"
  The signal is generated; a trigger was (internally or externally) initiated in triggered mode.
- "Stopped"
  The signal is not generated and the instrument waits for a trigger event.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:RMODe? on page 861
[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe? on page 918
[:SOURce<hw>]:BB:MCCW:TRIGger:RMODe? on page 939

Time Based Trigger
Requires trigger "Mode" > "Armed Auto"/"Single".

Enables time-based triggering with a fixed time reference.

The R&S SMM100A triggers signal generation when its operating system time ("Current Time") matches a specified time trigger ("Trigger Time"). As a trigger source, you can use an internal trigger or an external global trigger.

How to: Section 4.4.3, "Time-based triggering", on page 114

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:TIME[:STATe] on page 862
[:SOURce<hw>]:BB:ARBitrary:TRIGger:TIME[:STATe] on page 919
[:SOURce<hw>]:BB:MCCW:TRIGger:TIME[:STATe] on page 941

Trigger Time
Requires trigger "Mode" > "Armed Auto"/"Single".

Sets date and time for a time-based trigger signal.

Set a trigger time that is later than the "Current Time". The current time is the operating system time of the R&S SMM100A. If you set an earlier trigger time than the current time, time-based triggering is not possible.

How to: Section 4.4.3, "Time-based triggering", on page 114

"Date" Sets the date of the time-based trigger in the format YYYY-MM-DD.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:TIME:DATE on page 861
[:SOURce<hw>]:BB:ARBitrary:TRIGger:TIME:DATE on page 918
[:SOURce<hw>]:BB:MCCW:TRIGger:TIME:DATE on page 940

"Time" Sets the time of the time-based trigger in the format hh:mm:ss.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:TIME:TIME on page 862
[:SOURce<hw>]:BB:ARBitrary:TRIGger:TIME:TIME on page 919
[:SOURce<hw>]:BB:MCCW:TRIGger:TIME:TIME on page 940

Arm
Stops the signal generation until a subsequent trigger event occurs.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute on page 863
[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute on page 920
[:SOURce<hw>]:BB:MCCW:TRIGger:ARM:EXECute on page 941

Execute Trigger
Requires trigger "Source" > "Internal"

Executes the trigger manually.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:EXECute on page 863
[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute on page 921
[:SOURce<hw>]:BB:MCCW:TRIGger:EXECute on page 941

Source
The following sources of the trigger signal are available:

- "Internal"
  The trigger event is internal. Tap "Execute Trigger" to trigger signal generation manually.
- "External Global Trigger"
  The trigger event is the active edge of an external trigger signal provided and configured at the User x connectors.
- "Baseband Sync In"
  Requires "Multi Instrument Trigger" > "Secondary" for primary-secondary instrument mode.
  Triggers signal generation at the secondary instrument by the active edge of the baseband synchronization signal of the primary instrument.

The polarity, the trigger threshold, and the input impedance of the input connectors can be configured in the "Local and global connectors settings" dialog.

See also Section 11.2, "Configuring local and global connectors", on page 563.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:SOURce on page 860
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce on page 918
[:SOURce<hw>]:BB:MCCW:TRIGger:SOURce on page 939

Sync. Output to Ext. Trigger/Sync. Output to Trigger
Enables signal output synchronous to the trigger event.

See also "Impact of additional trigger settings" on page 96.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut
on page 863
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut
on page 921
[:SOURce<hw>]:BB:MCCW:TRIGger:EXTernal:SYNChronize:OUTPut
on page 942

External Inhibit/Trigger Inhibit
Requires an external trigger signal.

Sets a time period to suppress trigger events. A trigger event within this period does not start or restart the signal generation.

After the time period expires, occurring trigger events start or restart the signal generation again.

For more information, see Section 4.4.1, "About common baseband characteristics", on page 85.

See also "Impact of additional trigger settings" on page 96.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit on page 865
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:INHibit on page 923
[:SOURce<hw>]:BB:MCCW:TRIGger[:EXTernal]:INHibit on page 942

External Delay Unit/Delay Unit
Determine whether the trigger delay is expressed in samples or directly defined as a time period (seconds).

To specify the delay, use (Specified) External Delay/(Specified) Trigger Delay.

The parameter Actual Trigger Delay/Actual External Delay displays the delay converted in time.

See also "To set delay and inhibit values" on page 98.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT on page 863
[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT on page 921

(Specified) External Delay/(Specified) Trigger Delay
The name of the parameter and the units the delay is expressed in, changes depending on the parameter External Delay Unit/Delay Unit.

Delays the trigger event provided by:
- The external trigger source
- Other instrument in primary-secondary instrument mode

Use the settings as follows:
- To synchronize the instrument with the device under test (DUT) or other external devices.

See also the following sections:
- "Impact of additional trigger settings" on page 96
- "To set delay and inhibit values" on page 98

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay on page 863
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:TDELay on page 864
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:DELay on page 922
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:TDELay on page 922
[:SOURce<hw>]:BB:MCCW:TRIGger[:EXTernal]:DELay on page 942

Actual Trigger Delay/Actual External Delay
Displays the delay time (in seconds) of an external trigger event or of a trigger event from the other signal path.

See also "To set delay and inhibit values" on page 98.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:RDELay? on page 864
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:RDELay? on page 922

Signal Duration
Requires trigger "Mode" > "Single".

Enters the length of the trigger signal sequence.

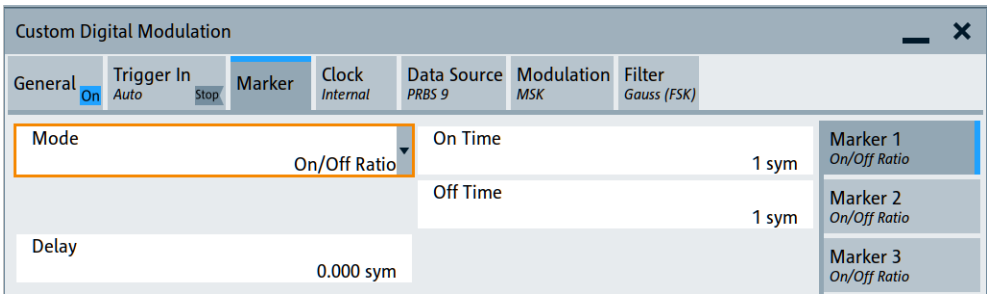
Use this parameter, for example, for the following applications:
- To output the trigger signal partly.
- To output a predefined sequence of the trigger signal.

Remote command:
`[:SOURce<hw>]:BB:DM:TRIGger:SLENgth` on page 861
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit` on page 920
`[:SOURce<hw>]:BB:MCCW:TRIGger:SLENgth` on page 941

4.4.2.2 Marker settings

Access:

► Select "Baseband" > "Custom Digital Mod" > "Marker".



This tab provides settings to select and configure the marker output signal including marker mode and marker delay.

Routing and activating a marker signal

1. To define the signal shape of an individual marker signal "x", select "Marker" > "Marker x" > "Mode".
2. Optionally, define the connector for signal output. See Section 4.4.2.4, "Local and global connectors settings", on page 114.
   You can map marker signals to one or more User x or T/M connectors.
3. Enable baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMM100A adds the marker signal to the baseband signal. Also, R&S SMM100A outputs this signal at the configured User x connector.

About marker output signals

This section focuses on the available settings.

For detailed information, see Section 4.4.1, "About common baseband characteristics", on page 85.

Settings:

Mode....112
Delay....112

Mode
Sets the marker mode that defines the shape and periodicity of the marker signal.

You can configure individual marker modes for each marker signal. The number of available markers is 3. The marker configuration changes with the selected marker mode.

How to: "Routing and activating a marker signal" on page 111

"CList" A marker signal as defined in the selected control list.

Remote command:
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE` on page 865
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 866
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 866
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern` on page 866
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime` on page 865
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime` on page 865
ARB: see "Mode" on page 164
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:MODE` on page 943
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 944
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 944
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PATTern` on page 943
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:ONTime` on page 943
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:OFFTime` on page 943

Delay
Delays the marker signal at the marker output relative to the signal generation start.

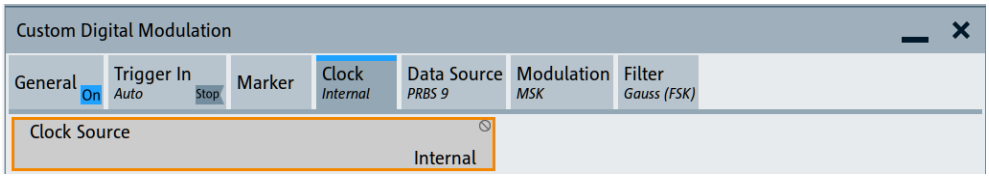
Variation of the parameter "Marker x" > "Delay" causes signal recalculation.

Remote command:
`[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay` on page 867
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay` on page 925
`[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:DELay` on page 944

4.4.2.3 Clock settings

Access:

► Select "Baseband" > "Custom Digital Mod" > "Clock".



This tab provides clock source settings.

Defining the clock

1. Select "Clock" > "Source" to define the source of the clock signal.
2. For external clock signals, define the connector for the signal input. See Section 4.4.2.4, "Local and global connectors settings", on page 114.
   You can map clock signals to one or more User x or T/M connectors.

   Local and global connectors settings allow you to configure the signal mapping, the polarity, the trigger threshold and the input impedance of the input connectors.
3. Activate baseband signal generation. In the block diagram, set "Baseband" > "On".

   The R&S SMM100A starts baseband signal generation with a symbol rate that equals the clock rate.

About clock signals

This section focuses on the available settings.

For detailed information, see Section 4.4.1, "About common baseband characteristics", on page 85.

Settings:

Clock Source 113

Clock Source
Selects the clock source.

- "Internal"
  The instrument uses its internal clock reference.

How to: "Defining the clock" on page 113

See also Section 4.4.1.2, "Clock signals", on page 87.

Remote command:
`[:SOURce<hw>]:BB:DM:CLOCk:SOURce` on page 867
`[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce` on page 925
`[:SOURce<hw>]:BB:MCCW:CLOCk:SOURce` on page 944

4.4.2.4 Local and global connectors settings

Opens a dialog to configure local connectors or global connectors.

The button is available in the following dialogs or tabs:

- "Trigger / Marker / Clock" dialog that is accessible via the "TMC" block in the block diagram.
- "Trigger In", "Marker" and "Clock" tabs of baseband signal configuration dialogs that you can open via the "Baseband" block in the block diagram. These tabs are available, for example, for "ARB" baseband signals.

See also Section 11.2, "Configuring local and global connectors", on page 563.

4.4.3 Time-based triggering

To synchronize signal generation of the R&S SMM100A to a common time reference, use the time-based trigger. Synchronization is useful for time-sensitive signal generation tasks.

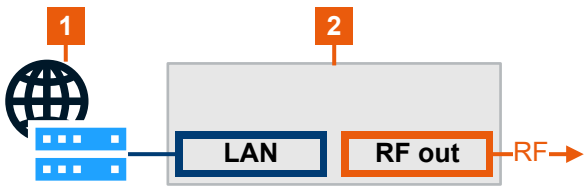
These tasks meet, for example, the following requirements:

- Absolute time reference for radar signal generation
- Radar system synchronization to a common time
- GNSS simulation time synchronization to GPS time

Test setup for internal time reference

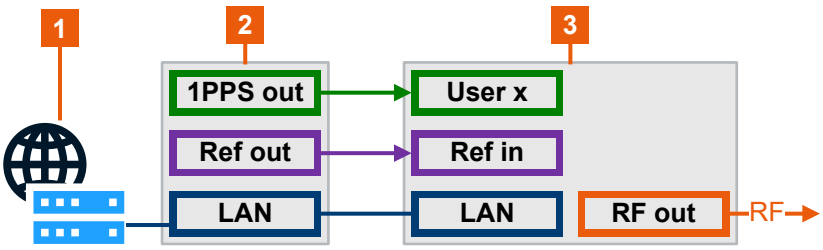
The R&S SMM100A is sufficient in a test setup and uses its internal time reference for triggering.

Test setup for coarse external time reference



1 = NTP server
2 = R&S SMM100A

Test setup for fine external time reference



1 = NTP server
2 = Time reference source
3 = R&S SMM100A

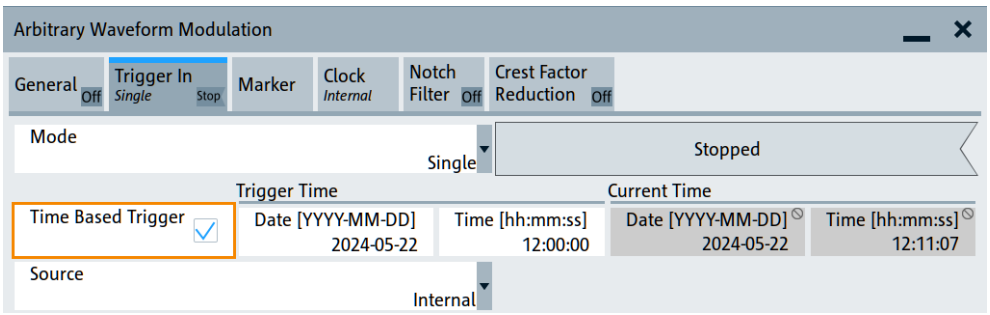
The following step-by-step instructions provide information on how to trigger signal generation to a specific time reference. These instructions use the ARB as a baseband signal source. The configuration in other baseband configuration dialogs is analogous.

- "To open time-based trigger settings" on page 115
- "To trigger to the internal time reference" on page 115
- "To trigger coarsely to an external time reference" on page 116
- "To trigger finely to an external time reference" on page 116

To open time-based trigger settings

1. Select "Baseband" > "ARB" > "Trigger In".
2. Select "Mode" > "Single"/"Armed Auto".

   For these trigger modes, the R&S SMM100A provides settings to trigger baseband signal generation at a defined time reference. You can configure external or internal trigger events. The configuration of these events is specific for each baseband signal.



To trigger to the internal time reference

To trigger to the operating system time or an arbitrary internal time at the R&S SMM100A, proceed as follows:

1. Open the time-based trigger settings of your digital baseband signal.

For example, see "To open time-based trigger settings" on page 115.

2. To configure "Trigger Time" settings, set "Time" and "Date", for example:
   a) Set "Time" > "11:00:00".
   b) Set "Date" > "2023-09-25".
3. Select "Source" > "Internal".
4. To activate signal generation at this specified time, select "Time Based Trigger" > "On".
5. Optionally, define an arbitrary internal time.
   To edit the "Current Time" settings, unlock the operating system time:
   a) Select "System Config" > "Setup" > "Security" > "Protection".
   b) Enter the protection level 1 password.
      See "Protection levels" on page 606.
   c) Set "Date" and "Time" of the "Current Time" settings as needed.
6. Set "Baseband" > "ARB" > "State" > "On".

   The R&S SMM100A starts signal generation, if the "Current Time" matches the "Trigger Time". The accuracy of the trigger point is on the order of milliseconds.
   If you need a higher accuracy on the order of microseconds, proceed with "To trigger finely to an external time reference" on page 116.

To trigger coarsely to an external time reference

1. Follow the instructions in "To trigger to the internal time reference" on page 115 until step (2).
2. Connect a suitable external time reference to the "LAN" connector of the instrument.
   This time reference provides time information from an NTP server.
3. Specify the NTP server address:
   a) Select "System Config" > "Setup" > "Maintenance" > "Date / Time".
   b) Select "Time Protocol" > "NTP".
   c) Enter the address of the NTP server.
4. Set "Baseband" > "ARB" > "State" > "On".

   The R&S SMM100A starts the signal generation if the "Current Time" matches the "Trigger Time" from the NTP server. The accuracy of the trigger point is on the order of milliseconds.
   If you need a higher accuracy on the order of microseconds, proceed with "To trigger finely to an external time reference" on page 116.

To trigger finely to an external time reference

1. Follow the instructions in "To trigger to the internal time reference" on page 115 until step (2).

2. Connect a suitable external time reference that collects time information from an NTP server:
   a) For the reference signal, use the "Ref In" connector.
   b) For the trigger signal, use one of the "User x" connectors, for example "User 1".

   The R&S SMM100A expects a 10 MHz reference signal at the "Ref In" connector and a 1PPS trigger signal at the "User x" connector.
3. Configure the R&S SMM100A for input of the external trigger signal:
   a) Select "Baseband" > "ARB" > "Trigger In".
   b) Select "Source" > "External Global Trigger".
   c) Select "Global Connectors" > "Routing".
   d) For "Connector" > "User 1", select "Direction" > "Input".
   e) Select "Signal" > "Global Trigger 1"
4. Configure the R&S SMM100A for input of the reference signal:
   a) In the status bar, select "Ext Ref" > "Reference Frequency".
   b) Select "Source" > "External".
   c) Select "External Reference Frequency" > "10 MHz".
5. Select "Baseband" > "ARB" > "Trigger In".
6. Select "Time Based Trigger" > "On".
7. Set "Baseband" > "ARB" > "State" > "On".

4.5 Generating custom digital modulation signals

The R&S SMM100A can generate digital modulation signals with user-definable characteristics. The baseband filtering and the symbol rate can be set within wide limits.

4.5.1 Required options

The equipment layout for generating the digital modulation signals includes:

- Option Baseband Generator (R&S SMM-B9)
- Baseband real-time extension including custom digital modulation (R&S SMM-K520)

4.5.2 About custom digital modulation

An introduction to the supported filter, modulation, and coding schemes are provided in:

- Section 4.4.1.8, "Supported baseband filters", on page 101
- Section 4.4.1.6, "Supported modulation signals", on page 99
- Section 4.4.1.7, "Supported coding schemes", on page 100.

About modulation types and coding schemes

Modulation types and coding schemes directly relate to each other. You cannot use all coding schemes for each modulation type. For available coding schemes, see Section 4.5.5.1, "Default settings and predefined configurations", on page 139.

An inappropriate change of a parameter triggers a settings conflict. The "Info" line displays this conflict with an info message. Although the R&S SMM100A displays the selected settings, the generated modulation signal does not correspond to this display. The conflict message disappears if you configure a conflict-free setting.

4.5.3 Custom digital modulation settings

Access:

► Select "Baseband" > "Custom Digital Mod".

The "Custom Digital Modulation" dialog provides settings to select the data source, the modulation standard, the symbol rate, the coding scheme, the modulation type and the baseband filter.

The remote commands required to define these settings are described in Section 13.17.5.2, "SOURce:BB:DM subsystem", on page 845.

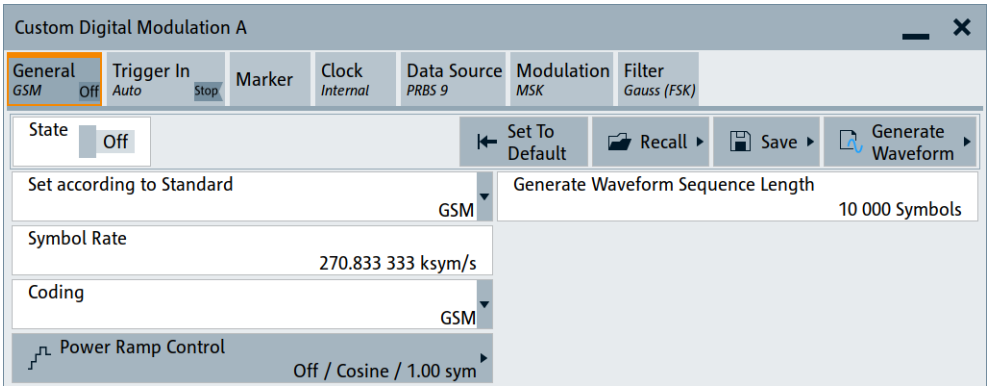
Settings:

- General settings 119
- Trigger, marker and clock settings 121
- Data source settings 122
- Modulation settings 124
- Filter settings 126
- Power ramp control settings 128
- Data list editor 130
- Control and marker lists editor 132

4.5.3.1 General settings

Access:

► Select "Baseband" > "Custom Digital Mod".



This tab provides settings to configure the default settings, save and recall settings and general settings to configure a custom digital modulation signal. These settings include a configuration that conforms with a standard or a user-defined configuration of the digital modulation signal.

Settings:

State 119
Set To Default 119
Save/Recall 120
Generate Waveform 120
Generate Waveform Sequence Length 120
Set according to Standard 120
Symbol Rate 121
Coding 121
Power Ramp Control 121

State
Enables digital modulation. Switching on digital modulation turns off all other digital standards.

The digital modulation is generated in real time (no precalculated signal), and therefore while the digital modulation is enabled, all parameter changes directly affect the output signal.

Remote command:
`[:SOURce<hw>]:BB:DM:STATe` on page 847

Set To Default
Calls default settings. The table Table 4-5 lists the most important values.

Remote command:
`[:SOURce<hw>]:BB:DM:PRESet` on page 848

Save/Recall
Opens the "Save/Recall" dialog that is the standard instrument function for saving and recalling the complete dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The settings are saved in a file with a predefined extension. You can define the filename and the directory, in that you want to save the file.

See also Section 10.5, "Saving and recalling settings", on page 529.

Remote command:
`[:SOURce<hw>]:BB:DM:SETTing:CATalog?` on page 850
`[:SOURce<hw>]:BB:DM:SETTing:DELete` on page 851
`[:SOURce<hw>]:BB:DM:SETTing:LOAD` on page 851
`[:SOURce<hw>]:BB:DM:SETTing:STORe` on page 851

Generate Waveform
With enabled signal generation, triggers the instrument to save the current settings of an arbitrary waveform signal in a waveform file with predefined extension `*.wv`. You can define the filename and the directory, in that you want to save the file.

Using the ARB modulation source, you can play back waveform files or process the file to generate multicarrier or multi-segment signals.

The waveform file has a defined sequence that depends on the ARB memory and its installed option.

Remote command:
`[:SOURce<hw>]:BB:DM:WAVeform:CREate` on page 848

Generate Waveform Sequence Length
Sets the sequence length of the waveform signal in symbols. The maximum number of symbols depends on the ARB memory and its installed option.

The R&S SMM100A creates an ARB file with this length. The length equals the input sequence in symbols. It is not the length of the I/Q sequence after an upsampling. The product of the "Sequence Length" * "Oversampling" is limited by the maximum number of samples of the selected ARB.

Remote command:
`[:SOURce<hw>]:BB:DM:SLENgth` on page 848

Set according to Standard
Selects a predefined communication standard.

Communication standard
Selects a predefined communication standard. If selected, the firmware automatically sets standard-compliant values for the following parameters: "Modulation Type", "Symbol Rate", "Filter" and "Coding". For "Set according to Standard" > "Telemetry - SOQPSK-TG", the "Data Source" is "Data List" only. See Section 4.5.3.3, "Data source settings", on page 122. See Table 4-6 for an overview of the available standards and standard-compliant settings of the modulation parameters.

"User" Set automatically, this value indicates a modification made on at least one of the parameters.
Use the "Save"/"Recall" function to save and recall customized settings.

"CW in Baseband"
Generates a continuous wave signal as a BPSK modulated signal with "Data Source" > "All 1".
Note that this setting also keeps the data source "All 1", if you change to another communication standard. The "CW in Baseband" signal is useful for phase coherence applications, and a test signal for testing and debugging.

Remote command:
`[:SOURce<hw>]:BB:DM:STANdard` on page 849

Symbol Rate
Selects the symbol rate. The value range of this parameter depends on the selected modulation type; the range is automatically redefined.

An error message appears if the selected symbol rate is outside of the redefined range. The symbol rate is set automatically to the maximum allowed value for the new modulation.

Remote command:
`[:SOURce<hw>]:BB:DM:SRATe` on page 848

Coding
Sets the coding scheme, see Section 4.4.1.7, "Supported coding schemes", on page 100.

The dialog shows only the coding settings that are permissible for the selected modulation type and installed options, see Table 4-8. All other coding methods are grayed out.

A subsequent modification to a modulation type for which the selected coding is not available, automatically disables the coding ("Coding = Off").

Remote command:
`[:SOURce<hw>]:BB:DM:CODing` on page 853

Power Ramp Control
Accesses the power ramp control dialog, see Section 4.5.3.6, "Power ramp control settings", on page 128.

4.5.3.2 Trigger, marker and clock settings

These tabs provide standard settings.

For detailed description, see:

- Section 4.4.2.1, "Trigger settings", on page 106
- Section 4.4.2.2, "Marker settings", on page 111
- Section 4.4.2.3, "Clock settings", on page 113
- Section 4.4.2.4, "Local and global connectors settings", on page 114

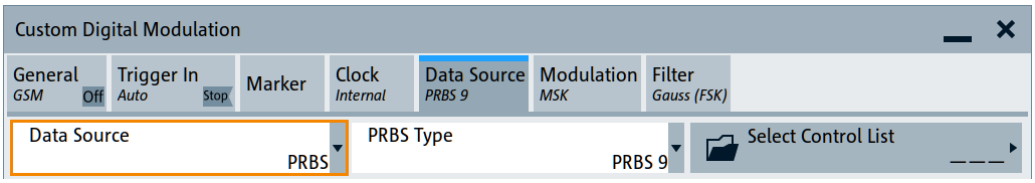
4.5.3.3 Data source settings

Access:

► Select "Baseband" > "Custom Digital Mod" > "Data Source".

This tab provides access to the settings necessary to select and configure the data source, like access to data and list editors or direct selection of PRBS data.

For an overview of the supported data sources, refer to Section 4.4.1.1, "About data signals", on page 86.



Settings:

Data Source 122
Select Data List 123
Select Control List 123
Connector Settings 123

Data Source
Selects the data source (see Section 4.4.1.1, "About data signals", on page 86).

The following data sources are available:

"All 0, All 1" A sequence containing 0 data or 1 data is internally generated.

"PRBS, PRBS Type"
Selects internally generated PRBS data in accordance with the IUT-T. Use the parameter "PRBS Type" to define the length.

Remote command:
`[:SOURce<hw>]:BB:DM:PRBS[:LENGth]` on page 850

"Pattern" Use the "Pattern" box to define a bit pattern with a maximum length of 64 bits.

Remote command:
`[:SOURce<hw>]:BB:DM:PATTern` on page 849

"Data List"
Binary data from data lists are used, see Select Data List.

Remote command:
`[:SOURce<hw>]:BB:DM:DLISt:CATalog?` on page 867
`[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 868

Remote command:
`[:SOURce<hw>]:BB:DM:SOURce` on page 849

Select Data List
Opens the standard "Select List" dialog to select an existing data list or to create a one.

Generate data lists externally or internally in the data editor.

- Select "Select Data List", navigate to the list file `*.dm_iqd` and tap "Select".
- Use the standard "File Manager" function to transfer external data lists to the instrument.
- Use the functions "New" or"Edit" to create a data list or to edit an existing data list, see Section 4.5.3.7, "Data list editor", on page 130.

See also Section 4.5.4.2, "How to create and assign a data list", on page 137.

Remote command:
`[:SOURce<hw>]:BB:DM:DLISt:CATalog?` on page 867
`[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 868
`[:SOURce<hw>]:BB:DM:DLISt:COPY` on page 871
`[:SOURce<hw>]:BB:DM:DLISt:DELete` on page 869

Select Control List
Accesses the standard "Select List" dialog to select an existing control list or to create a one.

Control lists can be generated externally or internally in the "Control and Marker Lists" editor.

- Select "Select Control List", navigate to the list file `*.dm_iqc` and tap "Select".
- Use the standard "File Manager" function to transfer external lists to the instrument.
- Use the functions "New" or"Edit" to create a data list or to edit an existing data list, see Section 4.5.3.8, "Control and marker lists editor", on page 132.

Irrespectively on the way they are created, control lists are not automatically used (see "To assign and activate control signals from a control list" on page 137).

Remote command:
`[:SOURce<hw>]:BB:DM:CLISt:CATalog?` on page 867
`[:SOURce<hw>]:BB:DM:CLISt:SELect` on page 868
`[:SOURce<hw>]:BB:DM:CLISt:COPY` on page 871
`[:SOURce<hw>]:BB:DM:CLISt:DELete` on page 869

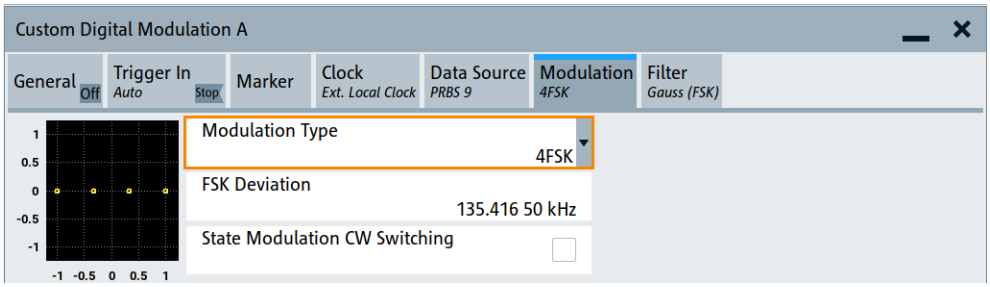
Connector Settings
Opens a dialog to configure connector settings.

See also Section 11.2, "Configuring local and global connectors", on page 563.

4.5.3.4 Modulation settings

Access:

► Select "Baseband" > "Custom Digital Mod" > "Modulation".



This tab provides the modulation settings, for example, modulation type, FSK deviation or modulation depth. Also, a graphic shows the theoretical constellation diagram of the selected modulation.

This section focuses on the available settings. For background information on how the settings affect the signal and the filter characteristics, refer to Section 4.4.1.6, "Supported modulation signals", on page 99.

Settings:

Modulation Type....124
Load User Mapping....124
ASK Depth....125
FSK Deviation....125
Angle Alpha....125
FSK Type....125
Deviation xxxx....125
Gamma/Gamma 1....126
State Modulation CW Switching....126

Modulation Type
Selects a modulation type. The associated symbol mapping is displayed.

If the configured modulation type does not allow a specific coding scheme, the "Coding" is "Off".

See also Table 4-7.

Remote command:
`[:SOURce<hw>]:BB:DM:FORMat` on page 854

Load User Mapping
Opens the "Select List File User Mapping" dialog to select the mapping table (see "User mapping" on page 100). The dialog provides all standard file management functions.

Remote command:
[:SOURce<hw>]:BB:DM:MLISt:SELect on page 868
[:SOURce<hw>]:BB:DM:MLISt:CATalog? on page 867
[:SOURce<hw>]:BB:DM:MLISt:DELete on page 869

ASK Depth
Sets the modulation depth *m* for ASK modulation.

$m = (Amplitude_{max}-Amplitude_{min}) / (Amplitude_{max}+Amplitude_{min})$

Remote command:
[:SOURce<hw>]:BB:DM:ASK:DEPTh on page 854

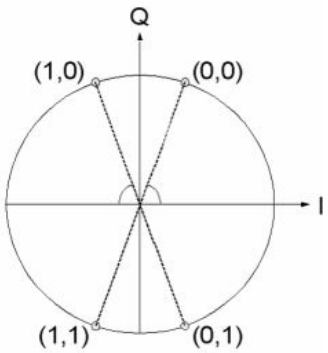
FSK Deviation
Sets the frequency deviation for FSK modulation. The range of values depends on the symbol rate, see "Symbol Rate" on page 121.

For more information, refer to the specifications document.

If you select "Modulation Type" > "FSK" > "MSK", the FSK deviation has a fixed value of 1/4 of the symbol rate.

Remote command:
[:SOURce<hw>]:BB:DM:FSK:DEViation on page 855

Angle Alpha
For AQPSK modulation, sets the angle alpha between the point (0,0) and the I axis.



Remote command:
[:SOURce<hw>]:BB:DM:AQPSk:ANGLe on page 854

FSK Type
For "Variable FSK", selects the FSK modulation type.

Available are 4FSK, 8FSK and 16FSK.

Remote command:
[:SOURce<hw>]:BB:DM:FSK:VARiable:TYPE on page 855

Deviation xxxx
For "Variable FSK", sets the deviation of the associated symbol. The number of symbols depends on the selected modulation type. The value of each symbol is indicated in binary format, i.e. x can be 1 or 0.

Remote command:
[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation on page 855

Gamma/Gamma 1
Selects the gamma function γ for the 16APSK and 32APSK modulations.

The values in brackets indicate the used code rate according to the DVB-S2 specification.

Remote command:
[:SOURce<hw>]:BB:DM:APSK16:GAMMa on page 856
[:SOURce<hw>]:BB:DM:APSK32:GAMMa on page 856

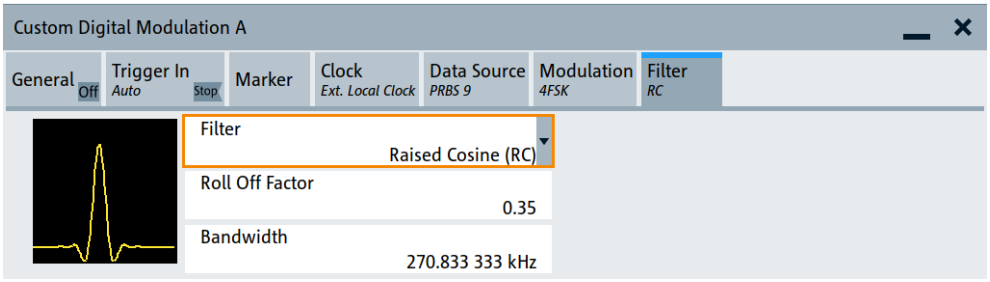
State Modulation CW Switching
Enables switching between the digitally modulated and an unmodulated (CW) signal.

Remote command:
[:SOURce<hw>]:BB:DM:SWITching:STATe on page 856

4.5.3.5 Filter settings

Access:

► Select "Baseband" > "Custom Digital Mod" > "Filter".



This tab provides filter settings, like filter type and if available further filter settings. A simplified diagram shows the filter characteristics of the selected filter.

This section focuses on the available settings. For background information on how the settings affect the signal and the filter characteristics, refer to Section 4.4.1.8, "Supported baseband filters", on page 101.

Settings:

Filter 127
Roll Off Factor/B*T 127
Cut Off Frequency Factor 127
Gauss Cut Off FrequencyLowpass Cut Off Frequency 127
Bandwidth 127
Load User Filter 127

Filter
Selects the baseband filter.

See Section 4.5.5.3, "Predefined baseband filters", on page 144 for an overview of the available filter types, their filter shapes and filter parameters.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:TYPE` on page 851

Roll Off Factor/B*T
Sets the rolloff factor or bandwidth time product of the corresponding filter type.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25` on page 852
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine[:ROLLoff]` on page 852
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:GAUSs` on page 852
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:PGAuss` on page 852
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:RCOSine` on page 852
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase` on page 852

Cut Off Frequency Factor
Requires the filter parameter "Lowpass (ACP optim.)" and "Lowpass (EVM optim.)".

Sets the cutoff frequency factor. Adjust the cutoff frequency of the filter to meet your spectrum mask requirements.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASs` on page 852
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASSEVM` on page 852

Gauss Cut Off FrequencyLowpass Cut Off Frequency
Requires the filter parameter "APCO25 (LSM)".

Sets the cutoff frequency of the filter. Adjust the cutoff frequency of the filter to meet your spectrum mask requirements.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:GAUSs` on page 852
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:LOWPass` on page 852

Bandwidth
Requires "Filter" > "Raised Cosine (RC)".

Sets the filter bandwidth, so that the equation H(f) = 0 holds for *f >= (1 + rolloff)* bandwidth /2*.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine:BANDwidth` on page 852

Load User Filter
Opens the dialog "Select User Filter" to load a user-defined filter file with file extension `*.vaf`. This dialog provides the standard file management functions, like save, load, delete.

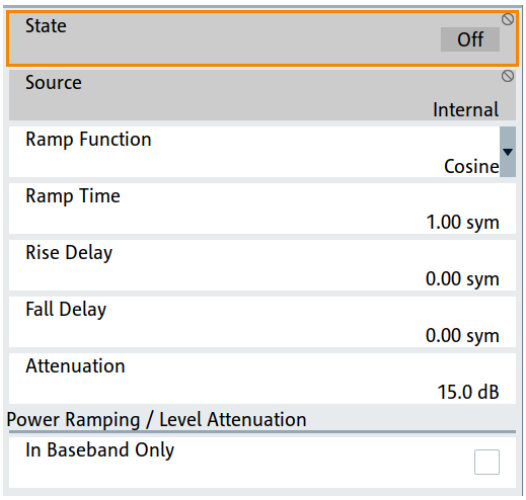
See also "User filter" on page 101.

Remote command:
[:SOURce<hw>]:BB:DM:FLISt:SELect on page 868
[:SOURce<hw>]:BB:DM:FLISt:CATalog? on page 867
[:SOURce<hw>]:BB:DM:FLISt:DELete on page 869

4.5.3.6 Power ramp control settings

Access:

► Select "Baseband" > "Custom Digital Mod" > "General" > "Power Ramp Control".



The dialog comprises the settings used to configure the power ramping, like the source of the control signals, the form of the ramp function and the applied attenuation.

See also "Power ramping and level attenuation" on page 88.

Power ramping is possible for symbol rates up to 5 MHz. A higher symbol rate disables the power ramping automatically and an error message is output.

Settings:

State....128
Source....129
Ramp Function....129
Ramp Time....129
Rise Delay....129
Fall Delay....129
Attenuation....129
In Baseband Only....130

State
Enables/disables power ramping.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp[:STATe] on page 858

Source
Defines the source for the power ramp control signals.

"Internal" The control signals as defined in the internal control list are used for control purposes.
See also Section 4.5.4.1, "How to create and assign a control list", on page 136.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:SOURce on page 857

Ramp Function
Selects the ramp function that describes the shape of the rising and falling edges during power ramp control, see Figure 4-3.

"Linear" The transmit power rises and falls in linear fashion.

"Cosine" The transmit power rises and falls with a cosine-shaped edge, resulting in a more favorable spectrum than the "Linear" setting.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:SHAPe on page 857

Ramp Time
Enters the power ramping rise time and the fall time for a burst. The setting is expressed in symbols. See also Figure 4-3.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:TIME on page 857

Rise Delay
Sets the offset in the rising edge of the envelope at the start of a burst, see Figure 4-3.

A positive value delays (the envelope length decreases) and a negative value causes an advance (the envelope length increases). The setting is expressed in symbols.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:RDELay on page 858

Fall Delay
Sets the offset in the falling edge of the envelope at the end of a burst, see Figure 4-3.

A positive value delays (the envelope length increases) and a negative value causes an advance (the envelope length decreases). The setting is expressed in symbols.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:FDELay on page 858

Attenuation
Determines the level by that the average signal level is attenuated during the signal attenuation period, while the "Lev_Att" signal is high. See also Figure 4-2.

For information about the required control signal, refer to "Power ramping and level attenuation" on page 88.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation on page 858

In Baseband Only
Restricts power ramping to the baseband signal.

"Off" Level attenuation is affected via the attenuator stages in the RF section; only the remaining part is attenuated in the baseband. The signal is issued at the RF output with the defined level values.

"On" Level attenuation is affected in the baseband only.

Note:
This setting is mandatory in the following cases:
- When only the baseband signal is issued at the I/Q outputs
  It is thus ensured that, with power ramping active, this signal is output with the defined level values.
- For two-path instruments, when one baseband signal is applied to two RF paths.

Remote command:
[:SOURce<hw>]:BB:DM:PRAMp:BBONly[:STATe] on page 858

4.5.3.7 Data list editor

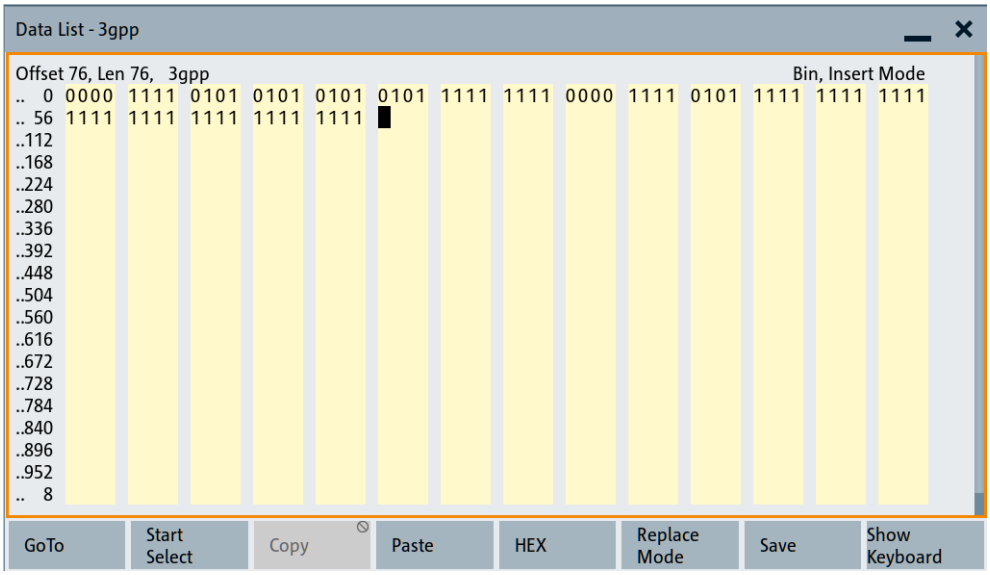
The R&S SMM100A provides the following ways to create a data list file:

- To use the dedicated "Data List Editor" and create a file with extension *.dm_iqd, see "To create data lists manually" on page 138.
- To use the tag-oriented format and create a data list file, see "To create a data list with tag file format" on page 178.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 179.

Access:

1. Select "Baseband > Custom Digital Mod > Data Source > Data List".
2. Select "Select Data List".
3. Navigate to the required directory.
4. Select "New".
5. Enter a filename.

For example, in the directory `/var/user/`, enter "Filename" = `dl_3gpp`



The "Data List Editor" is a list of binary values with a maximum length of 2^{31} bits. This value corresponds to a file size of approx. 268 Mbyte.
To increase readability, the bits are displayed in groups of four (binary format) or two (hexadecimal format). Also, above the list are displayed: The current cursor position and the length of the list and the list filename are displayed above the list. The offset starts with the value 0, which corresponds to the bit position on the left side of the first row, i.e. the beginning of the list. On the left edge of the editor, the last three offset positions are specified at the beginning of the row.
An existing list can be edited in the insert or replace mode. The upper right corner shows the current mode.
SCPI command:
`[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 868
`[:SOURce<hw>]:BB:DM:DLISt:DATA` on page 872
`[:SOURce<hw>]:BB:DM:DLISt:DATA:APPend` on page 873
The buttons below the binary list simplify the editing.

Settings:

GoTo....131
Start Select/Undo Select....132
Copy, Cut, Paste....132
BIN/HEX....132
Replace Mode/Insert Mode....132
Save....132

GoTo
Opens the entry window for the bit position. The cursor marks the bit at the selected position.

Start Select/Undo Select
Defines the current cursor position as the start position for the range to be selected. To define the stop position, select "GoTo > Go To Offset" and define the offset.

Selecting "Undo Select" deactivates the selected range.

Copy, Cut, Paste
Standard copy, cut, and paste functions.

BIN/HEX
Switches between hexadecimal and binary display.

Every 4-bit group is displayed as a hexadecimal value. To increase readability, the hexadecimal values in turn are displayed in pairs of two.

The hex functions are automatically assigned to the numeric keys at the front panel.

Replace Mode/Insert Mode
Switches between replace and insert mode to enter new or replace old values.

Save
Saves the changes into the selected data list file.

4.5.3.8 Control and marker lists editor

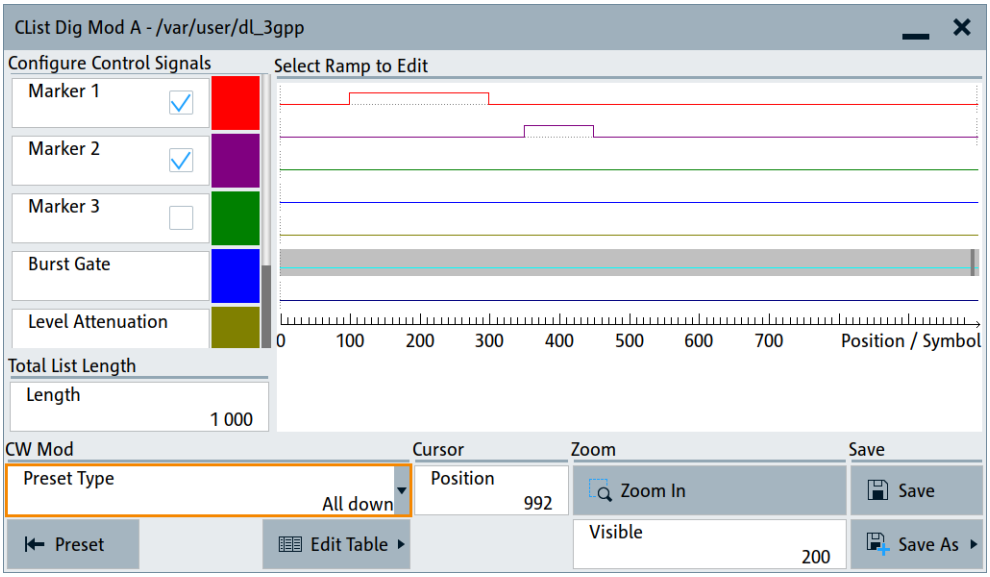
The R&S SMM100A provides the following ways to create a file containing control signals:

- To use the tag-oriented format and create a control list file, see "To create a control list with tag file format" on page 177.
- To use SCPI commands and create a file in binary format, see "To create a control list in binary format" on page 178.
- To use the dedicated "Control Data Editor" and create a file in ASCII format and with an extension `*.dm_iqc`.
  The "Control Data Editor" is described in this section. Refer to "To create a control list in ASCII format manually" on page 136 for step-by-step instructions.

To access the "Control Data Editor"

1. Select "Baseband" > "Custom Digital Mod" > "Data Source".
2. Select "Select Control List".
3. Navigate to the required directory, for example `/var/user/`.
4. Select "New".
5. In the "Filename" field, enter the name of the new control list, for example `dl_3gpp`.

6. Select "Edit".



The dedicated internal "Control Data Editor" is an intuitive graphical interface provided for defining and managing of:

- Marker signals
- Control signals, like the CW, "Hop", "Burst Gate", and "Lev_Att" control signals
  See also Section 4.4.1.3, "About control signals", on page 88.

A separate file with the file extension `*.dm_iqc` is created for each defined control signal and held on the instrument's hard disk. Control lists created with the editor are files in an ASCII file format.

In the "Control Data Editor" dialog, the available marker and control signals are displayed color-coded. The "Select Ramp to Edit" is a graphical display of the signal characteristics. To define the ramp for the individual markers or control signals, tap on the desired position or use the provided support functions "<Signal> Table" and "Cursor Position". To simplify the settings, use the predefined preset ramp characteristics in the "<Signal> Preset Type" section. The scaling of the x-axis is always adapted to the overall length of the control list to provide a constant overview of all defined ramps. For detailed representation, zoom the displayed area around the current cursor position.

In the "Configure Control Signal" section, a status checkbox indicates whether the individual marker or control signal is assigned or enabled (see Section 4.5.4.1, "How to create and assign a control list", on page 136).

SCPI command:

`[:SOURce<hw>]:BB:DM:CLISt:CATalog?` on page 867

`[:SOURce<hw>]:BB:DM:CLISt:SELect` on page 868

Settings:

Configure Control Signal....134
Select Ramp to Edit....134
Total List Length....134
Preset Type....134
Cursor Position....135

Positions Control Signal....135
Zoom/Visible....135
Save/Save As....135

Configure Control Signal
Displays the color the marker/control signal has been assigned.

The status checkbox indicates whether the individual marker or control signal is assigned or enabled (see Section 4.5.4.1, "How to create and assign a control list", on page 136).

Remote command:
n.a.

Select Ramp to Edit
Graphical representation for editing of the marker/control signals.

Refer to Section 4.5.4.1, "How to create and assign a control list", on page 136 for an overview of the editing capabilities of the display.

Remote command:
`{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}` on page 187
`[:SOURce<hw>]:BB:DM:CLISt:DATA` on page 871

Total List Length
Enters the length of the definition range of the control list in bits. The starting value is always bit 0. The entire definition range is displayed, i.e. the bit scale is adapted to the entry. If the definition range is decreased, the ramps outside the range are lost.

When used, the control list is always repeated over the length of the definition range if the length of the data list exceeds the length of the control list.

Tip: With long control lists, it is useful to zoom the displayed area around the current cursor position ("Zoom in").

Remote command:
`{CONTROL LENGTH: ControlLength}` on page 184

Preset Type
Triggered with "Preset", presets for the ramp characteristic of the selected control signal as defined with the "Preset Type".

"All Up, All Down"
Continuously high/low marker/control signal.

"Ramp Up, Ramp Down"
A ramp from low to high or from high to low is configured in the center of the displayed signal area; the ramp position can be later shifted as required.

"Ramp Up/Down, Ramp Down/Up"
Created is a ramp sequence of low to high and high to low transitions, respectively high to low, and low to high transitions. The ramps are symmetrically distributed around the center of the displayed signal area but can be later shifted as required.

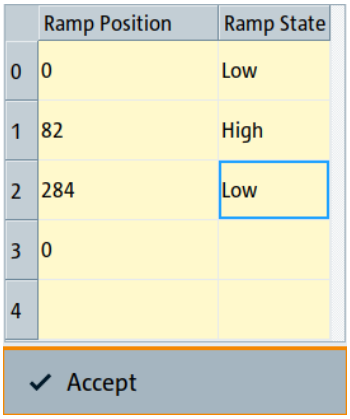
Remote command:
n.a.

Cursor Position
Displays/enters the cursor position in the graphical display

If the entered value exceeds the selected length of the definition range, the length is adjusted automatically.

Remote command:
n.a.

Positions Control Signal
Select "Edit ..." to access a dialog with a representation of the ramps of the selected signal in table form.



The bit position is specified in the "Ramp Position" column, the high or low signal status in the "Ramp State" column. Use the last blank row to enter the new ramps.

To apply the changes, press "Accept".

Remote command:
n.a.

Zoom/Visible
Zooms the displayed area of the control list. The designation of the button changes from "Zoom in" to "Zoom out".

With long control lists, it is helpful to display only a part of the control list. In such cases, set the "Visible/Bits Visible" to determine the number of symbols/bits to be displayed and select "Zoom" to focus the displayed area around the current "Cursor Position".

Ramps outside the displayed area are not lost by zooming.

Remote command:
n.a.

Save/Save As
Saves the changes in the selected control list file or in a new file.

Remote command:
n.a.

4.5.4 Creating data and control lists

This section provides step-by-step instructions on configuring and using the provided settings. For details on individual functions and settings, see Section 4.5.3, "Custom digital modulation settings", on page 118.

For more information, refer to the specifications document.

4.5.4.1 How to create and assign a control list

The R&S SMM100A provides the following ways to create a file containing control signals:

- To use the dedicated Control and marker lists editor and create a file in ASCII format and with an extension `*.dm_iqc`, see "To create a control list in ASCII format manually" on page 136.
- To use the tag-oriented format and create a control list file, see "To create a control list with tag file format" on page 177.
- To use SCPI commands and create a file in binary format, see "To create a control list in binary format" on page 178.

To create a control list in ASCII format manually

Use the intuitive build in Control and marker lists editor dialog:

1. To open the "Control Data Editor":
   a) Select "Baseband" > "Custom Digital Mod" > "Data Source" > "Select Control List".
   b) Select a file.
   You can select an existing file or a "New".

   If the selected file is an existing one, the dialog shows the used settings. If you create a file, the control list is empty.

2. Adjust the control signals as required.
   a) In the graphic editor "Select Ramp to Edit", select the color-coded trace of the required signal.
   b) Tap at a position, which requires a ramp. The number or ramps per marker is unlimited.
   c) To remove a ramp, place the cursor at the desired ramp position.
   Press the [Backspace] key.
   d) For faster marker and control signal definition, use the predefined ramp functions ("Preset Type"). Apply them with "Preset".
   e) If necessary, readjust the ramps with the help of the "Edit Table" function.
   f) Define the "Total List Lenght".
   g) To display only a part of the control list, set the "Visible/Bits Visible" to determine the number of displayed symbols/bits.
   Select "Zoom" to focus the displayed area around the current "Cursor Position".

   Ramps outside the displayed area are not lost.

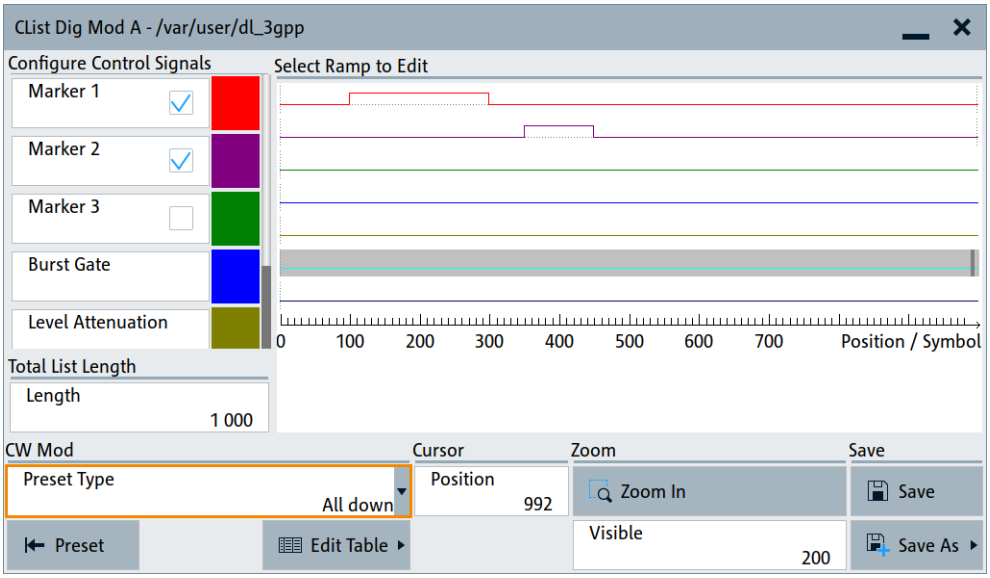


Figure 4-12: Example of control list settings

3. Select "Save" or "Save As" to save the used settings as a control list file.

   The created file is an ASCII file with the extension `*.dm_iqc`.

   Enable the instrument to use the control list, e.g. for the marker and/or other control signals.
   Enabled control signals are indicated as active in the "Configure Control Signal" section.

To assign and activate control signals from a control list

Irrespectively on the way they are created, generated control lists are not automatically used. To use a marker signal or a control signal from a control list and to output this signal at the supported connector, proceed as follows:

► Enable the R&S SMM100A to use the control list for marker output 2.
Output this signal at the T/M2 connector:

a) Select "Baseband" > "Custom Digital Mod" > "Marker".
b) Select "Marker 2" > "Mode" > "CList".
c) Select "Baseband" > "Custom Digital Mod" > "Marker" > "Local Connectors".
d) Select "Routing" > "T/M 2" > "Direction" > "Output".
The output signal is "Signal" > "Baseband Marker 2".

4.5.4.2 How to create and assign a data list

The R&S SMM100A provides the following ways to create a data list file:

- To use the dedicated Data list editor and create a file with extension `*.dm_iqd`, see "To create data lists manually" on page 138.
- To use the tag-oriented format and create a data list file, see "To create a data list with tag file format" on page 178.

- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 179.

To create data lists manually

Use the intuitive build in Data list editor dialog:

1. To access the "Data List Editor":
   a) Select "Baseband" > "Custom Digital Mod".
   b) Select "Data Source" > "Data List".
   c) Select "Select Data List"
   d) Navigate to the required directory, for example `/var/user/`.
   e) Select "New". Enter a filename, for example `dl`.

   The "Data List Editor" opens; the data list is empty.
2. Enter a sequence of 0 and 1, for example *01110101*.

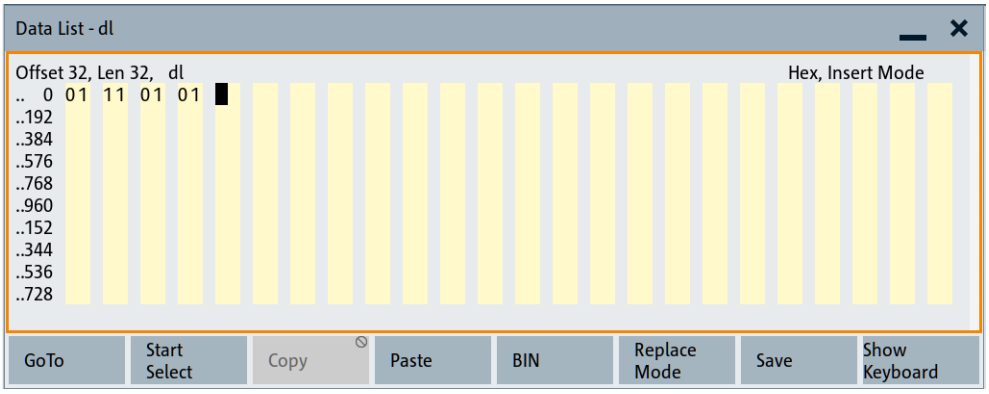


Figure 4-13: Example of data list

3. Select "Save" to save the used settings as a data list file.

   The instrument saves the `dl.dm_iqd` file in the `/var/user/` directory.

How to assign and activate data lists

Irrespectively on the way they are created, generated data lists are not automatically used.

1. To enable the R&S SMM100A to use the data list as a data source for the custom digital modulation:
   a) Select "Baseband" > "Custom Digital Mod".
   b) Select "Data Source" > "Data List".
   c) Select "Select Data List"
   d) Navigate through the file system.
   e) To select the file, confirm with "Select".
2. To enable the R&S SMM100A to use the data list as a data source for any of the digital standards:

a) Select the "Data List Name" in the individual dialog.
For example, for "Baseband" > "3GPP FDD" > "Basestations" > "BS1" > "Channel Table" > "P-CCPCH" > "Data" > "Data List".
b) Select "DList" > "None".
c) Select the file in the file system.

4.5.5 References

This section provides reference information on common custom digital modulation characteristics including default settings and predefined settings. It covers the following topics:

- Default settings and predefined configurations 139
- Common coding algorithms 142
- Predefined baseband filters 144

4.5.5.1 Default settings and predefined configurations

Table 4-5: Custom digital modulation default settings

Settings	Parameter	Value
"General"	"State" "Standard" "Symbol Rate" "Coding"	Not affected "GSM" "270.833333 ksym/s" "GSM"
"Data Source"	"Data Source" "PRBS Type"	"PRBS" "PRBS 9"
"Modulation"	"Modulation Type"	"MSK"
"Filter"	"Filter" "B*T"	"Gauss (FSK)" "0.30"
"Trigger In"	"Mode" "Source"	"Auto" "Internal"
"Marker"	"Mode"	"On/Off Ratio"
"Clock"	"Clock Source"	"Internal"
"Power Ramp Control"	"State" "Source" "Ramp Function" "Ramp Time" "Rise Delay" "Fall Delay" "Attenuation"	"Off" "Internal" "Cosine" "1.00 sym" "0.00 sym" "0.00 sym" "15.0 dB"

Table 4-6: Predefined settings for communication standards

Standard	Modulation	Symbol rate	Filter	Coding	SCPI filter type
APCO Phase1 C4FM	4FSK f_{dev} = 1.8 kHz	4.8 ksym/s	APCO25 Rolloff factor = 0.2	APCO25(FSK)	APCOPH1C4fm
APCO Phase1 CQPSK	pi/4-DQPSK	4.8 ksym/s	Raised Cosine Rolloff factor = 0.2 Bandwidth = 4.8 kHz	APCO25(PSK)	APCOPH1CQpsk
APCO Phase2 H-CPM	4FSK f_{dev} = 3 kHz	6 ksym/s	APCO25(H-CPM)	APCO25(FSK)	APCOPH2HCpm
APCO Phase2 H-DQPSK	pi/4-DQPSK	6 ksym/s	Raised Cosine Rolloff factor = 1 Bandwidth = 7.2 kHz	APCO25(PSK)	APCOPH2HDQpsk
APCO Phase2 H-D8PSK Wide	pi/8-D8PSK	4 ksym/s	Raised Cosine Rolloff factor = 1 Bandwidth = 7.2 kHz	APCO25(8PSK)	APCOPH2HD8PSKW
APCO Phase2 H-D8PSK Narrow	pi/8-D8PSK	4 ksym/s	Raised Cosine Rolloff factor = 1 Bandwidth = 5 kHz	APCO25(8PSK)	APCOPH2HD8PSKN
APCO Phase1 LSM	pi/4-DQPSK	4.8 ksym/s	APCO25(LSM) Gauss Cut Off Freq. = 2.04 kHz Lowpass Cut Off Freq. = 6.2 kHz	APCO25(PSK)	APCOPH1Lsm
APCO Phase1 WCQPSK	pi/4-DQPSK	4.8 ksym/s	Raised Cosine Rolloff factor = 1 Bandwidth = 7.2 kHz	APCO25(PSK)	APCOPH1Wcqpsk
Bluetooth	2FSK f_{dev} = 160 kHz	1 Msym/s	Gauss (FSK) B*T = 0.5	Off	BLUetooth
CDMA2000 Forward	QPSK	1.2288 Msym/s	cdmaOne + Equalizer	cdma2000	CFORward
CDMA2000 Reverse	Offset QPSK	1.2288 Msym/s	cdmaOne	cdma2000	CREVerse
CW in Baseband	BPSK	1 Msym/s	Gauss (FSK) B*T = 0.5	Off	CWBPsk
DECT	2FSK f_{dev} = 288 kHz	1.152 Msym/s	Gauss (FSK) B*T = 0.5	Off	DECT
ETC	ASK m = 100 %	1.024 Msym/s	Split Phase B*T = 2.0	Off	ETC
GSM	MSK	270.833333 ksym/s	Gauss (FSK) B*T = 0.3	GSM	GSM
GSM EDGE	8PSK EDGE (3pi/8 8PSK)	270.833333 ksym/s	Gauss Linearized	Off	GSMEdge

Standard	Modulation	Symbol rate	Filter	Coding	SCPI filter type
NADC	pi/4 DQPSK	24.3 ksym/s	Root Raised Cosine Rolloff factor = 0.35	NADC	NADC
PDC	pi/4 DQPSK	21 ksym/s	Root Raised Cosine Rolloff factor = 0.5	PDC	PDC
PHS	pi/4 DQPSK	192 ksym/s	Root Raised Cosine Rolloff factor = 0.5	PHS	PHS
TD-SCDMA	QPSK 45° Offset	1.28 Msym/s	Root Raised Cosine Rolloff factor = 0.22	Off	TCSCdma
Telemetry SOQPSK-TG	2FSK f_{dev} = 1.25 MHz	5 Msym/s	SOQPSK	Off	SOQPSKTG
TETRA	pi/4 DQPSK	18 ksym/s	Root Raised Cosine Rolloff factor = 0.35	TETRA	TETRa
TFTS	pi/4 DQPSK	22.1 ksym/s	Root Raised Cosine Rolloff factor = 0.4	TFTS/TETRA	TFTS
WCDMA-3GPP	QPSK 45° Offset	3.84 Msym/s	Root Raised Cosine Rolloff factor = 0.22	WCDMA 3GPP	W3GPp
Worldspace	QPSK	1.84 Msym/s	Root Raised Cosine Rolloff factor = 0.4	Off	WORLdspace

Table 4-7: Modulation type and coding combinations

Modulation	Coding	Modulation	Coding
ASK	Off Differential, Differential + Gray, Gray	pi/8 D8PSK	Off Gray APCO25(8PSK)
BPSK, AQPSK, OQPSK	Off Differential, Differential + Gray, Gray	8PSK	Off Differential, Differential + Gray, Gray VDL
QPSK	Off Differential, Differential + Gray, Gray INMARSAT, ICO, CDMA2000, WCDMA	16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM, 1024QAM	Off Differential, Phase Differential, Differential + Gray, Gray
QPSK 45° Offset	Off Differential, Differential + Gray, Gray ICO, CDMA2000, WCDMA	MSK, 2 FSK	Off Differential, Differential + Gray, Gray GSM
QPSK EDGE, 8PSK EDGE, 16QAM EDGE, 32QAM EDGE	Off	4FSK, Variable FSK > 4FSK	Off Differential, Differential + Gray, Gray APCO25(FSK)

Modulation	Coding	Modulation	Coding
OQPSK	Off Differential, Differential + Gray, Gray INMARSAT, ICO, CDMA2000, WCDMA	8FSK, 16FSK, 32FSK, 64FSK	Off
pi/4 QPSK	Off Differential, Gray	Variable FSK > 8FSK, Variable FSK > 16FSK	Off Differential, Differential + Gray, Gray
pi/2 DBPSK	Off Gray	16APSK, 32APSK	Off
pi/4 DQPSK	Off Gray NADC, PDC, PHS, TETRA APCO25(PSK), PWT, TFTS/ TETRA	User	Off

4.5.5.2 Common coding algorithms

Coding notation

In the notation used below, a_n denotes the n^{th} input symbol and b_n denotes the correspondingly coded output symbol. Individual bits in the symbols from the LSB (least significant bit) to the MSB (most significant bit) are denoted by a_{0n}, a_{1n}, etc. The same applies to the output symbols.

The table Table 4-8 lists common coding types and coding algorithms.

Table 4-8: Coding types and coding algorithms

Coding	Coding algorithm	Bit per symbol
"None"	$b_n = a_n$	k = 1 to 8
"Differential"	$b_n = (a_n + b_{-1})$ modulo 2^k	k = 1 to 7
"Differential + Gray"	Gray coding with additional differential coding	k = 1 to 7
"Phase Differential"	$b_{1n} = [\text{NOT } (a_{1n} \text{ EXOR } a_{0n}) \text{ AND } (a_{1n} \text{ EXOR } b_{1(n-1)})] \text{ OR } [(a_{1n} \text{ EXOR } a_{0n}) \text{ AND } (a_{1n} \text{ EXOR } b_{0(n-1)})]$ $b_{0n} = [\text{NOT } (a_{1n} \text{ EXOR } a_{0n}) \text{ AND } (a_{0n} \text{ EXOR } b_{0(n-1)})] \text{ OR } [(a_{1n} \text{ EXOR } a_{0(n-1)}) \text{ AND } (a_{0n} \text{ EXOR } b_{1(n-1)})]$	-

"Coding" > "INMARSAT" or "Phase Differential" corresponds to system standards Inmarsat-M and DVB according to ETS 300 429. You can use INMARSAT coding for modulation types with 2 bit/symbol coding, such as QPSK.

Examples

The following examples illustrate how some of the coding schemes and modulation type influence the signal.

Example: Differential coding for QPSK modulation with k = 2 bits per symbol

Decimal display; the value range for modulation symbols is $a_n = \{0, 1, 2, 3\}$.

According to Table 4-8 and for $k = 2$, the recursive coding is as follows:

$b_n = (a_n + b_{-1})$ *modulo 4*.

Depending on the state of a preceding modulation symbol b_{-1}, the coded modulation symbol b_n is obtained, for example, from modulation symbol, $a_n = 2$ as follows:

b_{-1}	0	1	2	3
b_n	2	3	0	1

With differential coding, the assignment of modulation symbols a_n (binary indication: MSB, LSB) to the phase differences shown in the following table is generated:

Table 4-9: Phase difference for QPSK

Modulation symbol a_n	**00**	**01**	**10**	**11**
Phase difference	0°	90°	180°	270°

Example: Differential coding for modulation type pi/4 DQPSK

With differential coding switched on at the same time, the obtained constellation diagram for pi/4DQPSK is similar to that of 8PSK. Phase shifts are however assigned to the individual modulation symbols. The Table 4-10 shows the assignment of modulation symbols a_n (binary indication: MSB, LSB) to phase shifts of the I/Q vector in relation to the selected coding.

Table 4-10: Phase shifts for pi/4DQPSK

Modulation symbol a_n	**00**	**01**	**10**	**11**
"Coding" > "Off"	+ 45°	+ 135°	- 135°	- 45°
"Coding" > "NADC"/"PDC"/"PHS"/"TETRA"/"APCO25(PSK)"	+ 45°	+ 135°	- 45°	- 135°
"Coding" > "TFTS"	- 135°	+ 135°	- 45°	+ 45°

Example: Gray and differential coding for 8PSK modulation

When this coding scheme is used, the gray coding according to the gray code is performed before the differential coding. The later uses the recursive coding algorithm quoted above, see Table 4-8. The assignment of modulation symbols a_n (binary indication: MSB, LSB) to the phase differences shown in the following table is generated:

Table 4-11: Differential coding according to VDL[1)]

Symbol d_n	**Phase difference**		**Symbol d_n**	**Phase difference**
000	0°		100	270°
001	45°		101	315°

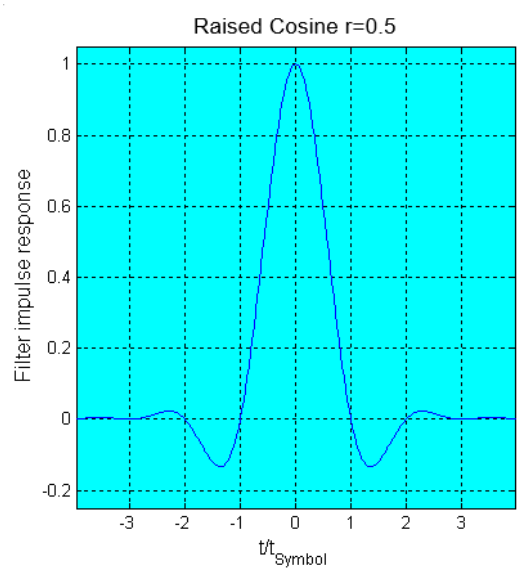
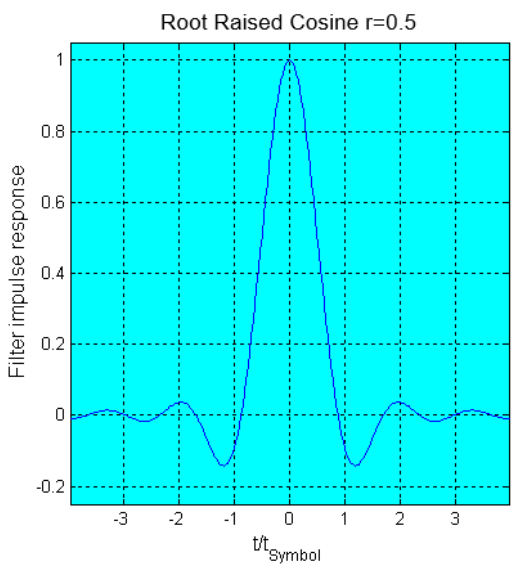
Symbol d_n	Phase difference		Symbol d_n	Phase difference
010	135°		110	225°
011	90°		111	180°

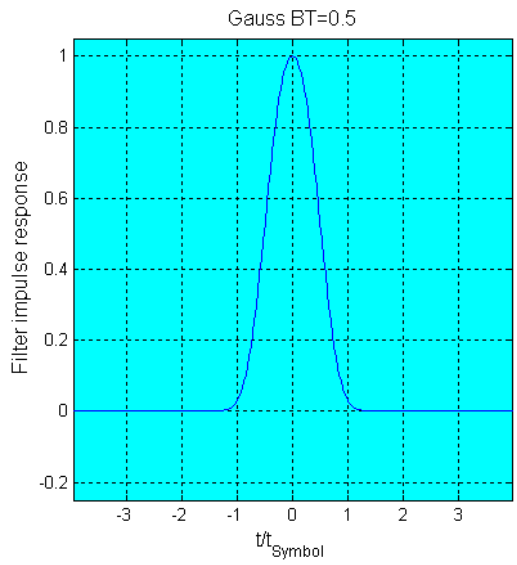
[1] VHF data link (VDL) coding for modulation types with 3 bits/symbol, for example 8PSK.

4.5.5.3 Predefined baseband filters

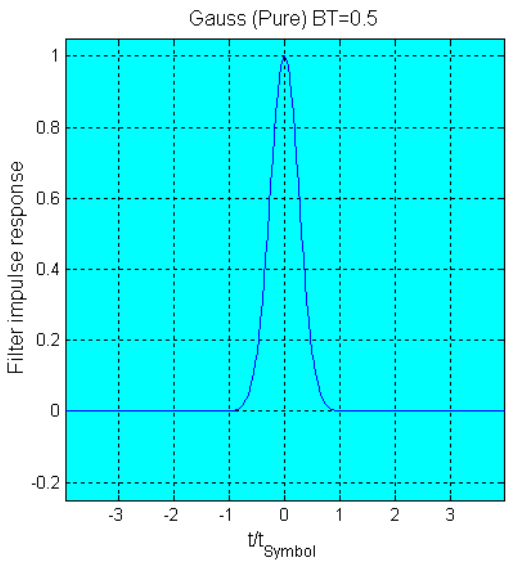
The Table 4-12 shows the filters that are available, together with their associated parameters. The filter characteristic is displayed in graphical form.

Table 4-12: Overview of the baseband filters

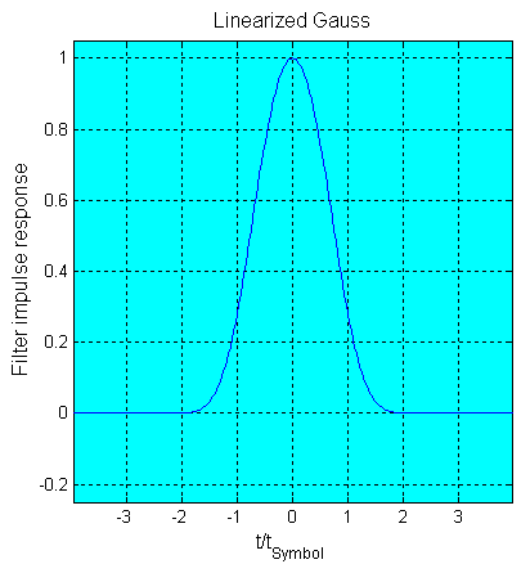
"Raised Cosine (RC)" "Roll Off Factor"	"Root Raised Cosine (RRC)" "Roll Off Factor"
	
"Gauss (FSK)" "B*T"	"Gauss (Pure)" "B*T"



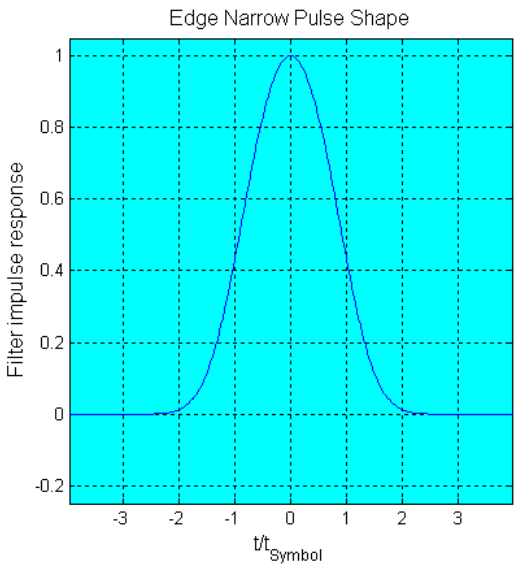
"Gauss Linearized"



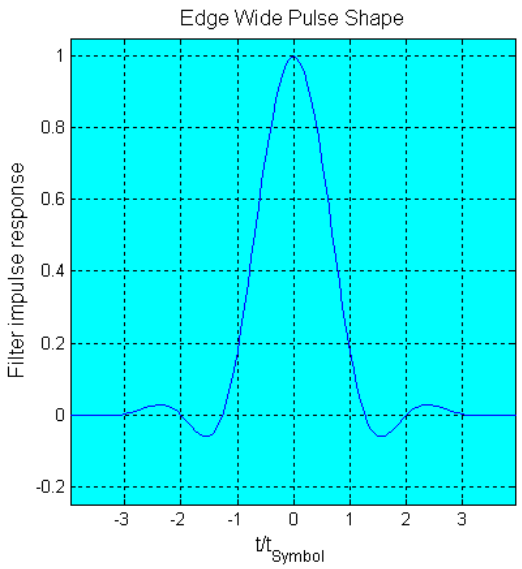
"Edge Narrow Pulse Shape"



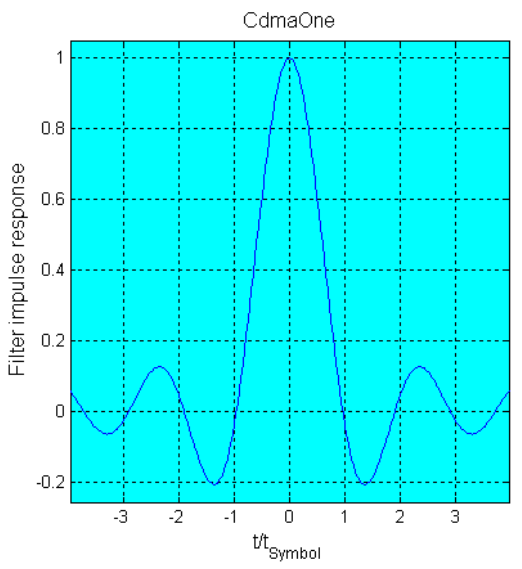
"Edge Wide Pulse Shape"



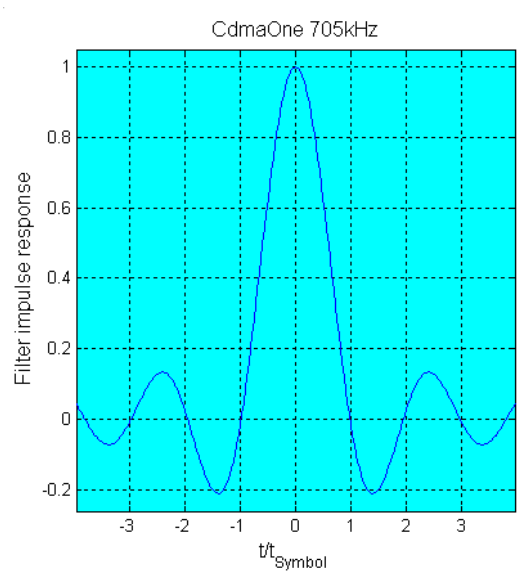
"cdmaOne"



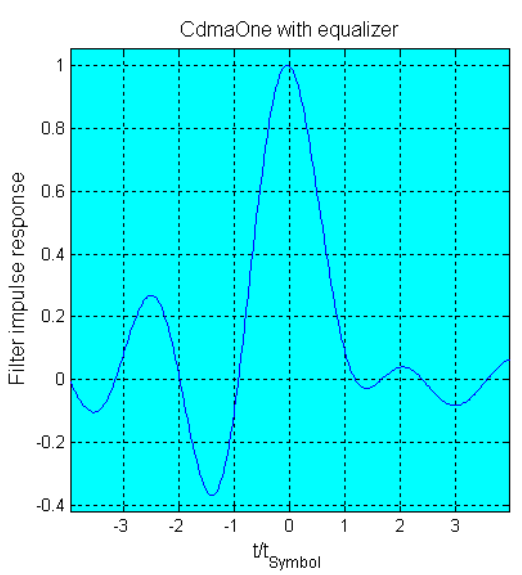
"cdmaOne 705kHz"



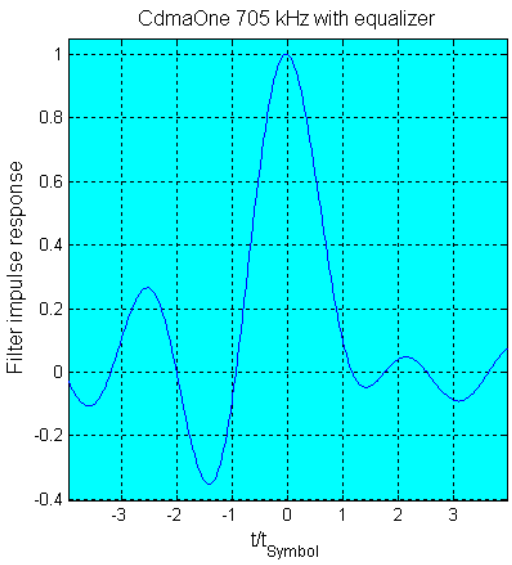
"cdmaOne + Equalizer"



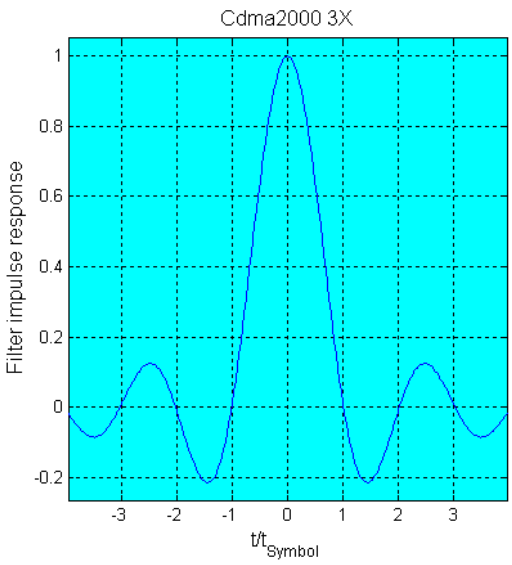
"cdmaOne 705kHz + Equalizer"



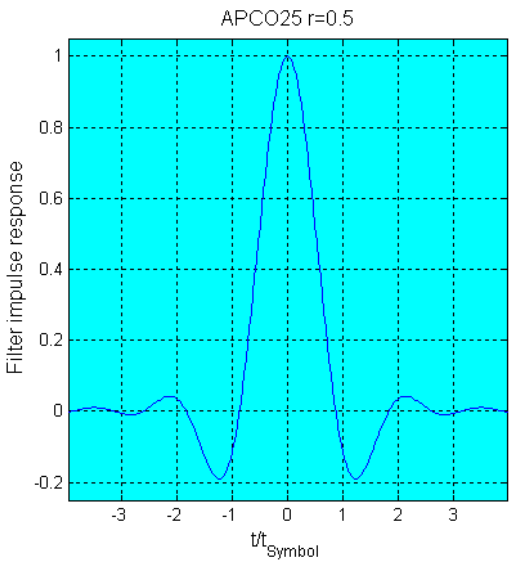
"cdma2000 3X"



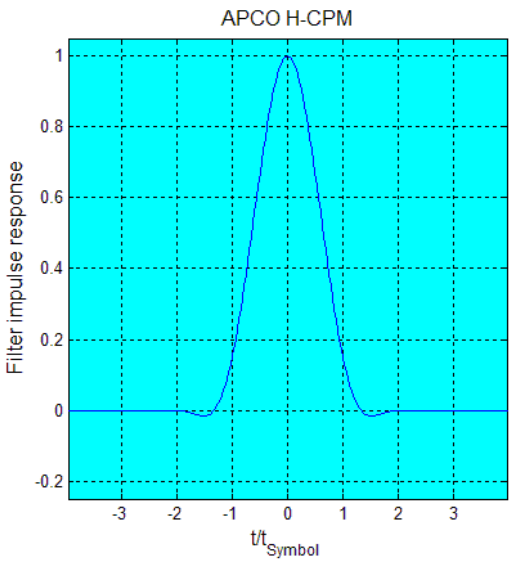
"APCO25"
"Roll Off Factor"



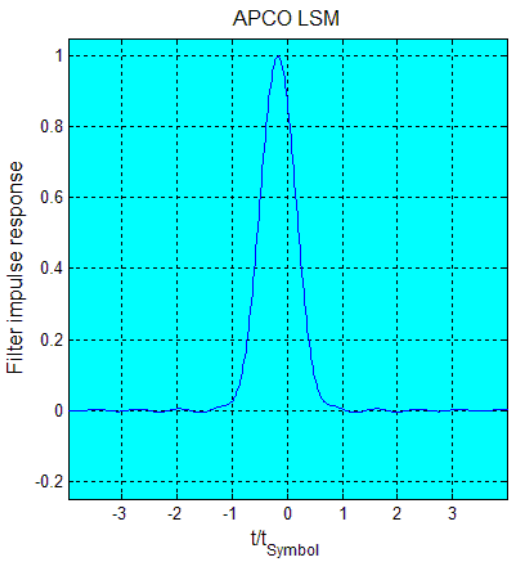
"APCO25 (H-CPM)"



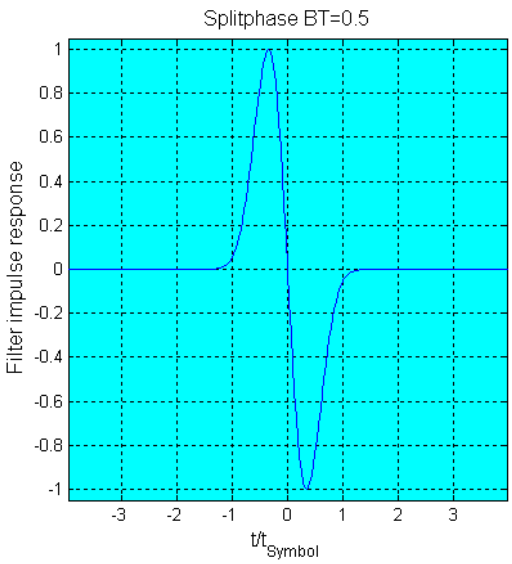
"APCO25 (LSM)"
"Gauss Cut Off Frequency"
"Lowpass Cut Off Frequency"



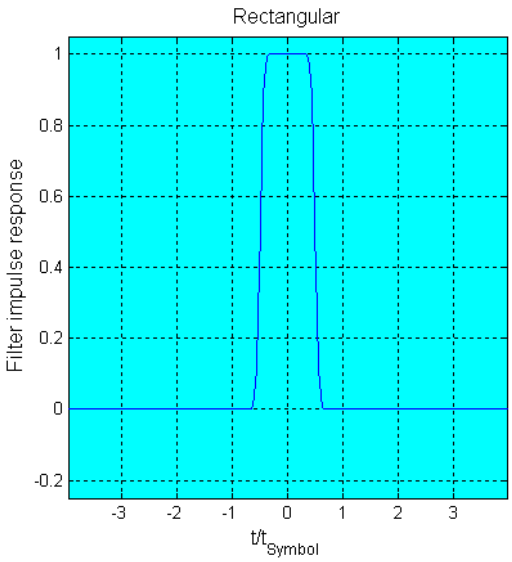
"Split Phase"
"B*T"



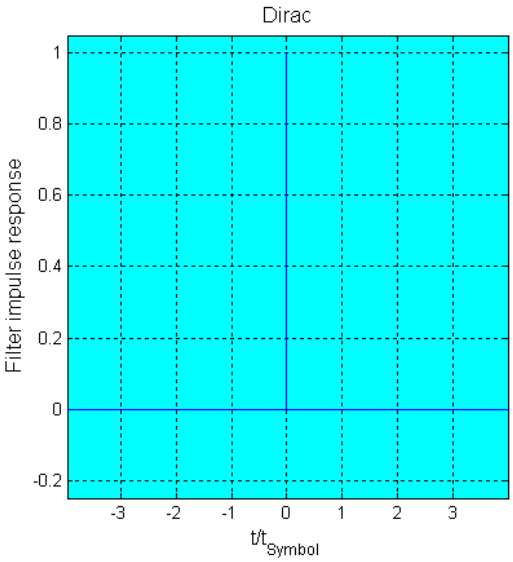
"Rectangular"



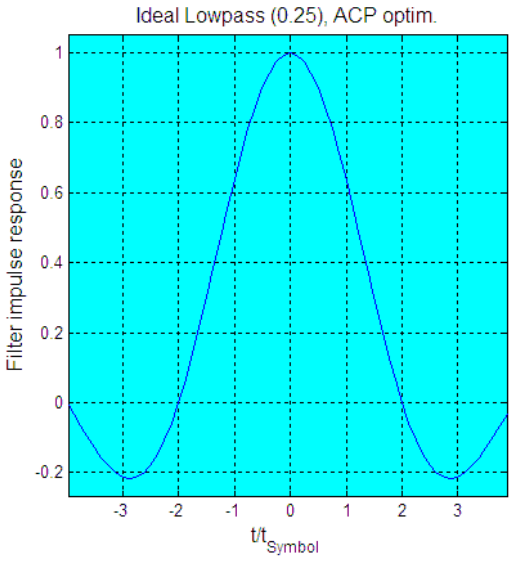
"Dirac"

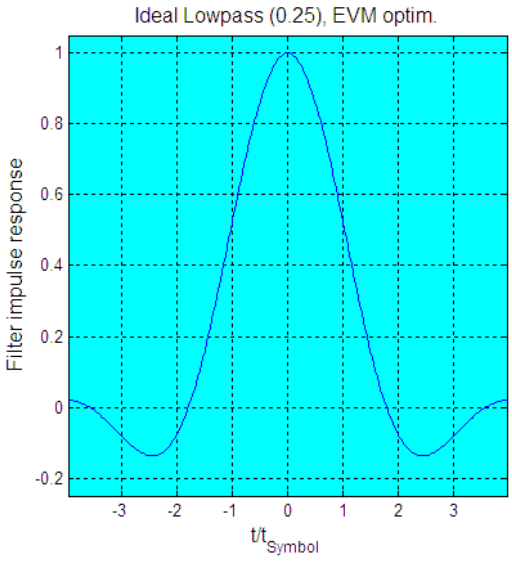


"Lowpass (ACP optim.)"

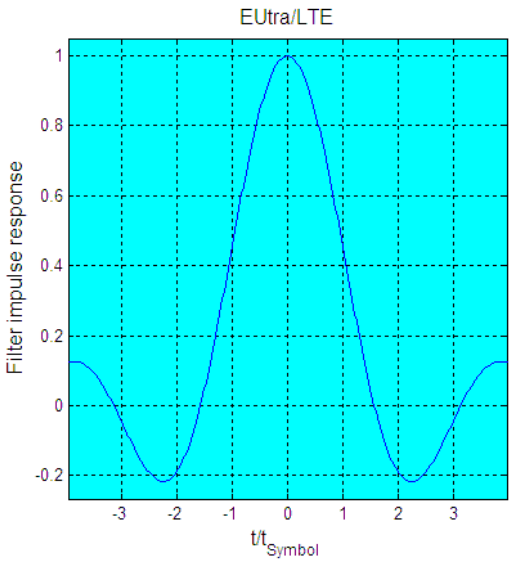


"Lowpass (EVM optim.)"





"EUTRA/LTE"



4.6 Using the arbitrary waveform generator (ARB)

The arbitrary waveform generator (ARB) is an I/Q modulation source of the R&S SMM100A. The ARB allows the playback and output of any externally calculated modulation signals in the form of waveform files. The ARB can also generate multicarrier or multi-segment signals from the waveform files.

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- About ARB 150
- ARB settings 156
- Playing waveform files 165
- Tags for waveforms, data and control lists 180

4.6.1 Required options

The equipment layout for processing of waveform files includes:

- Option Baseband Generator (R&S SMM-B9)
- Corresponding digital standard option (R&S SMM-K2xx/K4xx)
  Required to process a waveform file generated by the signal generation software R&S WinIQSIM2.
  For example, if you purchase option Digital Standard EUTRA/LTE R&S SMM-K255, you can process EUTRA/LTE waveform files generated by R&S WinIQSIM2.
- Optional ARB memory extension (R&S SMM-K511/-K512/-K513)

You can output waveform signals at several connectors. Dedicated connector output requires the following options:

- Output at the RF connector requires an RF frequency option, for example, option R&S SMM-B1006.
- Output at the Dig I/Q and HS Dig I/Q connectors requires option R&S SMM-B9 only.

For more information, refer to the specifications document.

4.6.2 About ARB

This section provides background information on the ARB functionality and the impact of the provided settings.

For more complex waveform signals, see the following sections:

- Section 4.10, "Generating multicarrier waveform signals", on page 234
- Section 4.9, "Generating multi-segment waveform files", on page 204
- Section 4.11, "Generating multicarrier continuous wave signals", on page 251

Related settings

See Section 4.6.3, "ARB settings", on page 156.

Related step-by-step descriptions

- Section 4.6.4, "Playing waveform files", on page 165
- Section 4.6.4.7, "Defining periodically repeating traces", on page 175
- Section 4.6.4.6, "Creating waveforms with tag file format", on page 171
- Section 4.6.4.8, "Creating control lists with tag file format", on page 177
- Section 4.6.4.9, "Creating data lists with tag file format", on page 178

- Section 4.6.4.10, "Editing waveform files, data and control lists", on page 179

This section covers the following topics:

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- About waveform files....151
- ARB test signals....152
- Waveform sample rate....154
- Marker signals and waveform length....155

4.6.2.1 About ARB file formats

In ARB mode, the R&S SMM100A can load and play back various file formats.

ARB file formats

You can load the following file formats using the "Load Waveform" function.

File format	I/Q format	Description	Max. file size
`*.wv`	Real and complex	Standard waveform file format, see Section 4.6.2.2, "About waveform files", on page 151.	Internal memory
`*.iq.tar`	Complex	Standard Rohde & Schwarz I/Q data format, see R&S iq-tar.	30 MB
`*.csv`	Complex	Predefined `*.csv` file format, see Section B, "ARB file formats CSV and MAT", on page 1138.	30 MB
`*.mat`	Complex	MATLAB® file format, see Section B, "ARB file formats CSV and MAT", on page 1138.	30 MB

For more information, refer to the specifications document.

For files with extension `*.iq.tar`, `*.csv` and `*.mat`, also the following applies:

- Load one I/Q stream per file as in the file format: `NumberOfChannels = 1`.

When playing iq-tar files, make sure that you level the I/Q data before recording, see Section 4.6.4.4, "Recording and playing iq-tar files", on page 167.

4.6.2.2 About waveform files

The R&S SMM100A uses waveform files to obtain the digital I/Q data of the baseband signal. The R&S SMM100A can play back a waveform file from the internal storage medium but it can also generate and play back simple waveforms for test purposes.

What is a waveform?

A waveform is a file with a specified file format containing raw I/Q samples. Waveform files have the file extension `*.wv` and contain calculated I/Q values.

When creating waveforms, the instrument inserts a waveform header at the beginning of each created ARB file. The header of the generated I/Q data files consists of tags in

braces "{ }". For a detailed description, see Section 4.6.5, "Tags for waveforms, data and control lists", on page 180.

Waveform file sources

The following waveform file sources are available:

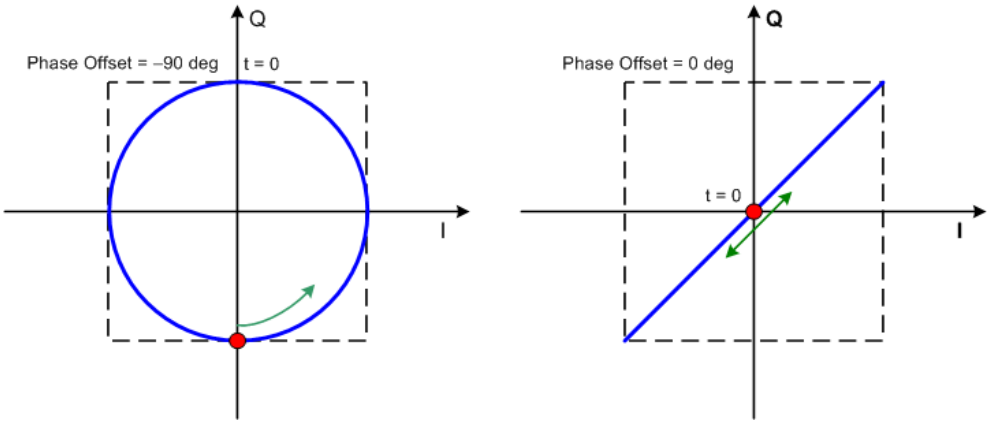
- **Internally generated waveforms**
  The ARB enables the calculation and the generation of waveform files. The ARB also provides a built-in function to create a test waveform and keep it as a file or in the RAM.
  Several digital standards provide the function "Generate Waveform ...". With this function, the R&S SMM100A creates a waveform file with the current configuration of the digital standard. You can also play back these files with the ARB.
- **Externally generated or created waveforms**
  The ARB processes externally created waveform files, for example:
  – The waveform files generated by software R&S WinIQSIM2, the R&S ARB Toolbox or the R&S Pulse Sequencer
  – A mathematical program, for example, MATLAB calculates the waveform signals. See Section 4.6.5, "Tags for waveforms, data and control lists", on page 180.

  You can load the externally generated waveform files into the instrument via one of the available interfaces, for example, USB or LAN. Usually, the waveform file is saved on one of the network drives that are accessible for the operating system.

4.6.2.3 ARB test signals

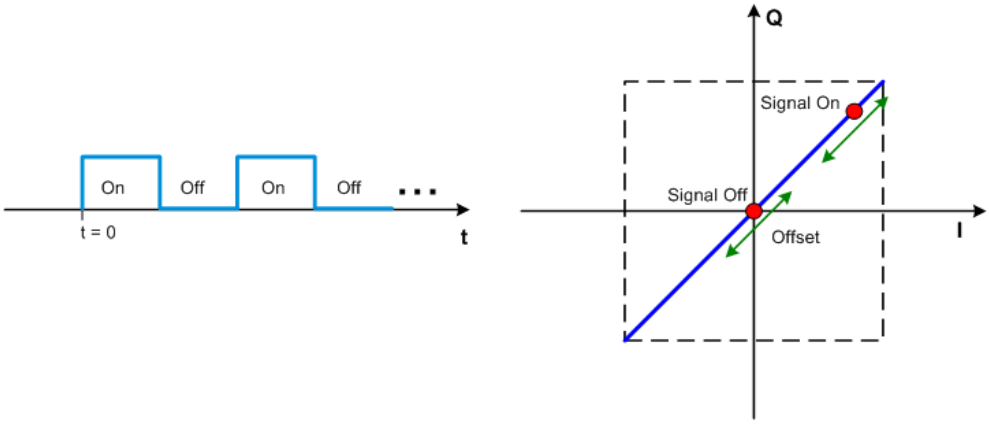
The following test signals are available:

- **"Sine" test signal**: Two sine-wave signals with a selectable (but equal) number of samples per period and equal frequencies. When the generation is triggered, the number of samples per period, together with the frequency of the test signal, determine the ARB clock frequency: "Clock Frequency" = "Frequency" * "Samples per Period".
  Note: Because the resulting clock rate must not exceed the maximum ARB clock rate, the number of sample values is automatically restricted depending on the selected frequency.
  The first sine signal is mapped on the I samples, the second on the Q samples. The two signals differ by a selectable phase offset. For a –90 deg offset, the result is a unit vector in the I/Q plane, rotating counterclockwise and starting at I = 0, Q = –1. For a 0 deg offset, the I and Q samples are on the diagonal of a unit square (I(t) = Q(t)).



In general, the I/Q samples are located on a deformed circle which is confined to the dashed square in the upper diagrams.

- **"Rect" test signal**: Rectangle signal with selectable but equal on and off periods and amplitude. The period is defined by the selected frequency: <Period> = 1 / "Frequency".
  The signal is mapped on both the I and Q samples. The mapping results in two distinct points in the I/Q plane. The "Offset DC" shifts both points along the diagonal I(t) = Q(t).



- **"Const I/Q" test signal:** Continuous test signal with constant I/Q and constant clock frequency of 10 kHz. The values for each I and Q components are selectable but constant. They are defined as a decimal number, which is decimal-to-binary converted internally. The signal is provided as a 16-bit wide digital signal for both I and Q channels.
  You can output the signal directly at the BNC connectors I and Q outputs of the instrument.
- **"AWGN" test signal:** Requires option R&S SMM-K811. Test signal comprising a noise signal. The 3 dB noise bandwidth is about 0.96 times the clock frequency.
  See also Section 4.7.4, "AWGN test signal settings", on page 201.

For more information, refer to the specifications document.

4.6.2.4 Waveform sample rate

The Arbitrary Waveform Generator includes a resampling unit that interpolates the input samples to target a certain digital output I/Q sample rate. The input sample rate f_{input} is retrieved from the waveform (the default sample rate tag) or is defined by the corresponding parameter in the ARB user interface.

The Figure 4-14 depicts the stages involved in the processing and resampling of a waveform in the ARB.

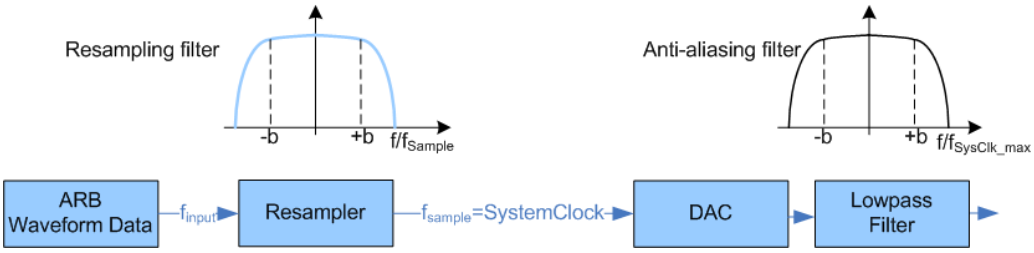


Figure 4-14: Processing of the waveform files in the ARB

f_{input} = Waveform sample rate
b = Usable bandwidth factor
f_{SysClk_max} = $SystemClock_{max}$ = $SampleRate_{max}$

Where:

- f_{SysClk_max} = $SystemClock_{max}$ = $SampleRate_{max}$ = 600 MHz
- b = 0.4165

Impact of the resampling filter

The filter in the resampling stage is distortion-free for baseband signals with the maximum usable bandwidth f_{b_max} as follows:

$f_{b_max} = b * f_{input}$

The usable bandwidth factor b equals b = 0.4165.

An externally created waveform file has to provide a sample rate f_{input} that is high enough for perfect signal reconstruction. For distortion-free resampling the lower bound of the sample rate f_{input} is then calculated as follows:

$f_{input} \geq f_{b_max} / b$

For example, a modulation signal with a sample rate f_{input} of 600 MHz ensures the highest value of f_{use_max}. After the DAC, this signal features a maximum RF bandwidth f_{max} as follows:

$f_{max} = 2 * b * f_{input}$

$f_{max} = 2 * b * 600\ MHz$

$f_{max} = 1\ GHz$

Impact of the oversampling factor

Waveforms generated by the R&S WinIQSIM2 software can be optimized by choosing a suitable integer oversampling factor.

Conventional ARB often assumes an oversampling factor of 4. The ARB of the R&S SMM100A requires low oversampling factors and still provides excellent signal quality in terms of EVM and ACP.

A reduced sample rate saves significantly the amount of memory or allows an increased signal cycle time, and vice versa.

4.6.2.5 Marker signals and waveform length

The R&S SMM100A provides the possibility to define marker signals that are sent to the marker outputs in synchronicity with the I/Q output signals. Marker signals can be either predefined or later defined.

The I/Q data and marker data are located in separate memory areas of the SDRAM and can be independently configured. Each marker signal requires 1 bit of the available memory size. Sometimes, it is useful to generate a modulation signal without extra marker signals to increase the maximum waveform length.

The following example explains the dependency between the number of enabled marker signals, the available memory size, and the resulting waveform length.

Example: Calculating the maximum waveform length

The calculation assumes a R&S SMM100A with an ARB memory of 512 Msample, see Section 4.6.1, "Required options", on page 150.

- Total memory size = 512 Mbyte
- Required memory size (per complex sample) = 32 bit + 4 bit = 36 bit = 4.5 byte, where:
  - The raw I/Q samples are saved as 16-bit values. For the length of the I/Q data that is:
    2 x 16 bit = 32 bit (16 bit per I/Q channel)
  - Each marker requires one bit. Four enabled markers require 4 bit.
- Maximum waveform length with 3 markers = 512 Mbyte / 4.5 byte = 113 Msample
- Theoretical maximum waveform length (no markers) = 512 Mbyte / 4 byte = 128 Msample

A memory size of 512 Mbyte yields a maximum waveform length of 113 Msample, if three markers are enabled. The maximum waveform length increases to 128 Msample, if the internal hardware markers are used, and the complete memory is available for I/Q data.

4.6.3 ARB settings

Access:

► Select "Baseband" > "ARB".

The "ARB" dialog enables direct selection of the waveform file to be processed, the selection of a test signal or access to the multi-segment and multicarrier settings.

The remote commands required to define these settings are described in Section 13.17.5.3, "SOURce:BB:ARBitrary subsystem", on page 873.

Settings:

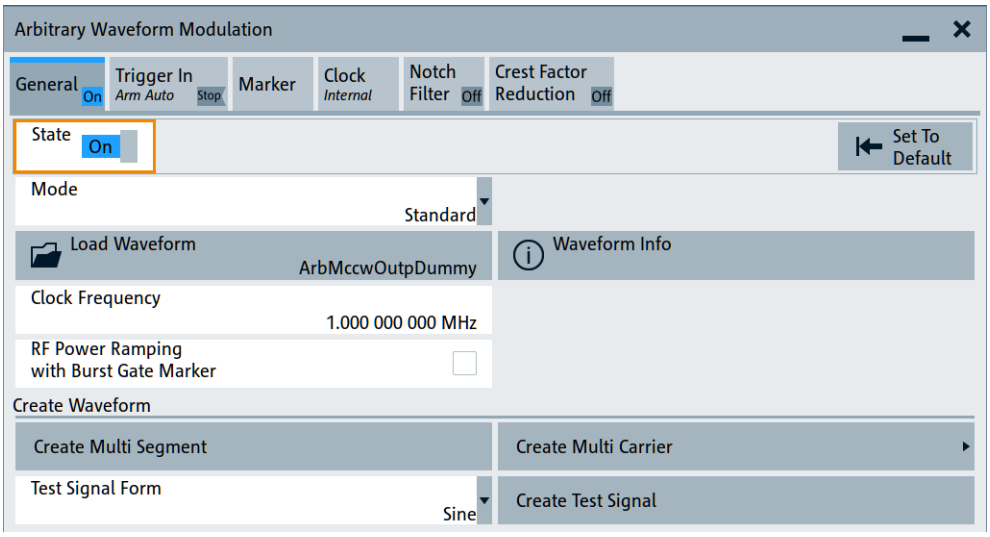
- ARB general settings 156
- Sine test signal settings 159
- Rectangular test signal settings 161
- Constant IQ test signal settings 162
- Trigger, marker and clock settings 163

4.6.3.1 ARB general settings

Access:

► Select "Baseband" > "ARB".

This tab provides general settings to select and create a waveform file and enable the ARB.



Further settings depend on the system configuration and the waveform type:

- If you use a single-segment waveform, the tab also provides settings for configuring the test signal and access to the settings for calculating a multi-segment or a multicarrier waveform.

- If you load a multi-segment waveform, the tab expands and displays the dedicated section "Multi Segment Waveform Options".
  This section provides settings to configure the segment to be output and adjust the trigger for the switch between the segments of the multi-segment waveform.
  The displayed parameters depend on the trigger source. The provided parameters are identical with the parameters in the section "Next Segment Trigger In" in the "Trigger" tab. See Section 4.9.3.5, "Multi-segment waveform trigger settings", on page 222.

Settings:

State....157
Set To Default....157
Load Waveform....158
Waveform Info....158
Clock Frequency....158
RF Power Ramping with Burst Marker....159
Create Multi Segment....159
Create Multi Carrier....159
Test Signal Form....159
Create Test Signal....159

State
Enables the baseband signal application and disables all the other baseband signal applications in the same signal path.

The generated ARB baseband signal originates from the loaded waveform file.

Note: ARB stays disabled.
You cannot enable the ARB in the following cases:

- **No or empty waveform file**
  By default, no waveform file is loaded. The "Load Waveform" button displays "None".
  Remedy: Select a waveform file, before activating the ARB.
- **Missing burst gate marker in the waveform**
  The "RF Power Ramping with Burst Gate Marker" state is "On" and the loaded ARB waveform does not contain a control list or the burst gate marker is not defined. An error message indicates the message above.
  Remedy: Define a burst gate marker in your waveform file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:STATe` on page 882

Set To Default
Calls the default settings. The table below lists the default values of the main parameters.

Parameter	Default value
State	Off
Clock frequency	1 MHz
Trigger mode	Auto

Parameter	Default value
Trigger source	Internal
Marker mode	Unchanged
Clock source	Internal

Remote command:
[:SOURce<hw>]:BB:ARBitrary:PRESet on page 882

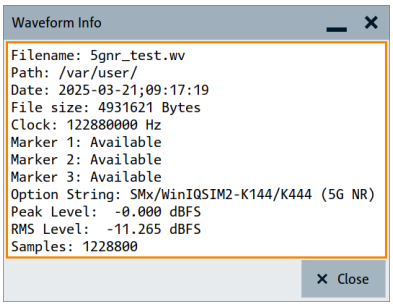
Load Waveform
Opens the standard "File Select" function of the instrument. The provided navigation possibilities in the dialog are self-explanatory.

If you select a file, the button displays the name of the waveform file. Enable the ARB to load and play the file.

For supported waveform file formats, see Section 4.6.2.1, "About ARB file formats", on page 151.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect on page 888

Waveform Info
Opens a dialog that displays detailed information on this waveform file. For example, it displays the filename, the clock frequency, the number of markers and samples or required options ("Option String") to play the waveform file.



Remote command:
n.a.
For non-multi-segment waveform files, use the `Tag` commands. See Section 4.6.5, "Tags for waveforms, data and control lists", on page 180.

Clock Frequency
Displays or sets the ARB output clock rate.

The value of this parameter is set to the clock rate defined in the loaded waveform file (`{CLOCK}` tag). The value can be changed afterwards.

Note: The clock frequency must match the value of the externally applied clock source.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CLOCk on page 890

RF Power Ramping with Burst Marker
Option: R&S SMM-K22

If activated, the burst gate marker signal included in the ARB waveform file is used as the marker signal for the pulse modulator.

If this parameter is activated, but the loaded ARB waveform does not contain a control list or the burst gate marker is not defined, the ARB cannot be activated. An error message indicates this situation, too.

You can create the suitable waveform files including the required burst gate marker signals, for example, with the R&S Pulse Sequencer software.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:PRAMp[:STATe]` on page 883

Create Multi Segment
Opens the dialog for creating multi-segment waveforms, see Section 4.9, "Generating multi-segment waveform files", on page 204.

Create Multi Carrier
Opens the dialog for creating multicarrier waveforms, see Section 4.10, "Generating multicarrier waveform signals", on page 234.

Test Signal Form
Selects the form of the test signal. A choice between a sinusoidal, rectangular, AWGN or test signal with constant I/Q is provided.

To access further settings, select Create Test Signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE` on page 883

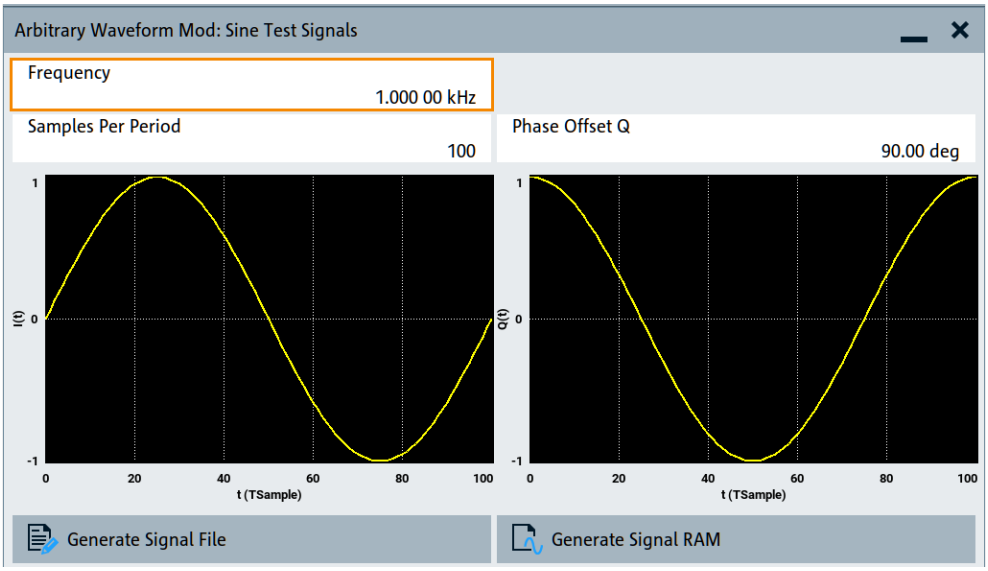
Create Test Signal
Opens a dialog with further test signal settings. Provided are the following test signals:
- Section 4.6.3.2, "Sine test signal settings", on page 159
- Section 4.6.3.3, "Rectangular test signal settings", on page 161
- Section 4.6.3.4, "Constant IQ test signal settings", on page 162
- Section 4.7.4, "AWGN test signal settings", on page 201

4.6.3.2 Sine test signal settings

Access:

1. Select "Baseband" > "ARB" > "General".
2. Select "Test Signal Form" > "Sine".

3. Select "Create Test Signal".



This dialog provides settings to configure a sinusoidal test signal. A sine wave is generated on the I path, and a sine wave of the same frequency but phase-shifted is generated on the Q path. For more information, refer to Section 4.6.2.3, "ARB test signals", on page 152.
The dialog displays the characteristic of the currently selected signal.

Settings:

Frequency 160
Samples per Period 160
Phase Offset Q 160
Generate Signal File 161
Generate Signal RAM 161

Frequency
Enters the frequency of the test signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency` on page 885

Samples per Period
Enters the number of sample values required from the sine wave per period.

The maximum allowed value is determined by the maximum ARB clock rate and the selected frequency.

For more information, refer to the specifications document.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles` on page 886

Phase Offset Q
Enters the phase offset of the sine-wave signal on the Q channel relative to the sine-wave signal on the I channel.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:PHASe on page 885

Generate Signal File
Generates a signal and saves it as a waveform file on the hard disk. Use the standard "File Select" function to save the file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed on page 886

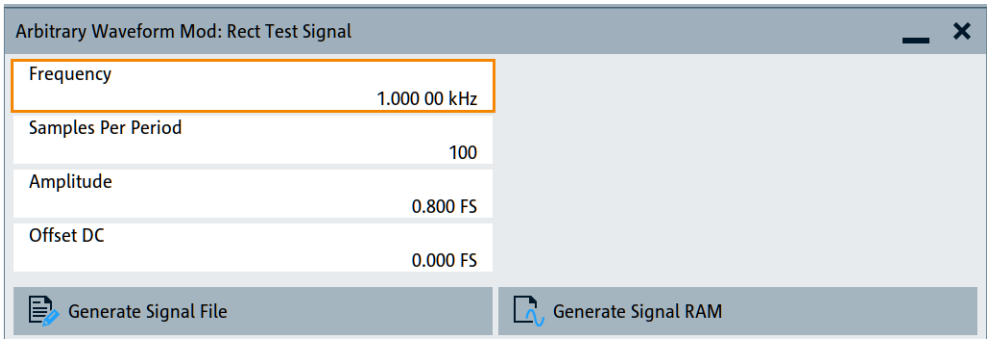
Generate Signal RAM
Generates a signal and uses this signal as output straight away. The instrument saves the file using a predefined filename.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate on page 886

4.6.3.3 Rectangular test signal settings

Access:

1. Select "Baseband" > "ARB" > "General".
2. Select "Test Signal Form" > "Rect".
3. Select "Create Test Signal".



This dialog provides settings to configure a rectangular test signal. A rectangular test signal with a duty factor of 0.5 is created. Amplitude and offset are adjustable. Both paths, I and Q, use the same signal.
For more information, refer to Section 4.6.2.3, "ARB test signals", on page 152.

Settings:

Frequency 162
Samples per Period 162
Amplitude 162
Offset DC 162
Generate Signal File 162
Generate Signal RAM 162

Frequency
Enters the frequency of the test signal.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency on page 884

Samples per Period
Enters the number of sample values required for the rectangular signal per period.

The maximum allowed value is determined by the maximum ARB clock rate and the selected frequency.

For more information, refer to the specifications document.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:SAMPles on page 885

Amplitude
Enters the digital amplitude of the rectangular wave. The abbreviation FS means full-scale.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude on page 884

Offset DC
Enters a DC component.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet on page 884

Generate Signal File
Generates a signal and saves it as a waveform file on the hard disk. Use the standard "File Select" function to save the file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed on page 886

Generate Signal RAM
Generates a signal and outputs it straight away. The instrument saves the file using a predefined filename.

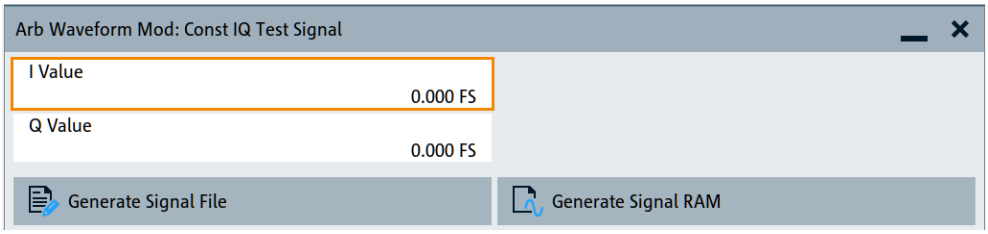
Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate on page 886

4.6.3.4 Constant IQ test signal settings

Access:

1. Select "Baseband" > "ARB" > "General".
2. Select "Test Signal Form" > "Const IQ".

3. Select "Create Test Signal".



This dialog provides settings to configure a continuous test signal with constant IQ. The I and Q values for each path are adjustable but constant. For more information, refer to Section 4.6.2.3, "ARB test signals", on page 152.
If converted to an analog signal, the signal is output directly at the I and Q connectors of the instrument.

Settings:

I ValueIQ Value....163
Generate Signal File....163
Generate Signal RAM....163

I ValueIQ Value
Sets the value for the I component and Q component of the test signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I` on page 884
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q` on page 884

Generate Signal File
Generates a signal and saves it as a waveform file on the hard disk. Use the standard "File Select" function to save the file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed` on page 886

Generate Signal RAM
Generates a signal and uses this signal as output straight away. The instrument saves the file using a predefined filename.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate` on page 886

4.6.3.5 Trigger, marker and clock settings

These tabs provide standard settings.

For a detailed description, see the following sections:

- Section 4.4.2.1, "Trigger settings", on page 106
- Section 4.4.2.2, "Marker settings", on page 111
- Section 4.4.2.3, "Clock settings", on page 113
- Section 4.4.2.4, "Local and global connectors settings", on page 114

The following settings are specific to the ARB dialog.

Processing Time....164
Mode....164
Delay (Time)....164

Processing Time
Displays the internal processing time.

The processing time is the elapsed time between the input of the external trigger event and the output of the baseband signal. An additional delay applies to the RF signal with respect to the baseband signal depending on the RF frequency.

For more information, see "Starting the signal generation with the first sample" on page 97.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:PTIMe?` on page 921

Mode
Sets the marker mode that defines the shape and periodicity of the marker signal.

You can configure individual marker modes for each marker signal. The number of available markers is 3. The marker configuration changes with the selected marker mode.

For more information on marker modes, see Section 4.4.1.4, "About marker signals", on page 90.

Note: Setting an ARB marker mode that is different than "Unchanged" does not change the marker trace in the loaded waveform file. But, when playing the waveform file the instrument uses the configured ARB marker mode.

The instrument routes the generated marker signals to the selected output connectors.

See also Section 11.2, "Configuring local and global connectors", on page 563.

"Unchanged" The waveform file with its configured marker traces defines the marker signal of the ARB baseband signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE` on page 923
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 924
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 924
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern` on page 924
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime` on page 924
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime` on page 924

Delay (Time)
Shows the marker delay time in microseconds, milliseconds or seconds depending on the marker delay.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DINSec?` on page 925

4.6.4 Playing waveform files

This section provides step-by-step instructions to create, generate and play waveform files on the R&S SMM100A. Provided the R&S SMM100A is equipped with the required option, you can load this waveform file and process it with the instrument.

For details on individual functions and settings, see Section 4.6.3, "ARB settings", on page 156.

Some test cases do not require a real-time signal generation according to a digital standard. For these test cases, the replay of a previously generated waveform is sufficient. Generate these waveform files as follows:

- Internal waveform generation with the following functions:
  - "Generate Waveform File" function, see Section 4.6.4.2, "Using the function Generate Waveform", on page 166.
  - "Create Test Signal" function, see Section 4.6.4.1, "Generating ARB test signals", on page 165.
- External waveform generation with Rohde & Schwarz software products:
  - For R&S WinIQSIM2, see Section 4.6.4.5, "Working with R&S WinIQSIM2", on page 167
  - For R&S ARB Toolbox, see 1GP88.
  - For R&S SMM-K300/-K301 Pulse Sequencer, see the R&S Pulse Sequencer software user manual.
- External waveform generation with MATLAB, see Section 4.6.4.6, "Creating waveforms with tag file format", on page 171 and 1GP60.

This section provides examples on the internal waveform file generation and on the external generation with R&S WinIQSIM2.

- Generating ARB test signals 165
- Using the function Generate Waveform 166
- Loading and playing waveform files 167
- Recording and playing iq-tar files 167
- Working with R&S WinIQSIM2 167
- Creating waveforms with tag file format 171
- Defining periodically repeating traces 175
- Creating control lists with tag file format 177
- Creating data lists with tag file format 178
- Editing waveform files, data and control lists 179

4.6.4.1 Generating ARB test signals

If your test case requires a simple sine signal or square signal, use the ARB test signals.

To generate a sine test signal

1. Select "Baseband" > "ARB"
2. Select "Create Test Signal" > "Sine".

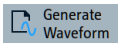
3. Adjust the "Sine Test Signal" settings as required.
4. Select "Generate Signal File".
   A standard file select dialog opens.
   a) Navigate to the directory in that you want to save the file, for example /var/user/.
   b) Enter a filename, for example `sine_waveform`.
   c) Click "Save".

   The R&S SMM100A saves the generated waveform file and automatically loads it in the ARB.
5. Select "ARB" > "State" > "On".

   The R&S SMM100A processes the waveform file.

4.6.4.2 Using the function Generate Waveform

The general settings dialog of several digital standards provides the built-in function "Generate Waveform".



This function enables the calculation of the signal and saves the information in a waveform file. After saving, you can load the waveform file in the ARB.

To generate an LTE waveform file

1. Select "Baseband" > "EUTRA/LTE/IoT".
2. Adjust the settings as required, for example:
   a) Select "Link Direction" > "Downlink".
   b) Select a predefined test model, for example, "Test Models" > "E-TM1_1__10MHz".
3. Select "State" > "On".
4. Select "Generate Waveform".
   A standard file select dialog opens.
   a) Navigate to the directory in that you want to save the file, for example /var/user/.
   b) Enter a filename, for example `lte_waveform`).
   c) Click "Save".

   The R&S SMM100A saves the generated waveform file `lte_waveform.wv` in the selected directory `/var/user/`.

To process the waveform file, load it in the ARB, see Section 4.6.4.3, "Loading and playing waveform files", on page 167.

4.6.4.3 Loading and playing waveform files

Irrespectively on how you generate a waveform, you can transfer it to the instrument, load it in the ARB and play it.

To load and play a waveform file

1. Transfer an externally created waveform file to the instrument.
   See Section 10.10, "Transferring files from and to the instrument", on page 546.
2. Select "Baseband" > "ARB".
3. Select "Load Waveform".
   A standard file select dialog opens.
   a) Navigate to the directory that the waveform file contains.
   b) Select the waveform file, for example `/var/user/lte_waveform`.
   c) Click "Select".

   The "ARB" dialog confirms that the waveform file is loaded.
4. Select "ARB" > "State" > "On".

   The R&S SMM100A processes the waveform file.

4.6.4.4 Recording and playing iq-tar files

You can record and save I/Q data in an iq-tar file with file extension `*.iq.tar`. For example, use a Rohde & Schwarz signal and spectrum analyzer.

If you play unleveled I/Q data at the ARB of the R&S SMM100A, a level overload can occur. The following step-by-step instruction shows how to play leveled `*.iq.tar` files.

1. At the analyzer, proceed as follows:
   a) Open a suitable application, for example the I/Q analyzer.
   b) Configure a suitable data acquisition.
   c) Select [AUTO SET] > "Auto Level".
   d) Export the I/Q data with file format `*.iq.tar`.
   e) Save the file.
2. At the R&S SMM100A, load the file into the ARB.
3. Select "ARB" > "On" to play the file.

4.6.4.5 Working with R&S WinIQSIM2

The following example illustrates how to use R&S WinIQSIM2 simulation software to generate an EUTRA/LTE waveform and load it in the ARB of the R&S SMM100A.

The workflow consists of three main steps, each described in a separate step-by-step instruction:

- Configuring the connection between the R&S WinIQSIM2 and the R&S SMM100A
- Generating of a waveform file with the required settings
- Transferring the waveform file to and playing it with the R&S SMM100A.

This section does not describe the R&S WinIQSIM2 simulation software but focuses on the task-related settings. For a description of the simulation software, see the R&S WinIQSIM2 user manual.

To define the R&S SMM100A as destination instrument

In this example, we assume that the R&S WinIQSIM2 is installed on a remote controller. This remote controller is connected over LAN to the R&S SMM100A.

The general instrument settings of the destination instrument affect various functions, for example, the maximum size of the file the waveform is saved in. We recommend that you configure the destination instrument before you generate the waveform with the R&S WinIQSIM2.

1. In the R&S WinIQSIM2, select "File" > "New" to preset the software.
2. In the block diagram, select "Vector Sig Gen" > "Instruments".

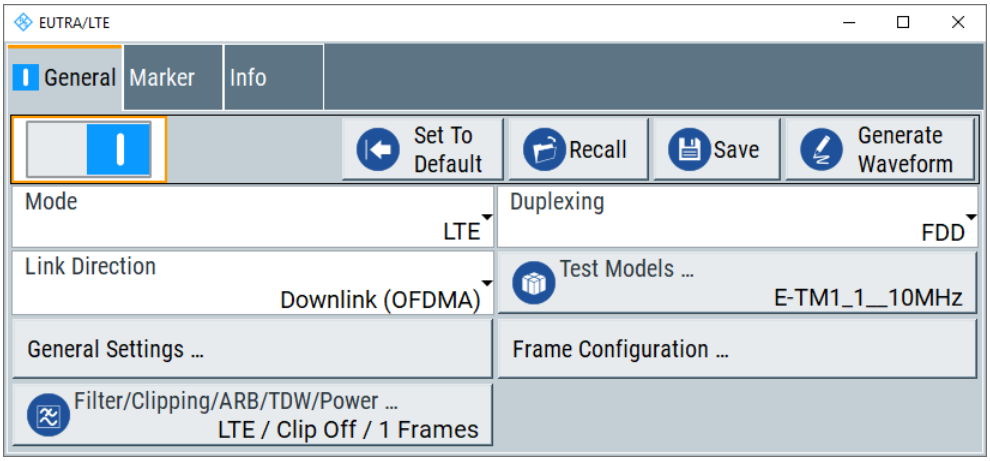
   The "Configure Instruments" dialog opens. The list of configured instruments is empty.
3. Select "Configure Instruments" > "Scan".

   The software scans the network for connected and active instruments. Alternatively, use the "New" function to add the R&S SMM100A manually to the list of instruments.
4. Close the dialog.
5. In the block diagram, select "Vector Sig Gen" block and select the R&S SMM100A form the list.
6. In the block diagram, select "ARB Sig Gen" block and select the R&S SMM100A form the list.

   The two lines to the "Vector Sig Gen" and "ARB Sig Gen" blocks on the block diagram confirm that a remote connection to the R&S SMM100A is established.

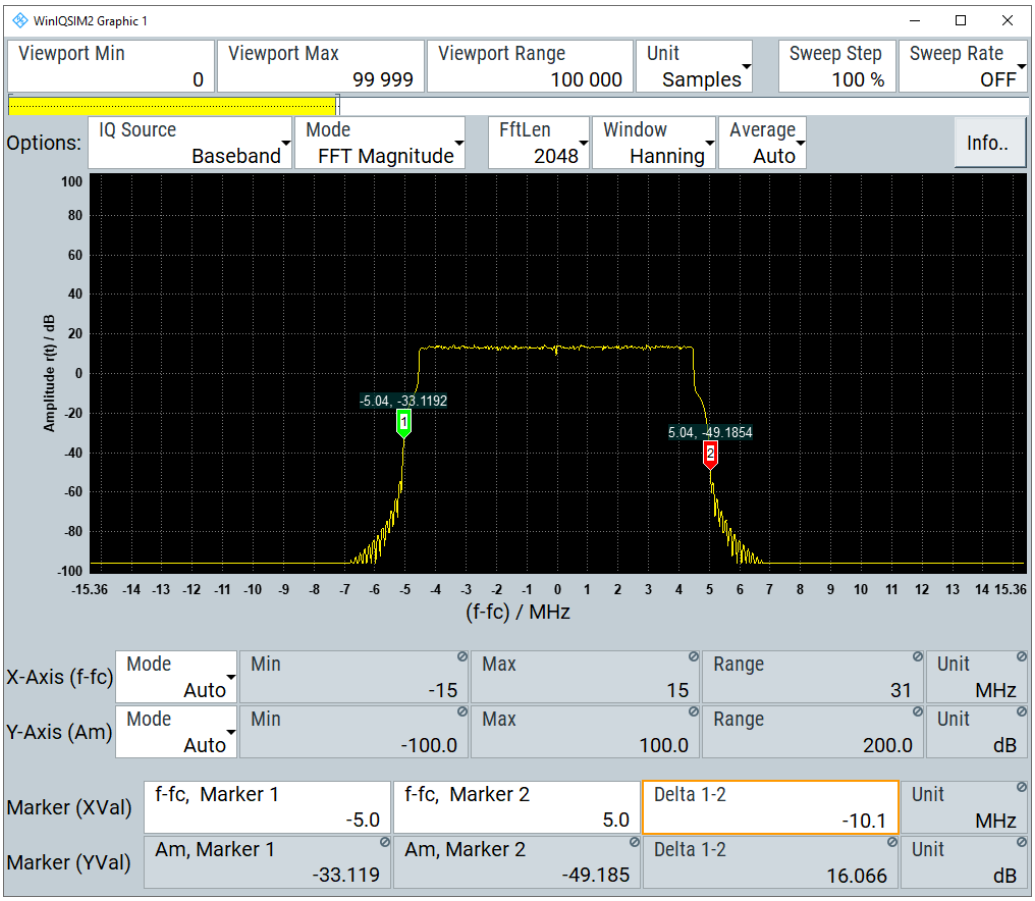
To generate a waveform file with R&S WinIQSIM2

1. In the block diagram of R&S WinIQSIM2, select "Baseband" > "EUTRA/LTE/IoT".
2. Adjust the settings as required, for example:
   a) Select "Link Direction" > "Downlink (OFDMA)"
   b) Select a predefined test model, for example, "Test Models" > "E-TM1_1__10MHz".
3. Select "EUTRA/LTE/IoT" > "State" > "On".



R&S WinIQSIM2 calculates the signal and displays important signal parameters, for example, number of samples "Samples" and "Sample Rate".

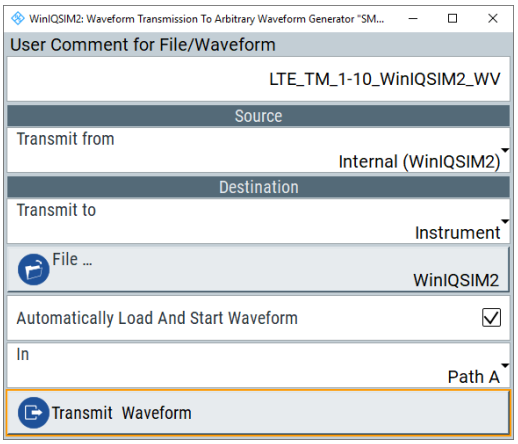
Select "Graphics" > "Graphic 1 (Complete)" to check for more information on the generated signal.



The display confirms the expected EUTRA/LTE 10 MHz spectrum.

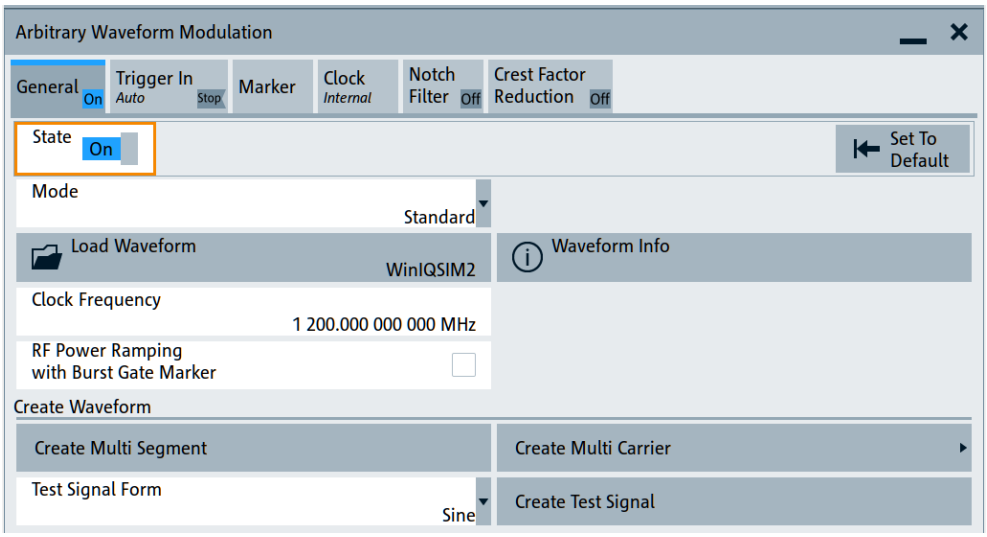
To transfer the waveform file to the R&S SMM100A

1. At R&S WinIQSIM2, select "Transmission" > "Transmit".
2. In the "Waveform Transmission to Arbitrary Waveform Generator" dialog, proceed as follows:
   a) "Transmit from" > "Internal (WinIQSIM2)".
   b) "Transmit to" > "Instrument".
   c) Select "File".
   d) Define the filename of the transmitted file.
   e) Activate "Automatically Load and Start Waveform".
   f) Select the required baseband, for example "Path A".
   g) Add a comment to the waveform, for example as follows:
   "User Comment for File/Waveform" > "LTE_TM_1-10_WinIQSIM2_WV"
   h) Select "Transmit".



R&S WinIQSIM2 transmits the waveform to the default directory of the R&S SMM100A.

3. In the R&S SMM100A, select "Baseband" > "ARB".



The dialog confirms that the ARB is active and plays the transmitted waveform.

4.6.4.6 Creating waveforms with tag file format

The provided example uses a sine function in the I channel and a cosine function in the Q channel, each with 20 points. The example uses a short program written in the programming language C to calculate the sine and cosine values (see Example "C-program for creating a waveform file" on page 174). They are saved in the file `SICO.txt`. The decimal values in `SICO.txt` are normalized such that they are between –1.0 and +1.0. The data is converted into binary format. The appropriate mandatory tags are added and the data is packed into the `WAVEFORM` tag. As result, the waveform file `SICO.wv` is generated.

This example follows the general principle of creating of a waveform manually, using the tag file format. The Figure 4-15 illustrates this general workflow.

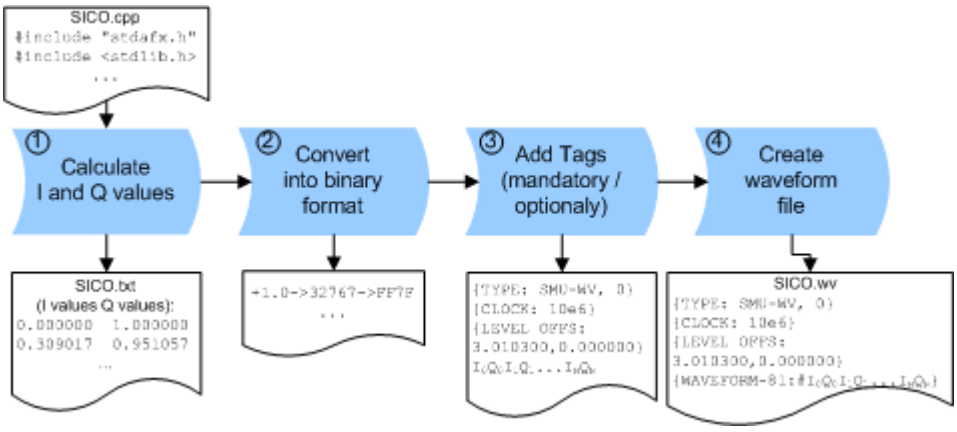


Figure 4-15: Principle of creating a waveform manually

The following steps outline how to create the waveform file `SICO.wv`:

1. Calculate the sine and cosine values. For example, use the `SICO.cpp` program.

   The result is saved in the file `SICO.txt`.

```
 0.000000  1.000000
 0.309017  0.951057
 0.587785  0.809017
 0.809017  0.587785
 0.951057  0.309017
 1.000000 -0.000000
 0.951057 -0.309017
 0.809017 -0.587785
 0.587785 -0.809017
 0.309017 -0.951057
-0.000000 -1.000000
-0.309017 -0.951056
-0.587785 -0.809017
-0.809017 -0.587785
-0.951056 -0.309017
-1.000000  0.000000
-0.951056  0.309017
-0.809017  0.587785
-0.587785  0.809017
-0.309017  0.951057
```

Figure 4-16: Contents of SICO.txt: first column Sine (I), second column Cosine (Q)

2. Convert the values from the file `SICO.txt` into binary format consisting of 16-bit signed integer numbers. The numeric range between –1.0 and +1.0 corresponds to the modulation range of the waveform 16-bit D/A converter of -32767 to +32767.

+1.0 ->	32767 ->	= 0x7FFF
0.0 ->	0 ->	= 0x0000
-1.0 ->	-32767 ->	= 0x8001

   The Figure 4-17 shows the calculation and conversion steps. The highlighted columns contain the resulting I and Q values represented in Little endian format.

Sample n	deg = 360°/20 * n	I = sin(deg)	$I_{quant,dec}$ = I * FS = I * (2^{15}-1)	$I_{quant,hex}$	$I_{quant,hex}$ (little-endian waveform file representation)	Q = cos(deg)	$Q_{quant,dec}$ = I * FS = I * (2^{15}-1)	$Q_{quant,hex}$	$Q_{quant,hex}$ (little-endian waveform file representation)
0	0	0.000000	0	0000	0000 I_0	1.000000	32767	7FFF	FF7F Q_0
1	18	0.309017	10126	278E	8E27	0.951057	31163	79BB	BB79
2	36	0.587785	19260	4B3C	3C4B	0.809017	26509	678D	8D67
3	54	0.809017	26509	678D	8D67	0.587785	19260	4B3C	3C4B
4	72	0.951057	31163	79BB	BB79	0.309017	10126	278E	8E27
5	90	1.000000	32767	7FFF	FF7F	0.000000	0	0000	0000
6	108	0.951057	31163	79BB	BB79	-0.309017	-10126	D872	72D8
7	126	0.809017	26509	678D	8D67	-0.587785	-19260	B4C4	C4B4
8	144	0.587785	19260	4B3C	3C4B	-0.809017	-26509	9873	7398
9	162	0.309017	10126	278E	8E27	-0.951057	-31163	8645	4586
10	180	0.000000	0	0000	0000	-1.000000	-32767	8001	0180
11	198	-0.309017	-10126	D872	72D8	-0.951057	-31163	8645	4586
12	216	-0.587785	-19260	B4C4	C4B4	-0.809017	-26509	9873	7398
13	234	-0.809017	-26509	9873	7398	-0.587785	-19260	B4C4	C4B4
14	252	-0.951057	-31163	8645	4586	-0.309017	-10126	D872	72D8
15	270	-1.000000	-32767	8001	0180	0.000000	0	0000	0000
16	288	-0.951057	-31163	8645	4586	0.309017	10126	278E	8E27
17	306	-0.809017	-26509	9873	7398	0.587785	19260	4B3C	3C4B
18	324	-0.587785	-19260	B4C4	C4B4	0.809017	26509	678D	8D67
19	342	-0.309017	-10126	D872	72D8	0.951057	31163	79BB	BB79

Figure 4-17: I and Q values calculation and conversion

3. Use an ASCII editor which is able to handle binary data. Create and add the following mandatory tags before this binary data set can be further processed:
   - `CLOCK`
   - `LEVEL OFFS`

   An example of the `SICO.wv` file contents could be:

   ```
   {TYPE: SMU-WV, 0}{CLOCK: 10e6}{LEVEL OFFS: 3.010300,0.000000}
   0000FF7F8E27BB79 ... 72D8BB79
   ```

   To simplify the example, the checksum is set to 0, i.e. the instrument does not evaluate a checksum.

   Tip: The tags `TYPE`, `CLOCK`, `LEVEL OFFS` and `WAVEFORM` are mandatory for each waveform. All other tags are optional and can be inserted after the `TYPE` tag in arbitrary order.

4. Pack the binary data into a `WAVEFORM` tag with the described structure.

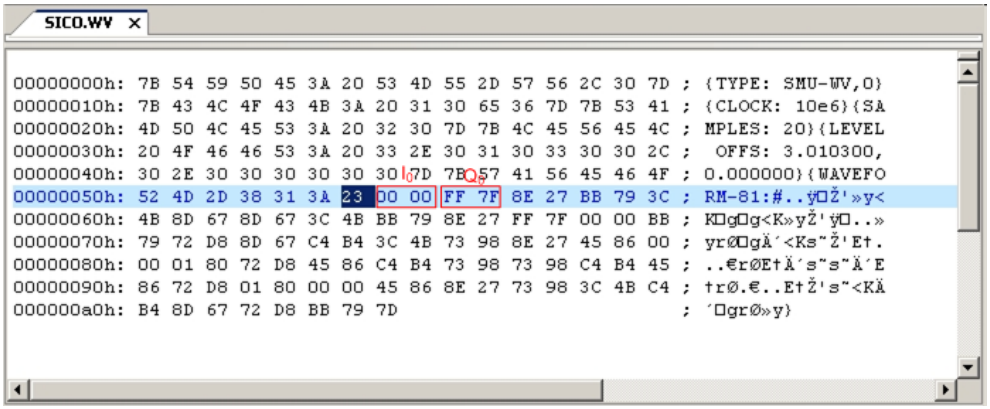
   ```
   {WAVEFORM-Length: #I0Q0I1Q1I2Q2 ... InQn}
   ```

   - Calculate the `Length`
     Length = Number of I/Q pairs * 4 + 1 = 20*4 + 1 = 81 bytes
   - Place the string `{WAVEFORM-81:#` at the beginning of the data set
   - Place the symbol `}` at the end of the data set

   The contents of the waveform file `SICO.wv` for 20 I/Q pairs is now ready for operation and reads:

   ```
   {TYPE: SMU-WV,0}
   {CLOCK: 10e6}
   {LEVEL OFFS: 3.010300,0.000000}
   {WAVEFORM-81:#I0Q0I1Q1...InQn}
   ```

There is no readable representation for binary values in this document. This example uses the sequence `I0Q0I1Q1...InQn` to characterize the binary code. The following figure shows this waveform in a data editor.



Example: C-program for creating a waveform file

C-program `SICO.cpp` for creating the file `SICO.txt` containing 20 sine and cosine pairs, converting them into binary data and creating the waveform file `SICO.wv`.

```
// SICO.cpp
// Defines the entry point for the console application

#include "stdafx.h"
#include <stdlib.h>
#include <stdio.h>
#include <math.h>

int _tmain(int argc, _TCHAR* argv[])
{
    const unsigned int samples = 20;
    const float pi = 3.141592654f;
    int i;

// SICO.txt
// Creating the file SICO.txt containing 20 sine and cosine pairs
    float grad, rad;
    FILE *fp;
    fp = fopen("SICO.txt", "w");
    if (fp == 0)
        return;
    for (i=0; i<samples; i++)
    {
        grad = (360.0f / (float)samples) * (float)i;
        rad = grad * (pi / 180.0f);
        fprintf(fp, "%f %f\n", sin(rad), cos(rad));
    }
    fclose(fp);
```

```
// SICO.wv
// Generating a binary data set from the I/Q pairs in the file SICO.txt
// and storing the result to file SICO.wv
    FILE *fp_sour, *fp_dest;
    float i_float, q_float;
    unsigned short i_usint, q_usint;
    fp_sour = fopen("SICO.TXT", "rt");
    if (fp_sour == 0)
        return -1;
    fp_dest = fopen("SICO.WV", "wb");
    if (fp_dest == 0)
    {
        fclose(fp_sour);
        return -1;
    }
    // Write required tags to waveform file
    fprintf(fp_dest, "{TYPE: SMU-WV,0}");
    fprintf(fp_dest, "{CLOCK: 10e6}");
    fprintf(fp_dest, "{SAMPLES: %d}", samples);
    // RMS, Peak
    fprintf(fp_dest, "{LEVEL OFFS: %f,%f}", -1.0f * 20.0f * log10(1.0f/sqrt(2.0f)), 0.0f);
    fprintf(fp_dest, "{WAVEFORM-%d:#", (samples * 4) + 1);
    for (i=0; i<samples; i++)
    {
      // Read I/Q pair from ASCII file
         if (fscanf(fp_sour, "%f %f", &i_float, &q_float) == EOF)
            break;
        // Convert I/Q pair to unsigned short
        i_usint = (unsigned short)floor((i_float * 32767.0) + 0.5);
        q_usint = (unsigned short)floor((q_float * 32767.0) + 0.5);
        // Write converted I/Q pair to waveform file
        fwrite(&i_usint, 2, 1, fp_dest);
        fwrite(&q_usint, 2, 1, fp_dest);
    }
    fprintf(fp_dest, "}");
    fclose(fp_dest);
    fclose(fp_sour);
return 0;
}
```

4.6.4.7 Defining periodically repeating traces

If you test setup requires marking an event, for example, each frame start, it is sufficient to define the trace ones and repeat it over the length of a waveform. Repeating is useful for long waveforms with periodical marker signals.

The following examples use marker traces. You can use control lists analogously.

To define periodical marker trace

The waveform in the example below consists of three frames, each frame has a length of 100 samples. Waveform processing is continuous via "Trigger Mode" > "Auto".

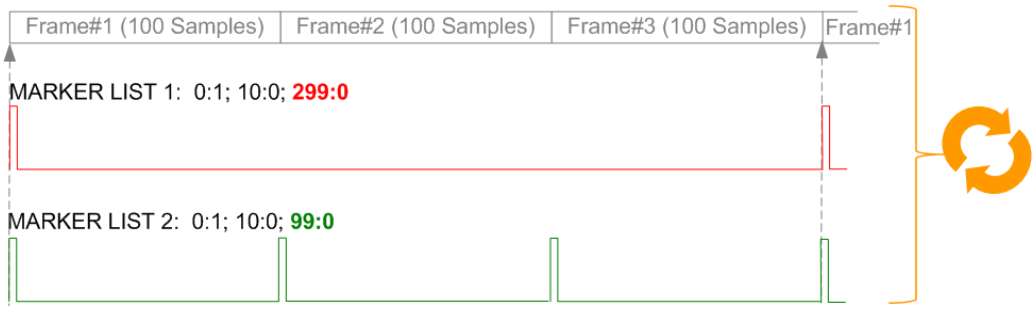


Figure 4-18: Example: Defining marker traces without CONTROL LENGTH tag

To define a restart marker and a frame start marker, use the following tags:

1. The waveform is 300 samples long, i.e. set `{SAMPLES: 300}`.
2. Set two `[TRACE] LIST` tags:
   - For Marker 1 that acts as a restart marker:
     `{MARKER LIST 1: 0:1; 10:0; 299:0}`
   - For Marker 2 that marks each frame start:
     `{MARKER LIST 2: 0:1; 10:0; 99:0}`
3. Do not use the `CONTROL LENGTH` tag.

   The length of the repeated patterns is determined by the last sample number in the `[TRACE] LIST` that is the last {**Pos:**State}.

Example: CONTROL LENGTH tag and trace processing

In the example below, use the same marker traces and set the `CONTROL LENGTH` tag, for example `{CONTROL LENGTH: 150}`.

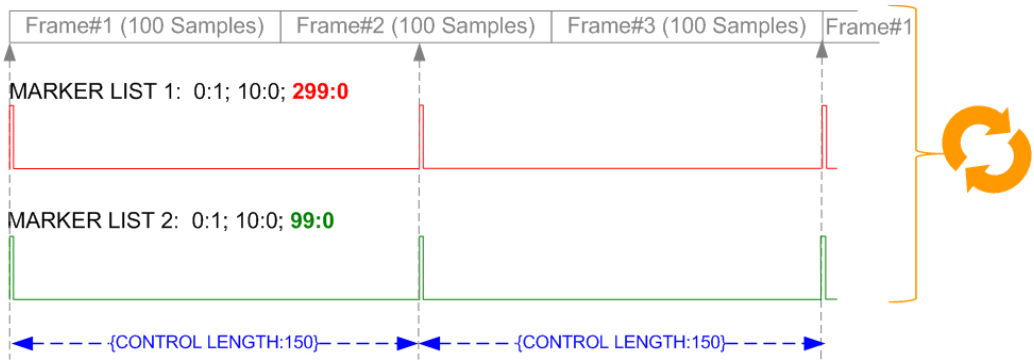


Figure 4-19: Example: Processing control signals with CONTROL LENGTH tag

The length of **all** control signals is determined by the `CONTROL LENGTH`. Observe how the marker traces are processed. In this example, both marker traces are repeated every 150 samples.

4.6.4.8 Creating control lists with tag file format

The R&S SMM100A provides the following ways to create a file containing control signals:

- To use the dedicated "Control Data Editor" and create a file in ASCII format and with an extension `*.dm_iqc`.
- To use the tag-oriented format and create a data list file, see "To create a data list with tag file format" on page 178.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 179.

To create a control list with tag file format

To create an ASCII control list file directly, use the provided tag commands.

1. Use a hex data editor.
2. Create the **mandatory** tags:
   - `TYPE`
   - `[TRACE] LIST`

   The `[TRACE] LIST` tag defines the individual markers or control traces in a combined `{Pos:State}` way within the control list period (`CONTROL LENGTH`).
3. Create the **recommended** tag `CONTROL LENGTH`.

   This tag defines the periodicity of the total control list.
4. Add required optional tags.
   Insert these tags after the `TYPE` tag in arbitrary order.

   For example, the control list file contains the following information:

```
{TYPE:SMU-CL}{COPYRIGHT:Rohde&Schwarz}
{DATE:2012-06-11;15:00:09}{HOP LIST:0:0;498:1;506:0}
{CW MODE LIST:0:0;380:1}{LEVATT LIST 3:0:0;464:1}
{BURST LIST:0:0;122:1;270:0;582:1;924:0}
{MARKER LIST 4:0:0;706:1;764:0}
{MARKER LIST 3:0:0;530:1;633:0}
{MARKER LIST 2:0:0;350:1;457:0}
{MARKER LIST 1:0:0;108:1;160:0}
{CONTROL LENGTH:1000}
```

   The Figure 4-12 shows the representation of the created control list in the "CList" data editor dialog.
   Compare the displayed ramp values of "Marker 1" and the "Total List Length" with the values in the corresponding tags.
   Note: In the provided example, the tags have been separated by line breaks for better reading.
   See also Example "To assign and activate control signals" on page 178.

To create a control list in binary format

Generation of a control list in binary format is not necessary but possible.

► Use the commands `BB:DM:CLISt:...` to generate a control list in binary format (see "Handling list files" on page 867 and the example in `[:SOURce<hw>]:BB:DM:CLISt:DATA` on page 871).

See also Example "To assign and activate control signals" on page 178.

Example: To assign and activate control signals

Note: Irrespectively on the way they are created, generated control lists are not automatically used.

We assume that a control list `clist.dm_iqc` containing information on marker 2, burst gate and level attenuation control signals is created and saved in the directory `/var/user/temp/`.

The following example shows how to enable the R&S SMM100A to:

- Use the control list for a particular marker output, for example "Custom Digital Mod" > "Marker 1".
- Use the Burst Gate and Level Attenuation control signals as defined in a control list.

```
MMEM:CDIRectory "/var/user/temp"
SOURce1:BB:DM:CLISt:CATalog?
// Response: clist
SOURce1:BB:DM:CLISt:SELect "clist"
SOURce1:BB:DM:TRIGger:OUTPut1:MODE CLISt
SOURce1:BB:DM:PRAMp:SOURce INTernal
```

4.6.4.9 Creating data lists with tag file format

The R&S SMM100A provides the following ways to create a data list file:

- To use the dedicated "Data List Editor" and create a file with extension `*.dm_iqd`, see "To create data lists manually" on page 138.
- To use the tag-oriented format and create a data list file, see "To create a data list with tag file format" on page 178.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 179.

To create a data list with tag file format

1. Use a hex data editor.
2. Create the mandatory tags: `{TYPE}`, `{DATA BITLENGTH}` and `{DATA LIST}`
3. Consider the tag syntax and rules.

   The following is an example of the data list file content. The tags are separated by line breaks for better reading. The text in brackets is short explanation.

For details, see the tag description:

- TYPE
- {DATA BITLENGTH}
- {DATA LIST-Length}

```
{TYPE:SMU-DL}{COPYRIGHT:Rohde&Schwarz}
{DATE:201-06-11;15:00:09}
{DATA BITLENGTH: 8}
{DATA LIST-2: #d0d1...d7}
```

(1 byte containing 8 data bits d0 to d7 in binary format, where d0 is the MSB)

See also:

- Figure 4-13 for representation of the created data list in the "Data List Editor".
- Example "To assign and activate a data list" on page 179

To create a data list in binary format

► Use the commands BB:DM:DLISt:....
See "Handling list files" on page 867.

```
MMEM:CDIRectory "/var/user"
// Create a new data list file.
SOURce1:BB:DM:DLISt:SELect "dl_new"
// Append data to the data list and query the content.
FORMat ASCii
SOURce1:BB:DM:DLISt:DATA:APPend 0,1,1,1,0,1,0,1
SOURce1:BB:DM:DLISt:DATA?
// Response: 0,1,1,1,0,1,0,1
```

See also Example "To assign and activate a data list" on page 179.

Example: To assign and activate a data list

We assume, that a created data list file dl.dm_iqd in the directory /var/user/. The following example shows how to use this data list as data source for the custom digital modulation.

```
MMEM:CDIRectory "/var/user"
SOURce1:BB:DM:DLISt:CATalog?
// Response: dl
SOURce1:BB:DM:DLISt:SELect "dl"
```

4.6.4.10 Editing waveform files, data and control lists

You can edit the internally and externally crated waveform files, data and control lists. The waveform, data and control lists files contain binary and ASCII data.

Consider the following rules while editing files with binary data.

Rules for editing binary data

- **Use hex data editor**
  Always use a hex data editor to edit files containing binary data.

Editing of binary data file with a text editor, even if you only change the ASCII part of the file, corrupts the file.

- **Adapt the length information in the `{EMPTYTAG}`**
  If you change the content of a waveform file, change also the `{EMPTYTAG-Length}` value.
  For example, change this value, if you add a tag or add bytes to an existing tag. Reduce the value by the number of newly introduced bytes.

4.6.5 Tags for waveforms, data and control lists

The instrument uses a simple tag-oriented format for externally or internally generated waveforms, data and control lists. Files with this format can be transmitted from an external computer to the instrument and vice versa.

The instrument transmits these files as a binary data block, using the following SCPI command:

- `[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA`
- `[:SOURce<hw>]:BB:DM:DLISt:DATA`
- `[:SOURce<hw>]:BB:DM:CLISt:DATA`

You can transmit files via the GPIB interface of the instrument.

Tag general format

Tags are self-contained information units, enclosed in braces { }. Their general format is `{Name: Data}` or `{Name-Length: Data}`. The colon separates the name part and the data part. The colon can be followed by a space for the sake of readability.

- The **`Name`** identifies the tag. It is always expressed in capital letters.
- The **`Data`** is tag-specific, and usually it is in ASCII plain text.
- The **`Length`** specifies the number of bytes in a `WAVEFORM` tag, `DATA LIST` tag, or `EMPTYTAG`
  Length is an ASCII integer value, defining the number of bytes from the colon `:` to the end brace `}`

Rules

Each waveform file must begin with the `TYPE` tag. The sequence of the remaining tags is arbitrary. For each tag, an indication shows whether it must be included in the file concerned (mandatory) or can be included (optional).

Unknown tags are not analyzed by the R&S SMM100A; they are left unchanged and saved without an error message for a possible further read back.

R&S SMU waveforms can also be loaded on the instrument, where they are converted internally into an R&S SMM100A waveform.

In all examples of file contents listed in this section, the tags have been separated by line breaks for better reading.

Tag description

This section describes the **mandatory `TYPE` tag** followed by a description of all other tags, grouped per file type and listed in an alphabetical order. Some tags are valid for all three file types. If a tag is valid only for a single file type, e.g. only for a waveform, this fact is indicated in the description.

Related step-by-step descriptions

See:

- Section 4.6.4.7, "Defining periodically repeating traces", on page 175
- Section 4.6.4.6, "Creating waveforms with tag file format", on page 171
- Section 4.6.4.8, "Creating control lists with tag file format", on page 177
- Section 4.6.4.9, "Creating data lists with tag file format", on page 178
- Section 4.6.4.10, "Editing waveform files, data and control lists", on page 179

Supported tags:

- Common tags....181
- Tags for waveforms....183
- Tags for multi-segment waveforms....189
- Tags for data lists....194
- Tags for control lists....195

4.6.5.1 Common tags

The following tags are common to all file types. For all tags, see "Supported tags:" on page 181.

Common tags

{TYPE: magic, xxxxxxxx}....181
{COMMENT: string}....182
{COPYRIGHT: string}....183
{DATE: yyyy-mm-dd;hh:mm:ss}....183

{TYPE: magic, xxxxxxxx}

(mandatory, must be the first tag in the file)

Identifies the file as a valid R&S SMM100A file. It must be present and must be the first in the waveform. If a file of the same name exists on the target medium, it is overwritten.

Setting parameters:

magic — Designates the file type and has the following values:

SMU-WV
A valid R&S SMM100A waveform.

SMU-MWV
A valid R&S SMM100A multi-segment waveform.

SMU-DL
A valid R&S SMM100A data list.

SMU-CL
A valid R&S SMM100A control list.

xxxxxxxx Is an ASCII-coded checksum of the data part of the `WAVEFORM` tag in the file. This value is always 0 for data lists and control lists.
The checksum for waveforms is used for detecting transmission errors. If the `TYPE` tag contains 0 or a non-numeric value for the checksum, it is ignored.
It is calculated in accordance with the algorithm given bellow, where:
`start` is a pointer to the first byte after the `#` character in the `WAVEFORM` tag
`length` is the number of bytes between `start` and the closing curly bracket (excluding the latter; `length`'must be divisible by 4 without a remainder.

```
UINT32 checksum(void *start, UINT32 length)
{
UINT32 i, result = 0xA50F74FF;
for(i=0; i < length/4; i++)
result = result ^ ((UINT32 *)start)[i];
return(result);
}
```

The checksum is currently not verified when waveforms are loaded.

Example:
```
{TYPE: SMU-WV,106656}
BB:ARB:WAV:TAG? 'TYPE'
```
Queries the content of the `TYPE` tag.
```
Response: 'SMU-WV,106656'
```
This is a valid waveform.

{COMMENT: string}

The tag contains a plain text ASCII string of arbitrary length. The string is not analyzed in the R&S SMM100A. It is used to describe the file. The string is allowed to contain all printable ASCII characters except the closing curly bracket.

Example:
```
{COMMENT: File with data for 3GPP enhanced
channels}
BB:ARB:WAV:TAG? 'COMMENT'
```
Queries the content of the `COMMENT` tag of the selected waveform file.
```
Response: 'File with data for 3GPP enhanced
channels'
```
The comment on the waveform reads "File with data for 3GPP enhanced channels".

Usage: Setting only

{COPYRIGHT: string}

The tag contains an ASCII string of arbitrary length. The string is not analyzed in the R&S SMM100A. It is used to save copyright information about the file content.

Example: `{COPYRIGHT: Rohde&Schwarz}`
`BB:ARB:WAV:TAG? 'COPYRIGHT'`
Queries the content of the `COPYRIGHT` tag of the selected waveform file.
`Response: 'Rohde&Schwarz'`
Copyright resides with Rohde & Schwarz.

Usage: Setting only

{DATE: yyyy-mm-dd;hh:mm:ss}

(optional)

The tag contains the date and time at which the file was created. Enter the year as four digits. The instrument does not analyze this tag.

Example: `{DATE: 2009-04-02;14:32:12}`
`BB:ARB:WAV:TAG? 'DATE'`
Queries the content of the `DATE` tag of the selected waveform file.
`Response: '2009-04-02;14:32:12'`
The waveform was created on April 2, 2009 at 14 hrs 32 min.

Usage: Setting only

4.6.5.2 Tags for waveforms

The following tags apply to waveforms exclusively. For all tags, see "Supported tags:" on page 181.

Waveform tags

{CLOCK: frequency}....184
{CONTROL LENGTH: ControlLength}....184
{EMPTYTAG-Length: #EmptySequence}....185
{LEVEL OFFS: RMSOffset_dB,PeakOffset_dB}....186
{MARKER MODE [#]: GENERATOR}....186
{SAMPLES: Samples}....187
{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....187
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....187
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....187
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....187
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....187
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....187
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}....187
{WAVEFORM-Length: #I0Q0I1Q1...IxQx...IN-1QN-1…}....189

{CLOCK: frequency}

(mandatory for waveforms)

The tag specifies the clock frequency at which the waveform has to be output, in Hz (on multi-segment waveforms this tag contains the maximal clock of all segments).

A query of `ARB:CLOCk?` after loading the waveform returns the value set using the `CLOCK` tag. This value can later be altered with the command `ARB:CLOCk?`.

Example:
```
{CLOCK: 54000000}
BB:ARB:WAV:TAG? 'CLOCK'
```
Queries the content of the `CLOCK` tag.
```
Response: 54000000
```
The clock frequency is set to 54 MHz.

Usage: Setting only

{CONTROL LENGTH: ControlLength}

(optional / recommended for marker and control lists)

The tag specifies the length of *all* control or marker list in ASCII format.

The control length influences the way the marker and control lists are processed, in particular the way traces are repeated; see Figure 4-20.

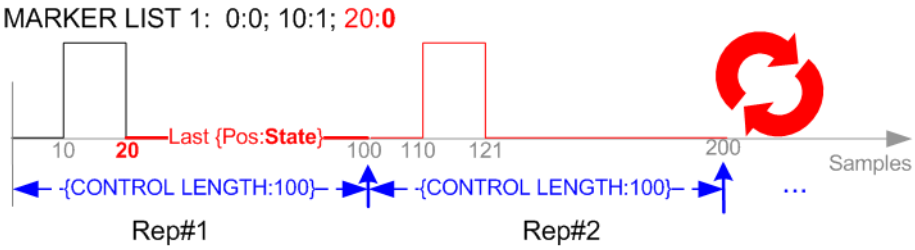


Figure 4-20: Example: Processing of MARKER TRACE if CONTROL LENGHT is specified

If the `CONTROL LENGTH` tag is not used, the marker and control list length are determined by the last position, that is the last {**Pos**:State} couple, defined in the particular `[TRACE] LIST` tag; see Figure 4-21.

Figure 4-21: Example: Processing of MARKER TRACE if CONTROL LENGHT is not used

To maintain marker signals and waveform data synchronized, set the `CONTROL LENGTH` to be equal to the number of samples specified with the tag `SAMPLES`.

See also Section 4.6.4.7, "Defining periodically repeating traces", on page 175.

Example:
```
{CONTROL LENGTH: 500}
SOURce:BB:ARBitary:CLISt:TAG? 'CONTROL LENGTH'
```
Queries the length of the control list.
```
Response: 500
```

Manual operation: See "Total List Length" on page 134

{EMPTYTAG-Length: #EmptySequence}

(mandatory in automatically generated one and multi-segment waveforms)

This tag is empty, i.e. contains no data, and is used as placeholder.

Setting parameters:

Length — 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 brace `}`
Note: If you change the content of a waveform file, change also the `{EMPTYTAG-Length}` value. For example, if you add a tag or add bytes to a tag, reduce the length by the number of newly introduced bytes.

EmptySequence — An empty sequence containing blanks only. The number of used blanks is calculated as the difference between the hex addresses of the `{WAVEFORM}` tag and the hash sign `#` in the `{EMPTYTAG}`.
The `{WAVEFORM}` tag always starts at hex address #4000.

Example:
```
{TYPE:SMU-WV, 837236424}
{COPYRIGHT:2003 Rohde&Schwarz SMU}
{DATE:2012-07-11;14:38:01}
{SAMPLES:80000}
{CLOCK:8666666.666666666}
{VECTOR MAX:1.000000038569158}
{LEVEL OFFS:3.333553817875577e-07,0}
{MARKER LIST 1:0:1;1:0;1249:0}
{MARKER LIST 2:0:1;1:0;1249:0}
{MARKER LIST 3:0:1;1:0;1249:0}
{MARKER LIST 4:0:1;1:0;1249:0}
{EMPTYTAG-15947:# ...}
{WAVEFORM-320017:#IQIQIQ...}
```

The example waveform file contains 436 (0x1b4) bytes before the `#` sign in the `EMPTYTAG`; the hex address of the `#` sign is *0x1b5*. The `{WAVEFORM}` starts at *0x4000*. The `EMPTYTAG` contains *15946* blanks and has a length of (15946+1) bytes.

Usage: Setting only

{LEVEL OFFS: RMSOffset_dB,PeakOffset_dB}

(recommended for waveforms)

The tag determines the level of the ARB signal in the waveform file. The offset levels define the offset of RMS and peak value relative to the 16-bit full scale modulation (-32767 to + 32767) = 0 dB.

Setting parameters:

RMSOffset_dB — Defines the RMS level offset of the signal relative to full scale ARB signal in the `WAVEFORM` tag. The offset is defined in ASCII float format. The value is always positive.
A 3 dB value indicates that the RMS level of the signal is 3 dBs below the full scale.
full scale = max. amplitude of vector of I/Q samples = $|S_{IQ}|max$ = $sqrt(I^2+Q^2)max$ = 0 dB

PeakOffset_dB — Defines the peak level offset of the signal relative to full scale for the ARB signal in the `WAVEFORM` tag. The offset is defined in ASCII float format.
The value usually equals 0 dB as usually the I/Q samples (signed 16-bit integer values) are modulated to full scale: Full scale = 0 dB = max. amplitude of vector of I/Q samples = $|S_{IQ}|$ max = $sqrt(I^2+Q^2)max$ = $(2^{15})-1$ = 32767.
A positive `PeakOffset_dB` value indicates that a headroom to full scale is provided when generating the waveform. A negative PeakOffset_dB value indicates that overrange is likely for some samples, i.e. clipping might occur.
The crest factor can be calculated from the two values as follows:
`Crest Factor = |PeakOffset_dB - RMSOffset_dB|`

Example:

```
{LEVEL OFFS: 3.45,2}
BB:ARB:WAV:TAG? 'LEVEL OFFS'
```

Queries the content of the `LEVEL OFFS` tag of the selected waveform file.

```
Response: 3.45,2
```

The level of the waveform is below full scale, clipping does not occur.

Usage: Setting only

{MARKER MODE [#]: GENERATOR}

(Optional for waveforms)

The tag defines how the marker signals are generated. The tag is included in the waveforms, created by the R&S WinIQSIM2 software.

- Tag not used

The marker signals defined with the tag MARKER LIST are converted into a separate binary control list. When the waveform is loaded into the ARB, this control list is also loaded automatically and processed synchronous with the waveform.
Note: This method reduces the maximum waveform length (given as number of samples). The number of available samples is limited, because each marker requires 4 bits per I/Q sample, additionally to the 32 bits required to describe an I/Q sample.

- Tag is used
  The marker signals defined with the tag MARKER LIST are processed internally; additional control list is not created. If the tag is used for **all 3 markers**, the whole ARB memory is available for the I/Q samples.
  Note: If this tag is used, the maximum number of marker states defined with the tag MARKER LIST is 64, i.e. Pos_{63}:$State_{63}$

Setting parameters:

[#] 1 to 3
Sets the marker number.

Example:
```
{MARKER MODE 1: GENERATOR}
{MARKER MODE 2: GENERATOR}
{MARKER MODE 3: GENERATOR}
```

Usage: Setting only

{SAMPLES: Samples}

(recommended for waveforms)

The tag contains the number of I/Q samples in the waveform in ASCII format.

On multi-segment waveforms, this tag contains the total I/Q samples of all segments.

Example:
```
{SAMPLES: 1000}
BB:ARB:WAV:TAG? 'SAMPLES'
```
Queries the content of the SAMPLES tag of the selected waveform file.
```
Response: 1000
```
The waveform contains 1000 I/Q samples.

Usage: Setting only

See also Section 4.6.4.7, "Defining periodically repeating traces", on page 175.

{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}

(mandatory for control lists / optional for waveforms)

The tag contains the data for the marker and control signals in the control list or the marker signals of ARB waveforms.

Depending on the control length, the instrument processes traces differently, see `{CONTROL LENGTH: ControlLength}` on page 184.

How to: Section 4.6.4.7, "Defining periodically repeating traces", on page 175

Also, the processing of the marker traces (`MARKER LIST`) depends on the presence of the marker mode tag. See `{MARKER MODE [#]: GENERATOR}` on page 186.

Setting parameters:

[TRACE] MARKER | BURST | LEVATT | CW MODE | HOP | MAP

Name of the marker or control signal.
For ARB waveforms, it is only meaningful to define marker signals; in the ARB multi-segment waveforms these tags are ignored.

[#] 1 to 3

Sets the marker or control trace number; supported is only `LEVATT LIST 1`.

Pos Specifies in ASCII format the position (i.e. sample number or data value), with the effect from which the binary `State` of the marker or of the control signal changes.
If you use the marker mode tag, the maximum number of marker states is 64, i.e. Pos_{63}:$State_{63}$. See `{MARKER MODE [#]: GENERATOR}` on page 186.

State 0 | 1

Specifies the binary state of the marker or of the control signal from Pos_N to Pos_{N+1} exclusive in ASCII format.

Example:

```
{MARKER LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'MARKER LIST 1'
```

Queries the content of the `MARKER LIST 1` tag of the selected control list file.

```
Response: '0:0;10:1;20:0;30:1'
```

The marker setting for samples 0 to 9 = 0 (low), for 10 to 19 = 1 (high) and for 20 to 29 = 0. From sample 30 onward, the marker setting is 1 (high).

Example:

```
{LEVATT LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'LEVATT LIST 1'
```

Queries the content of the `LEVATT LIST 1` tag of the selected control list file.

```
Response: '0:0;10:1;20:0;30:1'
```

Level attenuation applies to data values 10 to 19 (high) and from data value 30 onward.

Usage: Setting only

Manual operation: See "Select Ramp to Edit" on page 134

{WAVEFORM-Length: #l0Q0l1Q1...lxQx...lN-1QN-1…}

(mandatory for waveforms)

Setting parameters:

Length — Sets 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 `#`)

IxQx — `IxQx…` represents binary data (16-bit signed integer in 2's complement notation) containing the I and Q component alternately and starting with the I component. Each component consists of 2 bytes in little endian format representation, i.e the 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). This value is transferred to the D/A converter.
This tag is also used to store multi-segment waveforms. The I/Q streams of the individual waveforms are directly concatenated to one collective waveform I/Q stream.
The number of segments and the start offset and length of the individual segments inside the total waveform I/Q stream is determined by the additional tags `MWV_SEGMENT_COUNT`, `MWV_SEGMENT_START`, and `MWV_SEGMENT_LENGTH`.
Further `MWV_SEGMENT_...` tags are also available, for example for level and clock information.

Example: **One segment waveform**
{WAVEFORM-401:#I_0,Q_0,I_1,Q_1,I_2,Q_2,...I_{99}, Q_{99}}
100 I/Q pairs with 4 bytes each are transmitted - none multi-segment.

Example: **Multi-segment waveform**
{WAVEFORM-1201:
#$I_{0,Seg0}$,$Q_{0,Seg0}$,$I_{1,Seg0}$,$Q_{1,Seg0}$,...$I_{99,Seg0}$,$Q_{99,Seg0}$,$I_{0,Seg1}$,$Q_{0,Seg1}$,$I_{1,Seg1}$, $Q_{1,Seg1}$,… $I_{199,Seg1}$,$Q_{199,Seg1}$}
2 segments: segment 0 with 100 I/Q pairs; segment 1 with 200 I/Q pairs. Each I/Q pair consists of 2*16 bites = 4 bytes.
The data is transmitted using the SCPI command `[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA`.

Usage: Setting only

4.6.5.3 Tags for multi-segment waveforms

The following tags apply to multi-segment waveforms exclusively. For all tags, see "Supported tags:" on page 181.

Multi-segment waveform tags

{MWV_SEGMENT_COUNT: NumOfSeg}....190
{MWV_SEGMENT_DURATION: SegDur0, SegDur1, …, SegDurN-1}....190
{MWV_SEGMENT_LENGTH: SamplesSeg0, SamplesSeg1, …, SamplesSegN-1}....190
{MWV_SEGMENT_START:
SampleStartOffsetSeg0, SampleStartOffsetSeg1, …, SampleStartOffsetSegN-1}....191
{MWV_SEGMENT_CLOCK_MODE: Mode}....191
{MWV_SEGMENT_CLOCK: ClockSeg0, ClockSeg1, …, ClockSegN-1}....191
{MWV_SEGMENT_LEVEL_MODE: Mode}....192
{MWV_SEGMENT_LEVEL_OFFS:
RMSOffs_dBSg0,PeakOffs_dBSg0, …, RMSOffs_dBSgN-1, PeakOffs_dBSgN-1}....192
{MWV_SEGMENT_SETTINGS_FILE: SegSettingFilePath}....193
{MWV_SEGMENT_FILES:
“FileNameSeg0.wv”, “FileNameSeg1.wv”, …, “FileNameSegN-1.wv”}....193
{MWV_SEGMENTx_COMMENT: text}....193
{CONTROL LIST WIDTH4–Length: #m0m1…mx…mM-1}....193

{MWV_SEGMENT_COUNT: NumOfSeg}

(mandatory for multi-segment waveforms)

The tag contains the number of segments in the multi-segment waveform in ASCII integer format.

Example: `{MWV_SEGMENT_COUNT: 2}`
Multi-segment waveform with 2 segments

Usage: Setting only

{MWV_SEGMENT_DURATION: SegDur0, SegDur1, …, SegDurN-1}

(optional for multi-segment waveforms)

The tag gives the time duration (in seconds) per segment.

Example: `{MWV_SEGMENT_DURATION: 1,0.5}`
Multi-segment waveform with 2 segments, lasting 1 s and 0.5 s each.

Usage: Setting only

{MWV_SEGMENT_LENGTH: SamplesSeg0, SamplesSeg1, …, SamplesSegN-1}

(mandatory for multi-segment waveforms)

The tag contains a list of I/Q sample lengths for every segment in the multi-segment waveform in ASCII integer format.

Example: `{MWV_SEGMENT_LENGTH: 100,200}`
2 segments: 100 samples in segment 0 and 200 samples in segment 1.

Usage: Setting only

**{MWV_SEGMENT_START:
SampleStartOffsetSeg0, SampleStartOffsetSeg1, …, SampleStartOffsetSegN-1}**

(mandatory for multi-segment waveforms)

The tag contains a list of I/Q sample start offsets for every segment in the multi-segment waveform in ASCII integer format.

Example: `{MWV_SEGMENT_START: 0,100}`
2 segments with 100 samples in segment 0 and 200 samples in segment 1.
The start offset of first segment is 0 samples, start offset of next segment 1 is the sample length of segment 0 = 100 samples.

Usage: Setting only

{MWV_SEGMENT_CLOCK_MODE: Mode}

(mandatory for multi-segment waveforms)

The tag contains a string in ASCII format which supplies the clock rate mode. The calculation of the multi-segment output waveform uses this clock rate mode. See also "Clock" on page 217.

The tag `CLOCK` contains always the highest clock rate of all segments. The tag `MWV_SEGMENT_CLOCK` contains the clock rates of the individual segments.

Setting parameters:

Mode

UNCHANGED
The segments can have different clock rates; each segment is output with the clock rate defined in its waveform file.

HIGHEST
All segments are output at the highest available clock rate.

USER
All segments are output at the clock rate defined by the user.
Note: Only upsampling is allowed, no downsampling.

Example: `{MWV_SEGMENT_CLOCK_MODE: UNCHANGED}`

Usage: Setting only

{MWV_SEGMENT_CLOCK: ClockSeg0, ClockSeg1, …, ClockSegN-1}

(mandatory for multi-segment waveforms)

The tag contains a list of clock frequencies for every segment in the multi-segment waveform in ASCII floating point format.

Example: `{MWV_SEGMENT_CLOCK: 100e6,80e6}`
2 segments: clock of segment 0 is 100 MHz, the clock of segment 1 is 80 MHz.
Note: If the segments have different clock frequencies, there are some restrictions on signal output, i.e. seamless switching between segments is only possible, if all segments have the same clock frequency. Software resampling (upsampling) can be used to bring all segments to the same clock.

Usage: Setting only

{MWV_SEGMENT_LEVEL_MODE: Mode}

(optional for multi-segment waveforms)

The tag contains a string in ASCII format which supplies the clock rate mode, that was used for calculation of the multi-segment output waveform.

Setting parameters:

Mode

UNCHANGED
Concerning the level settings, the segments are output exactly as defined in the individual files.
The value displayed with the parameter "Task bar > Level" applies only to the segment with the highest RMS value. The remaining segments are output at a lower level than the displayed value.

EQUALRMS
Segments are output so that all segments have the same RMS value. The value displayed with the parameter "Task bar > Level" applies to all segments.

Example: `{MWV_SEGMENT_LEVEL_MODE: UNCHANGED}`

Usage: Setting only

{MWV_SEGMENT_LEVEL_OFFS:
RMSOffs_dBSg0,PeakOffs_dBSg0, …, RMSOffs_dBSgN-1, PeakOffs_dBSgN-1}

(mandatory for multi-segment waveforms)

The tag contains a list of level pairs in ASCII floating point format, one pair for every segment in the multi-segment waveform. The first value of a level pair defines the rms offset and the second value the peak offset relative to the 16-bit full-scale modulation (-32767; + 32767) = 0 dB. The meaning of one level value pair is the same as in the `LEVEL OFFS` tag for normal waveforms.

Example: `{MWV_SEGMENT_LEVEL_OFFS: 3.0,0.0,6.0,0.0}`
2 segments: The RMS level of segment 0 is 3 dB below full scale; RMS level of segment 1 is 6dB below full scale.
The peak level of both segments is 0 dB full scale.

Usage: Setting only

{MWV_SEGMENT_SETTINGS_FILE: SegSettingFilePath}

(optional for multi-segment waveforms)

The tag contains the file path and filename of the multi-segment file, used for the calculation of the multi-segment waveform.

Example: `{MWV_SEGMENT_SETTINGS_FILE: "/var/user/Settings.inf_mswv"}`
Multi-segment file path and filename.

Usage: Setting only

{MWV_SEGMENT_FILES: "FileNameSeg0.wv", "FileNameSeg1.wv", …, "FileNameSegN-1.wv"}

(optional for multi-segment waveforms)

The tag contains a list of filenames for every segment in the multi-segment waveform in ASCII format.

Example: `{MWV_SEGMENT_FILES: "/var/user/temp/sine.wv", "/var/user/temp/rect.wv"}`

Usage: Setting only

{MWV_SEGMENTx_COMMENT: text}

(optional for multi-segment waveforms)

The tag contains a user comment for a specific segment `x = [0…NumOfSeg-1]` in the multi-segment waveform in ASCII format.

Example: `{MWV_SEGMENT1_FILES: segment 1 contains a QPSK signal.}`

Usage: Setting only

{CONTROL LIST WIDTH4–Length: #m0m1…mx…mM-1}

(optional for waveforms and multi-segment waveforms)

The tag contains a binary marker element stream, which is output synchronously to the I/Q sample sequence. One marker element `mx` consists of 4 bites, which are assigned to the 3 possible marker traces of the instrument (1 bit per marker trace). One 4-bit marker element is required for every I/Q sample in the `WAVEFORM` tag. Hence, the number of marker elements `m` is equal to the number of I/Q samples. The `CONTROL LENGTH` tag has to contain the number of all marker elements `m`.

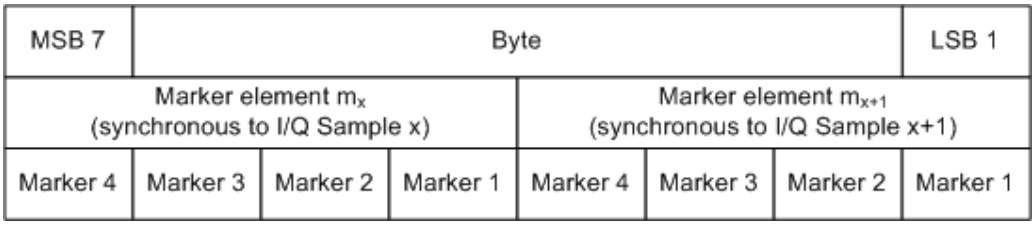


Figure 4-22: Marker element in 4-bit binary format bit order

For standard waveforms, the `MARKER LIST x` tags are a more compact way to define markers. In principle, however, the `CONTROL LIST WIDTH4` format can also be used instead of the `MARKER LIST x` tags.

For multi-segment waveforms, the `CONTROL LIST WIDTH4` format is required for marker definition. The binary marker streams of the individual segments are directly concatenated (without any gap) to one collective marker stream.

Setting parameters:

Length — Sets the number of bytes in the `CONTROL LIST WIDTH4` tag in ASCII Format and is calculated as follows:
*Length = size of "#" (1 byte) + number of marker elements m_x * (4 bit) / (8 bits/byte)*
The value is rounded up for byte alignment.

mx — Marker element in 4-bit binary format.

Example: {CONTROL LIST WIDTH4-51: #$m_0m_1…m_x…m_{99}$}
100 marker elements, each marker element with 4 bits

Usage: Setting only

4.6.5.4 Tags for data lists

The following tags apply to data lists exclusively. For all tags, see "Supported tags:" on page 181.

{DATA BITLENGTH: BitLength}..... 194
{DATA LIST-Length: #d0d1...dx...dN-1…}..... 195

{DATA BITLENGTH: BitLength}

(mandatory for data lists)

The tag defines the length of the data field in the `DATA LIST` tag in bits in ASCII format.

Example:
```
{DATA BITLENGTH: 444}
BB:DM:DLIS:SEL "/var/user/dl"
BB:DM:DLIS:TAG? "dl","DATA BITLENGTH"
```
Queries the content of the `DATA BITLENGTH` tag of the selected data list file.
```
Response: '444'
```
The data list is 444 bits long.

Usage: Setting only

{DATA LIST-Length: #d0d1...dx...dN-1…}

(mandatory for data lists)

The tag contains the actual bit sequence of the data list in binary format.

Setting parameters:

Length — Defines the number of bytes in the `DATA LIST` tag in ASCII Format (see `{WAVEFORM-Length: #I0Q0I1Q1...IxQx...IN-1QN-1…}` for details).

dx — Data bits in binary format (8-bit unsigned characters, MSB first).

Example: `{DATA LIST-17: #d0d1...dx...d127}`
16 bytes containing 128 data bits, first bit is the MS bit of the first byte.

Usage: Setting only

4.6.5.5 Tags for control lists

The following tags apply to control lists exclusively. For all tags, see "Supported tags:" on page 181.

{CONTROL LENGTH: ControlLength}..... 195
{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}..... 196
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}..... 196
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}..... 196
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}..... 196
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}..... 196
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}..... 196
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}..... 196

{CONTROL LENGTH: ControlLength}

(optional / recommended for marker and control lists)

The tag specifies the length of *all* control or marker list in ASCII format.

The control length influences the way the marker and control lists are processed, in particular the way traces are repeated; see Figure 4-20.

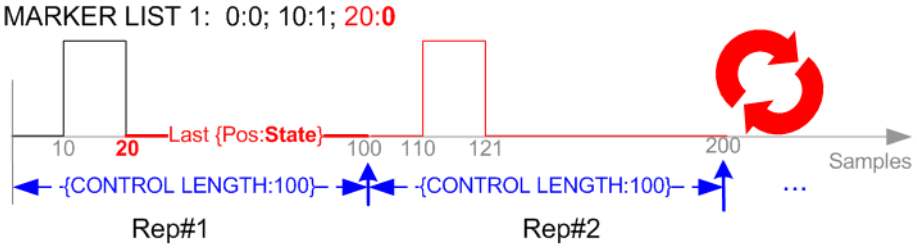


Figure 4-23: Example: Processing of MARKER TRACE if CONTROL LENGHT is specified

If the CONTROL LENGTH tag is not used, the marker and control list length are determined by the last position, that is the last {**Pos**:State} couple, defined in the particular [TRACE] LIST tag; see Figure 4-21.

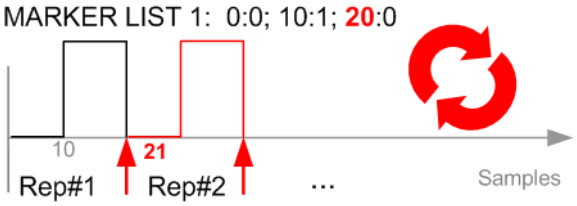


Figure 4-24: Example: Processing of MARKER TRACE if CONTROL LENGHT is not used

To maintain marker signals and waveform data synchronized, set the CONTROL LENGTH to be equal to the number of samples specified with the tag SAMPLES.

See also Section 4.6.4.7, "Defining periodically repeating traces", on page 175.

Example:
```
{CONTROL LENGTH: 500}
SOURce:BB:ARBitary:CLISt:TAG? 'CONTROL LENGTH'
```
Queries the length of the control list.
```
Response: 500
```

Manual operation: See "Total List Length" on page 134

{BURST LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{CW MODE LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{HOP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{LEVATT LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{MAP LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{MARKER LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}

(mandatory for control lists / optional for waveforms)

The tag contains the data for the marker and control signals in the control list or the marker signals of ARB waveforms.

Depending on the control length, the instrument processes traces differently, see {CONTROL LENGTH: ControlLength} on page 184.

How to: Section 4.6.4.7, "Defining periodically repeating traces", on page 175

Also, the processing of the marker traces (MARKER LIST) depends on the presence of the marker mode tag. See {MARKER MODE [#]: GENERATOR} on page 186.

Setting parameters:

[TRACE] MARKER | BURST | LEVATT | CW MODE | HOP | MAP

Name of the marker or control signal.
For ARB waveforms, it is only meaningful to define marker signals; in the ARB multi-segment waveforms these tags are ignored.

[#] 1 to 3

Sets the marker or control trace number; supported is only `LEVATT LIST 1`.

Pos Specifies in ASCII format the position (i.e. sample number or data value), with the effect from which the binary `State` of the marker or of the control signal changes.
If you use the marker mode tag, the maximum number of marker states is 64, i.e. Pos_{63}:$State_{63}$. See `{MARKER MODE [#]: GENERATOR}` on page 186.

State 0 | 1

Specifies the binary state of the marker or of the control signal from Pos_N to Pos_{N+1} exclusive in ASCII format.

Example:
```
{MARKER LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'MARKER LIST 1'
```
Queries the content of the `MARKER LIST 1` tag of the selected control list file.
```
Response: '0:0;10:1;20:0;30:1'
```
The marker setting for samples 0 to 9 = 0 (low), for 10 to 19 = 1 (high) and for 20 to 29 = 0. From sample 30 onward, the marker setting is 1 (high).

Example:
```
{LEVATT LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'LEVATT LIST 1'
```
Queries the content of the `LEVATT LIST 1` tag of the selected control list file.
```
Response: '0:0;10:1;20:0;30:1'
```
Level attenuation applies to data values 10 to 19 (high) and from data value 30 onward.

Usage: Setting only

Manual operation: See "Select Ramp to Edit" on page 134

4.7 Generating notched signals

If your instrument is equipped with the R&S SMM-K811, you can apply notched filter.

In the following, the notched filter settings are described based on the ARB functionality. The described settings also apply for:

- EUTRA/LTE
- OFDM Signal Generation

4.7.1 Required options

The basic equipment layout for the generation of notched signals includes the following options:

- Baseband Generator (R&S SMM-B9)
- Option Notched Signals (R&S SMM-K811)
  Sufficient for the generation of notched signals with the ARB

  For the generation of notched signals with one of the digital standards, also the corresponding option:
  - Option EUTRA/LTE (R&S SMM-K55)
  - Option OFDM Signal Generation (R&S SMM-K114)
- Frequency option (e.g. R&S SMM-B1006)

For more information, refer to the specifications document.

4.7.2 About the notch filters

The noise power ratio (NPR) measurement is a method for evaluating the linearity of wideband-amplifiers. The NPR measurement use notched filters that are applied on internally or externally created waveforms.

The R&S SMM100A equipped with the R&S SMM-K811 option allows you to define up to 25 notches. You can define the frequency offset and bandwidth of each notch individually. You can use frequency values with fixed resolution, where the resolution step depends on the used Clock Frequency.

The notched filters settings are available for the ARB generator and four digital standards. The provided settings are identical, merely the access to the settings and the remote control commands are different.

This section describes the notched filter settings based on the ARB functionality. The described settings, however, also apply for:

- EUTRA/LTE
- OFDM Signal Generation

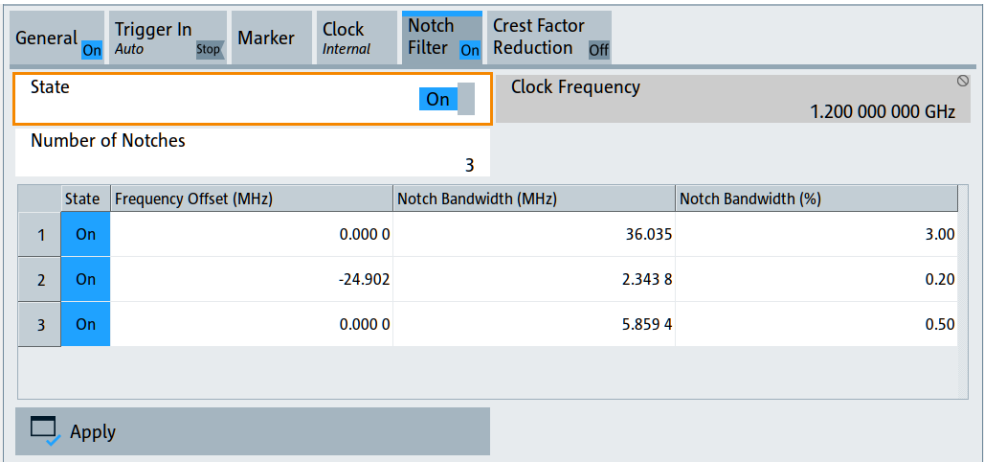
4.7.3 Notch filter settings

Access:

1. Select "Baseband" > "ARB" > "Notch Filter".
2. If needed, change the displayed clock frequency via "ARB" > "General" > "Clock Frequency".

   For example, if you need higher frequency offsets and notch bandwidth. At higher clock frequencies on the order of MHz, also the notch bandwidth and frequency offset change its resolution from kHz to MHz.

3. Set the number of notches, for example, "Number of Notches" = "3".
4. Define notch settings, for example, for the first notch:
   a) For notch#1, set "Frequency Offset" = "0 MHz" and "Notch Bandwidth" = "0.6 MHz".
   b) For notch#1, set "State" = "On".
5. Select "Notch Filter" > "Apply" to trigger the instrument to adopt the notch filter settings.
6. Select "ARB" > "General" > "State" > "On".



The dialog provides the settings to enable and configure the notch filters. It also displays the clock frequency for the waveform.

The remote commands required to define these settings are described in "Notch filter commands" on page 912.

The notched filters settings are available for the ARB and four digital standards. The provided settings are identical, merely the access to the settings and the remote control commands are different.

This section describes the notched filter settings based on the ARB functionality. The described settings, however, also apply for:

- EUTRA/LTE
- OFDM Signal Generation

Settings:

State....200
Clock Frequency....200
Number of Notches....200
Notch table....200
└ State....200
└ Frequency Offset (kHz)/Frequency Offset (MHz)....201

└ Notch Bandwidth (kHz)/Notch Bandwidth (MHz)..... 201
└ Notch Bandwidth (%)..... 201
Apply..... 201

State
If enabled, the defined notch filter is applied to the baseband signal.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:NOTCh on page 912
etc. for the corresponding option:
[:SOURce<hw>]:BB:EUTRa:NOTCh on page 912
[:SOURce<hw>]:BB:OFDM:NOTCh on page 912

Clock Frequency
Indicates the current clock frequency of the waveform signal.

The value equals the clock frequency of the ARB application: "ARB" > "General" > "Clock Frequency".

Notch Bandwidth (%) is related to this value.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:NOTCh:CLOCk? on page 912
etc. for the corresponding option:
[:SOURce<hw>]:BB:EUTRa:NOTCh:CLOCk? on page 912
[:SOURce<hw>]:BB:OFDM:NOTCh:CLOCk? on page 912

Number of Notches
Sets the number of notches.

Set individual notches in the notch table. The number of rows equals the set number of notches. One row provides individual settings to configure one notch.

At higher clock frequencies on the order of MHz, also the notch bandwidth and frequency offset change its resolution from kHz to MHz.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:NOTCh:COUNt on page 913
etc. for the corresponding option:
[:SOURce<hw>]:BB:EUTRa:NOTCh:COUNt on page 913
[:SOURce<hw>]:BB:OFDM:NOTCh:COUNt on page 913

Notch table
The notch table provides the settings to configure individual notch filters.

The notch filter is defined as a sequence of notches. It is described in a table form, where each table line corresponds to one notch and the number of lines is set with the parameter Number of Notches.

State ← Notch table
Enables a single notch in the notch table.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:STATe on page 913
etc. for the corresponding option:

[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:STATe on page 913
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:STATe on page 913

Frequency Offset (kHz)/Frequency Offset (MHz) ← Notch table
Sets the center frequency of the notch f_{offset}, where:

–Clock Frequency/2 < f_{offset} < + Clock Frequency/2

At higher clock frequencies on the order of MHz, also the notch bandwidth and frequency offset change its resolution from kHz to MHz.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:FREQuency:OFFSet on page 913
etc. for the corresponding option:
[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:FREQuency:OFFSet on page 913
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:FREQuency:OFFSet on page 913

Notch Bandwidth (kHz)/Notch Bandwidth (MHz) ← Notch table
Sets the absolute notch bandwidth.

The selected value is adjusted to the internal frequency grid.

The maximum notch bandwidth is calculated as Clock Frequency/10.

At higher clock frequencies on the order of MHz, also the notch bandwidth and frequency offset change its resolution from kHz to MHz.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:BWIDth[:ABSolute] on page 914
etc. for the corresponding option:
[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:BWIDth[:ABSolute] on page 914
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:BWIDth[:ABSolute] on page 914

Notch Bandwidth (%) ← Notch table
Sets the notch bandwidth relative to Clock Frequency.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:BWIDth:RELative on page 914
etc. for the corresponding option:
[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:BWIDth:RELative on page 914
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:BWIDth:RELative on page 914

Apply
Select "Apply" to adopt the configured settings.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:NOTCh:APPLy on page 914
etc. for the corresponding option:
[:SOURce<hw>]:BB:EUTRa:NOTCh:APPLy on page 914
[:SOURce<hw>]:BB:OFDM:NOTCh:APPLy on page 914

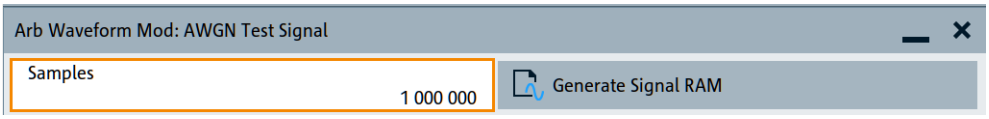
4.7.4 AWGN test signal settings

Option: R&S SMM-K811.

See also Section 4.7.1, "Required options", on page 198.

Access:

1. Select "Baseband" > "ARB".
2. Select "General" > "Test Signal Form" > "AWGN".
3. Select "Create Test Signal".



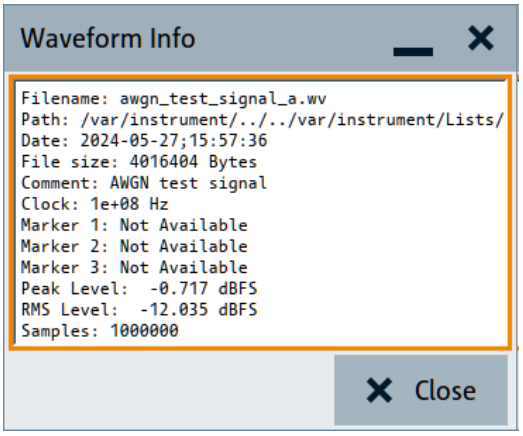
The dialog provides settings to generate an AWGN test signal waveform with a fixed number of samples.

The remote commands required to define these settings are described in Section 13.17.5.3, "SOURce:BB:ARBitrary subsystem", on page 873.

To generate an AWGN test signal

1. Open the AWGN test signal settings.
   See Section 4.7.4, "AWGN test signal settings", on page 201.
2. Set the number of samples that your AWGN test signal requires.
3. Select "Generate Signal RAM".

   Selecting triggers a creation of the waveform file with the set number of samples. The filename is `awgn_test_signal_a` and the file extension is `*.wv`. Also, loads this file to the "Load Waveform ..." selection in the ARB general settings tab.
4. Close the dialog.
5. To monitor waveform properties, select "Waveform Info".

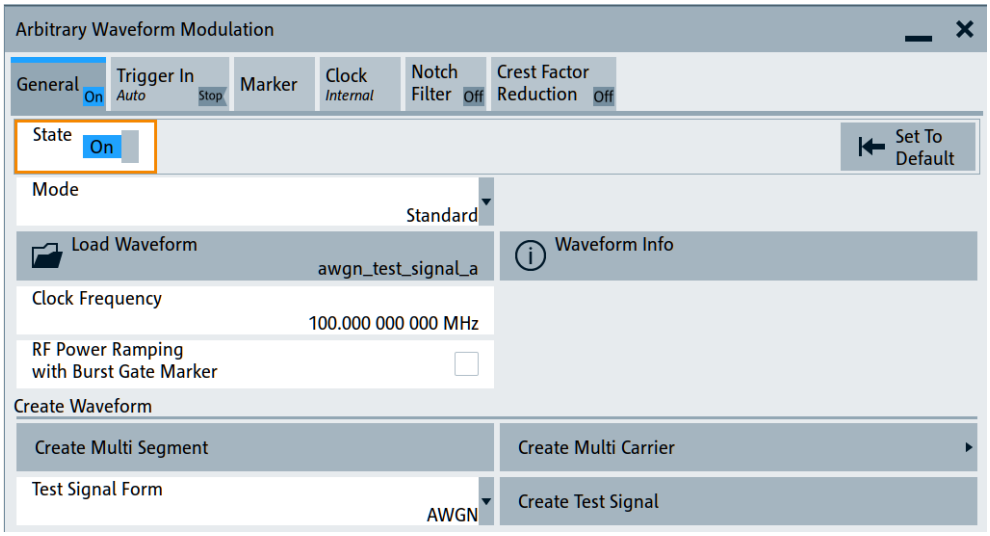


The clock frequency f_{clock} is 100 MHz per default. You can change it, see the next step.

6. Optionally, adjust the clock frequency f_{clock}. The bandwidth of the resulting noise signal is approximately 0.96 * f_{clock}.

   Example: A clock frequency f_{clock} of 100 MHz results in a noise signal bandwidth of about 0.96 * f_{clock} = 96 MHz.

7. Select "ARB > State > On" and "RF > On".



   The R&S SMM100A processes the waveform file and generates an AWGN signal.

Settings:

Samples 203
Generate Signal RAM 203

Samples
Sets the number of samples generated for the AWGN waveform.

The maximum number of samples depends on the installed ARB options.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:AWGN:SAMPles` on page 886

Generate Signal RAM
Generates an AWGN test signal waveform. The instrument saves the file with a predefined name and loads it into the ARB.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:AWGN:CREate` on page 887

4.8 Reducing the crest factor

Reducing the crest factor of waveforms is a function that requires the additional option Crest Factor Reduction (R&S SMM-K548).

See user manual R&S SMM-K548 Crest Factor Reduction.

4.9 Generating multi-segment waveform files

Modern chip technologies implement several communication standards within one chip and rise special verification and test requirements. To fulfill the requirements of these test systems and to enable rapid alternation between different waveforms with differing test signals, the R&S SMM100A provides the functionality to generate multi-segment waveform files.

This section introduces the concept of the multi-segment waveform files, together with a description of the provided settings and some typical configuration examples.

4.9.1 Required options

See Section 4.6.1, "Required options", on page 150.

Also, multi-segment waveform files require the corresponding digital standard options (R&S SMM-K2xx) of all included standards.

4.9.2 About the multi-segment waveforms

A multi-segment waveform is a composed signal that contains several multiple independent waveforms called segments. You can output each segment with its own marker and clock settings.

The figure Figure 4-25 shows the principle of building a multi-segment waveform.

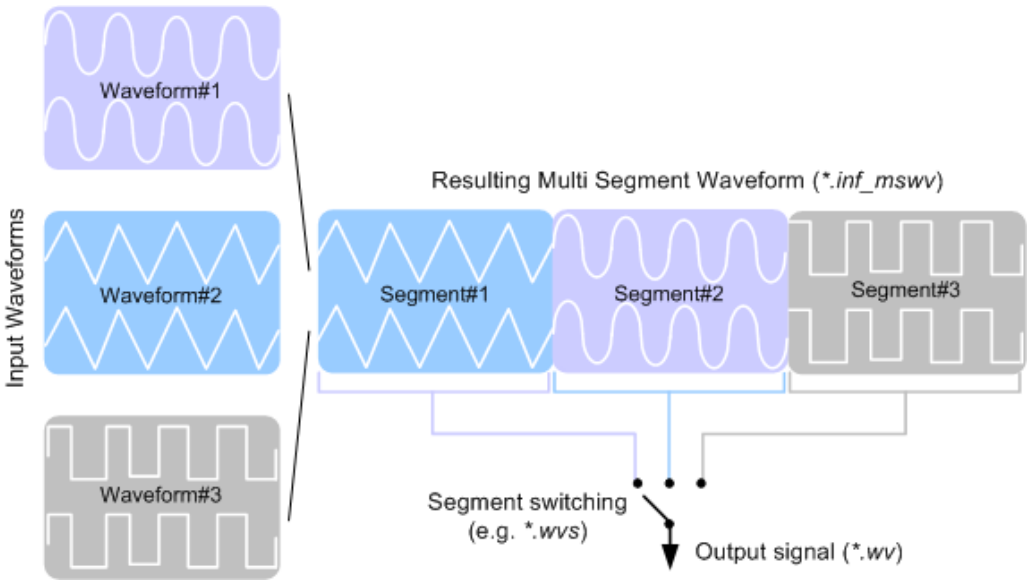


Figure 4-25: ARB multi-segment waveform concept

It is also possible to create and output a blank segment. These segments contain zero signal.

For typical applications of multi-segment waveforms, see Section 4.9.4, "Working with multi-segment waveform files", on page 226.

4.9.2.1 Multi-segment waveform processing

Processing of the waveform is triggered by the "Create" or "Create and Load" function. To process the waveform, the instrument loads the entire multi-segment waveform into the memory. It is therefore possible to alternate between the individual waveforms without delay due to loading. You can define the output order of the segments, and the segment intended to be output at any given moment.

When the created waveform is loaded, the graphical interface displays information on clock rate, number of samples and creation day. You can also acquire information about the waveform in the dedicated "Waveform Info" dialog.

4.9.2.2 ARB sequencer mode

If your setup requires a high switch-over speed, you can continuously scroll through the test signals with an external trigger or apply a predefined "Play List".

The R&S SMM100A provides settings to define a sequence of different segments. Also you can set the number of repetitions for playing the segment and adjust the transition between the segments.

Correct and fast processing and seamless transition between multiple waveforms requires segments with a common sample rate. If the combined waveforms feature different sample rates, set a common sample rate by resampling. Another advantage of this procedure is the scaling of the instantaneous amplitude of the various waveforms to a common RMS level.

4.9.2.3 File concept

To provide flexible configuration, the building of a composed multi-segment waveform file involves different stages; by completing of each of them, the R&S SMM100A creates and saves a dedicated file. The following files are used:

- The "Configuration List" is a dedicated file with details on how a multi-segment waveform is made up from different waveforms, the level and the clock rate settings, and the filename. The file extension is `*.inf_mswv`.
  You can create any number of configurations as a basis for defining further multi-segment waveforms.
- The "Output File" is the multi-segment waveform file. You can enter a filename, the file extension is `*.wv`. The instrument appends additional information to the header of the composed waveform file, for example user comments.
- The "Sequencing List" contains files created in the "Multi Segment Waveform Sequencing" dialog, when using the ARB sequencer mode. See Section 4.9.2.2, "ARB sequencer mode", on page 205.

The sequencing list file has an extension `*.wvs` and is automatically assigned to but independent from the multi-segment file. By default, both files have the same name and are located in the same file directory. You can create more than one sequencing list file per multi-segment waveform file.
The sequencing list file carries information only about the segment number, the corresponding waveform filenames are retrieved from the assigned multi-segment waveform file. That is, the same sequencing list file can be reused for different multi-segment waveform files with the same number of segments.
Changes and recalculations of a multi-segment waveform file cause a recheck of whether the assigned sequencing list files are still valid. A message is displayed to inform about necessary corrections in the “play list”.

4.9.2.4 Impact of the marker settings

The general purpose of the marker signal is the triggering of the DUT (device under test) and the synchronization with other measurement instruments.

For better flexibility, the instrument provides several possibilities to define marker signals:

- Segment markers
  Because the multiple segments are standalone waveforms, they can already carry marker signals. You can define how the instrument processes these available marker signals. The instrument can ignore them or use them in the composed multi-segment waveform.
- Additional segment restart and sequence restart markers
  Additional marker signal can be defined to restart the multi-segment sequence or to restart each of the multiple segments. A marker output configured and defined for one of these purposes overwrites markers that use the same output connector and that are defined in the individual waveforms.

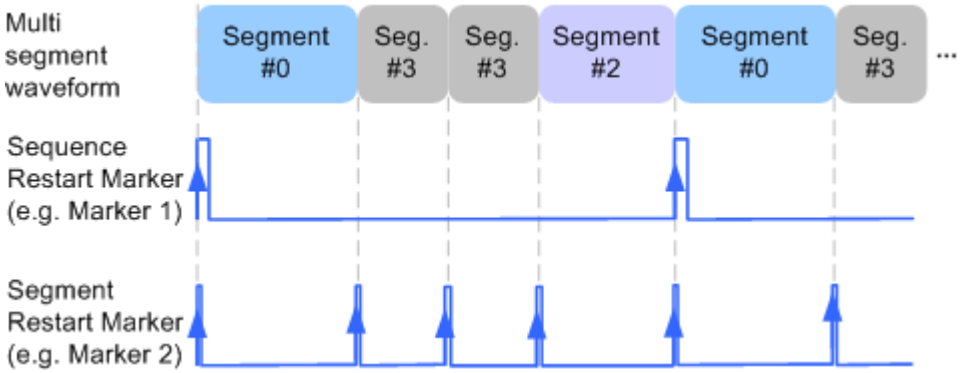


Figure 4-26: Example of marker signals

The segment start is defined by the low-high slope of the marker, which applies for switching between two segments and if there is a segment replay.

- General marker signals for the composed multi-segment waveform
  The "ARB" dialog also provides access to the standard marker settings. Settings other than "unchanged" overwrite existing markers in the waveforms or markers defined for the multi-segment waveform.

The Figure 4-27 shows schematically how the instrument evaluates the priorities of the different marker signals, if multiple marker signals are mapped to the same connector.

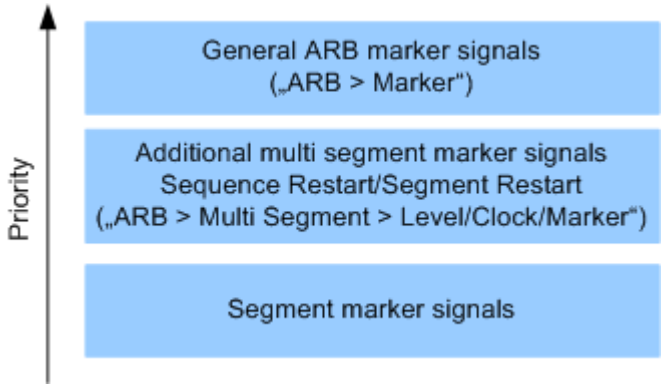


Figure 4-27: Marker priority and assigning of marker signals

4.9.2.5 Impact of the trigger settings and next segment settings

The ARB dialog provides the standard (regular) trigger settings. Use these settings to trigger of the composed multi-segment waveform as a sequence in one file. For background information, see also Section 4.4.1.5, "About trigger signals", on page 92.

This section focuses on the additional settings provided for triggering of the individual segments building the composed multi-segment waveform. These settings are enabled and visible only if a multi-segment waveform is loaded for processing. The settings are grouped in the "Multi Segment Waveform Options/Next Segment Trigger In" section.

The Figure 4-28 illustrates how trigger events affect the processing of the multi-segment waveforms.

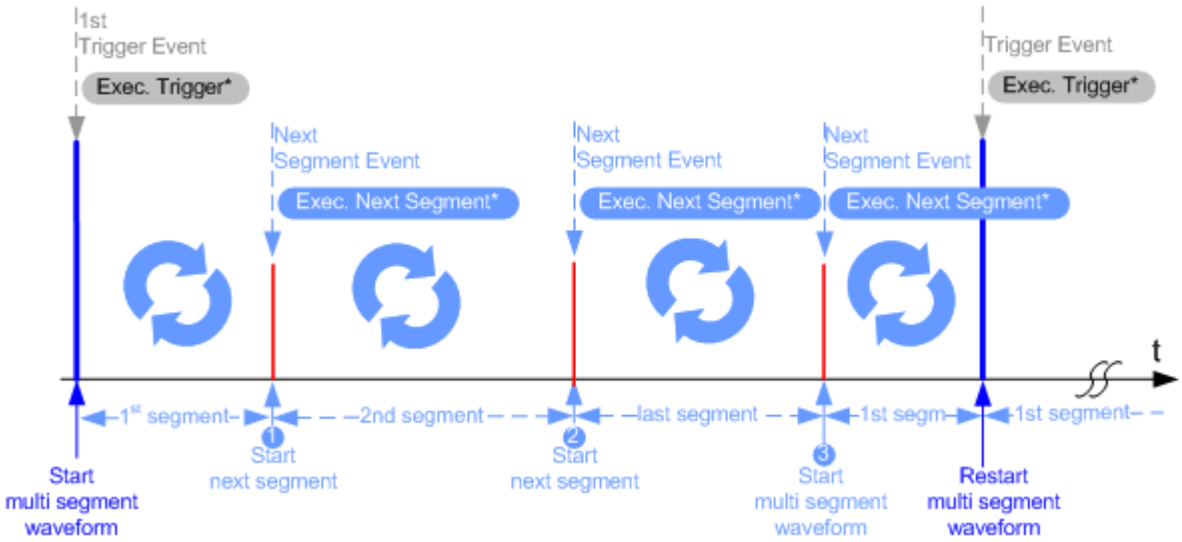


Figure 4-28: Principle of segment triggering

* = To simplify the description, an internal next segment trigger event ("Exec. Next Segment") and an internal trigger event ("Execute Trigger") are used; an external trigger event has the same effect on the signal generation.

1, 2 = Any next segment trigger event (internal or external) causes a switch over to the subsequent available segment in the waveform. The current output segment (segment filename and segment index) is indicated at "Current Segment".

3 = When the last segment of the multi-segment waveform is output, the sequence starts again with the output of the first segment after the next trigger event. Use a sequence of external next segment trigger events to output the segments in the multi-segment file cyclically.

Defining the next segment source

As with the standard trigger system, provided are the following two sources for the next segment signal:

- **Internal**: the switch over to the subsequent segment is triggered manually with the "Execute Next Segment" function.
  To trigger a switch over to any segment within the multi-segment waveform, change the value of the parameter "Segment".
- **External**: the instrument expects a trigger event ("Global Next Segment") on one of the two provided and configured User connectors.

Defining subsequent segments

By default, the instrument replays the segments in incremental order, for example "Segment#1". If you want to change the order is required, use one of the following possibilities:

- "Next Segment": defines the subsequent segment while triggering the segments manually, i.e. by "Next Segment Source" > "Internal"
- "Sequencing List": the subsequent segment is defined in the selected play list.

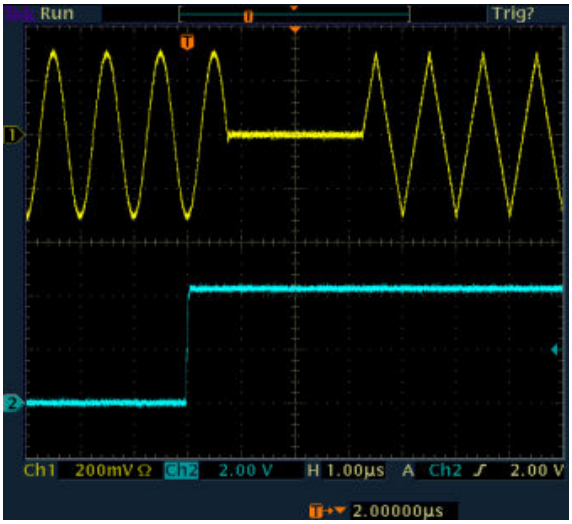
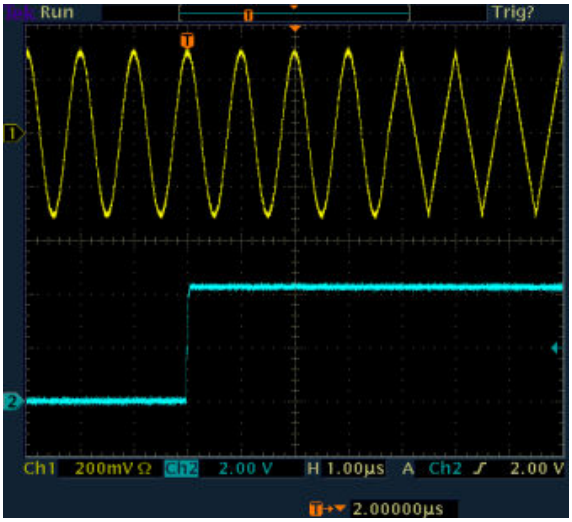
Defining the transition between the segments

The R&S SMM100A provides the parameter "Next Segment Mode" to define the transition to the next segment, see the table Table 4-13.

- "Next Segment": by receiving a next segment event, the ARB aborts immediately the playing of the current waveform and starts playing the next segment waveform, see Table 4-13.
- "Next Segment Seamless": by receiving a next segment event, the ARB completes the processing of the current waveform before starting the next segment waveform, see Table 4-13.
  Use this setting to avoid signal gaps and wrap-around problems. Seamless transition requires segments with equal clock rates.
  Another way to generate a multi-segment signal without signal gaps between the segments is to use the provided ARB sequencer mode, see Section 4.9.3.4, "Multi-segment waveform sequencing", on page 218.

The table Table 4-13 shows two examples of the transition from a sine-wave signal segment to a sawtooth segment (I channel, upper curve). The triggering mode is the next segment external triggering. The left graphic displays an abrupt transition. The right graphic displays the seamless transition case.

Table 4-13: Transition examples

Next segment switching	Next segment seamless
	

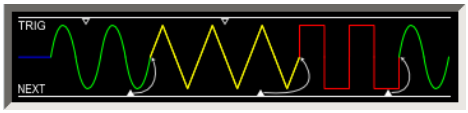
Understanding the trigger examples

A simplified diagram in the ARB dialog is intended to explain the effect of the triggering on the signal processing. The currently enabled settings for trigger and next segment mode are considered.

The curves plotted in the dialog are textbook examples, "not measured" waveforms. They are intended to visualize the trigger and the next segment settings more clearly.

- The triangle on the top line denotes a trigger event. A filled triangle on the bottom line denotes a next segment event.
- A green sine wave (or other shape) over a full period indicates one replay cycle of a segment. A shorter example signal indicates a replay cycle which was interrupted, e.g. due to a next segment event (compare the two graphics in Table 4-14).

Table 4-14: Trigger examples in the ARB dialog

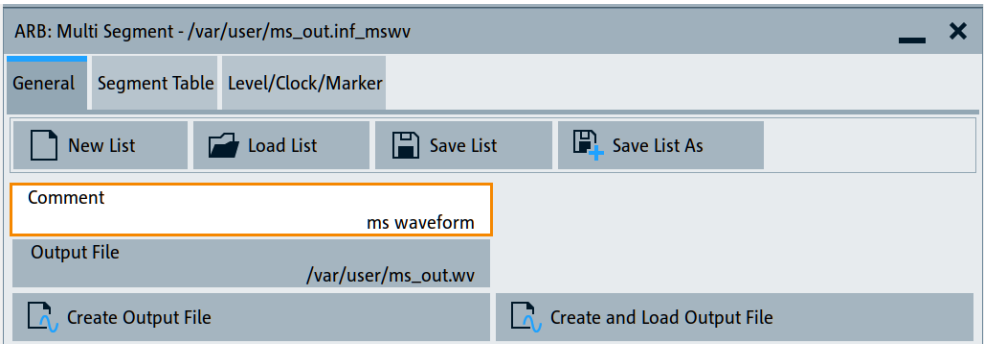
"Next Segment Mode = Next Segment"	"Next Segment Mode = Next Segment Seamless"
	

4.9.3 Multi-segment settings

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment".

The "ARB: Multi Segment" dialog enables direct assignment of waveforms to the multiple segments, adjusting the clock, level, and marker settings of the composed waveform and selecting the output file.



For description on the provided settings, refer to:
Section 4.9.3.1, "General settings", on page 211,
Section 4.9.3.2, "Segment table", on page 213 and
Section 4.9.3.3, "Level/Clock/Marker settings", on page 216

2. Select "ARB: Multi Segment" > "General" > "Create and Load Output File" to save and load the current multi-segment file.
3. Select "Multi Segment" > **"Sequencing List"** to access the settings for configuring a sequencing "Play List" for fast automatic processing of the multi-segment waveform.
   For a description of the provided settings, refer to Section 4.9.3.4, "Multi-segment waveform sequencing", on page 218.
4. Select "Baseband" > "ARB" > "General".

   The "Load Waveform" confirms that the current multi-segment file is loaded (filename as defined with "Output File").

   Note: The provided settings depend on the current waveform.
   The "Sequencing List" function requires the following:
   - Created multi-segment file via "Create Output File" or "Create and Load Output File".
   - The "Sequence Table" contains more than one segment.
5. Select "Baseband" > "ARB" > "Trigger In (MSW)".
   For related settings, see Section 4.9.3.5, "Multi-segment waveform trigger settings", on page 222.
6. Select "Baseband" > "ARB" > "General" > "State" > "On" to generate the multi-segment waveform.

The remote commands required to define these settings are described in Section 13.17.5.3, "SOURce:BB:ARBitrary subsystem", on page 873.

- General settings 211
- Segment table 213
- Level/Clock/Marker settings 216
- Multi-segment waveform sequencing 218
- Multi-segment waveform trigger settings 222

4.9.3.1 General settings

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment".

   The "General" tab provides standard functions for file handling, like selecting and loading of files, or determining the output filename.

2. Perform one of the following:
   - Select "New List" to create a multi-segment waveform file
   - Select "Load List" to load an existing one

3. Add a comment.

4. Select "Output File" to set the filename of the multi-segment waveform.

   Note: The provided settings depend on the current waveform.
   The "Sequencing List" function requires the following:
   - Created multi-segment file via "Create Output File" or "Create and Load Output File".
   - The "Sequence Table" contains more than one segment.

Settings:

New List 211
Load List 211
Save List/Save List As 212
Sequencing List 212
Comment 212
Output File 212
Create Output File/Create and Load Output File 212

New List
Opens the standard "Create Multi Segment Waveform List" function to enter the name of the new file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect` on page 900

Load List
Opens the standard "File Select" function to select the configuration file to be edited.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog? on page 897
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect on page 900
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete on page 898

Save List/Save List As...
Saves the current entries of the Segment table in a configuration list (file), including the level mode, clock mode, segment marker mode, and output filename settings.

See also Section 4.9.2.3, "File concept", on page 205.

Consider also the following remote control commands:
- To define the configuration file (`*.inf_mswv`) used by the calculation of the output file:
  – [:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate
  – [:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad
- To define the filename of the output waveform file (`*.wv`):
  [:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe

Remote command:
n.a.

Sequencing List
Requires a loaded multi-segment file.

Opens the dedicated dialog for configuring the associated play lists, see Section 4.9.3.4, "Multi-segment waveform sequencing", on page 218.

Remote command:
n.a.

Comment
Adds a comment to the composed multi-segment file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent on page 898

Output File
Opens the standard "File Select" dialog function and requests the filename for the multi-segment waveform to be calculated.

An output filename is required for further processing of the multi-segment waveform:
- For the internal storage triggered by the "Save List" function
- For the calculation and creation of the multi-segment waveform, triggered by the "Create" or "Create and Load" function.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe on page 898

Create Output File/Create and Load Output File
Creates a multi-segment waveform as follows:

"Create Output File"	Creates a multi-segment waveform using the current entries in the segment table, see Section 4.9.3.2, "Segment table", on page 213.

"Create and Load Output File" Creates a multi-segment waveform and loads it in the ARB.

The R&S SMM100A saves the multicarrier waveform as a file with filename, see"Output File" on page 212.

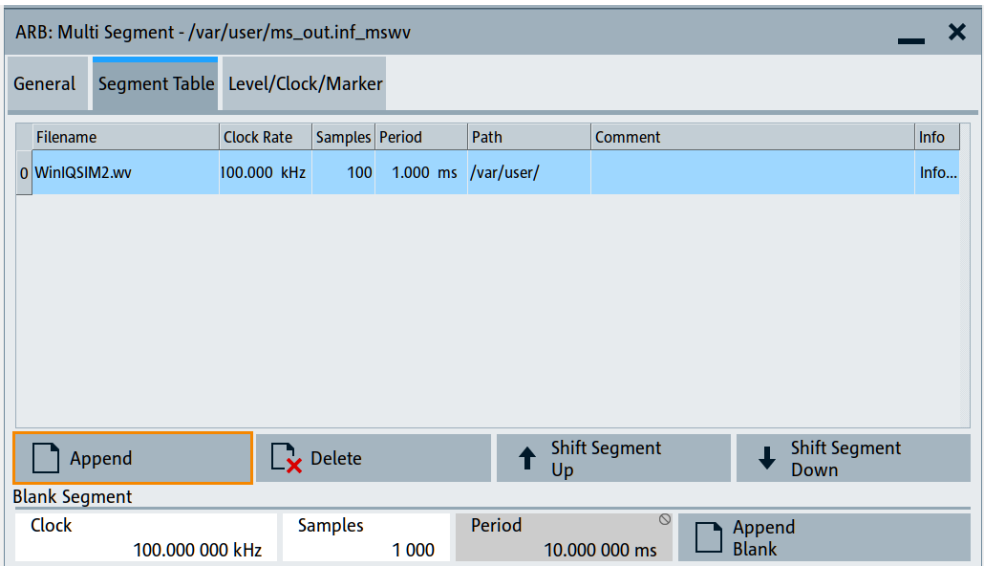
Depending on the configuration of the multicarrier waveform, calculation takes some time. Use the "Abort" function to interrupt the calculation.

Remote command:
To define the configuration file (`*.inf_mswv`) used by the calculation of the output file:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate`
Or `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad`
To define the filename of the output waveform file (`*.wv`):
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe`

4.9.3.2 Segment table

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment ...".
2. In the "Multi Segment" > "General" dialog, select an existing list.
3. Select "Multi Segment" > "Segment Table".
4. Select "Append" to add waveform segments.
5. Select "Append Blank" to add a bank segment
6. Configure the "Blank Segment Settings" as required.



This section provides settings to create and adjust the contents of the multi-segment file.

Settings:

Segment Table....214
Append....214
Delete....215
Shift Segment Up....215
Shift Segment Down....215
Blank Segment....215
Clock Rate....215
Samples....215
Period....215
Append Blank....216

Segment Table
The table lists the individual waveforms (segments) of the selected multi-segment waveform. The information about the segments is retrieved from the tags of the corresponding waveform files.

"Segment#" Indication of segment index. Within the manual and remote control configuration, this segment index indicates the segment explicitly.
Tip: Use the segment index, for example, to define the subsequent sequence to be output in next segment Mode "Next Segment" or "Next Segment Seamless".

"Waveform" Indication of the waveform filename of the segment.

"Clock Rate"
Indication of the clock rate of the selected waveform.

"Samples"
Indication of the number of samples in the segment.

"Period"
Indication of the segment duration.

"Path"
Indication of the location of the waveform file used for the corresponding segment.

"Comment"
Indication of the possible comments contained in the waveform.

"Info"
Indication of the possible comments contained in the waveform.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?`
on page 893

Append
Opens the standard "File Select" dialog for navigation to and selection of the waveform file to be added on the end of the existing list.

Only non-multi-segment waveforms can be loaded.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend`
on page 898

Delete
Removes the selected entry from the table. The waveform file itself is however not deleted.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DELete` on page 899

Shift Segment Up
Moves up the selected segment by one row in the segment table.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:UP` on page 899

Shift Segment Down
Moves down the selected segment by one row in the segment table.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DOWN` on page 899

Blank Segment
This section provides the settings to configure a blank segment. A blank segment is a zero signal with a defined clock rate and number of samples. For blank segments configure the following settings:

- "Clock Rate" on page 215
- "Samples" on page 215
- "Period" on page 215
- "Append Blank" on page 216

Clock Rate
Sets the clock rate of the blank segment.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend` on page 896

Samples
Sets the number of samples for the blank segment.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend` on page 896

Period
Displays the resulting period for the blank segment.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend` on page 896

Append Blank
Adds the blank segment to the segment table.

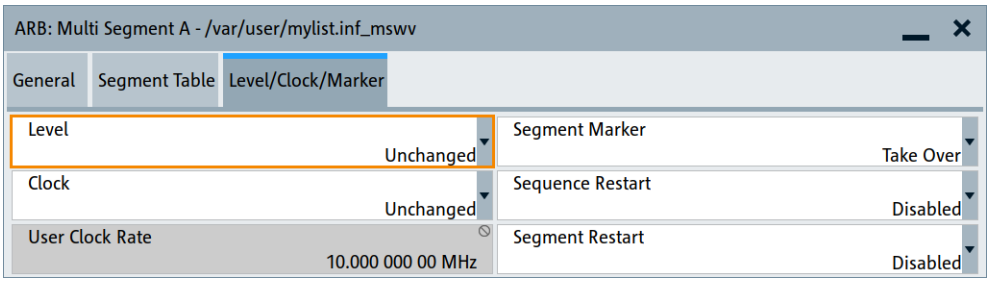
Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend`
on page 896

4.9.3.3 Level/Clock/Marker settings

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment".
2. In the dialog "ARB: Multi Segment" > "General", select an existing list.
3. Select "ARB: Multi Segment" > "Segment Table" to configure the segments.
4. Select "ARB: Multi Segment" > "Level/Clock/Marker".

   The "Level/Clock/Marker" tab provides settings to configure the level, marker and clock settings of the multi-segment waveform file.



Settings:

Level....216
Clock....217
User Clock Rate....217
Segment Marker....217
Sequence Restart....217
Segment Restart....218

Level
Defines the way that the instrument determines the output level of each of the multiple waveforms.

"Unchanged" Concerning the level settings, the segments are output exactly as defined in the individual files. The "Level" display applies only to the segment with the highest RMS value. Sometimes, the remaining segments are output at a lower level than the displayed value.

"Equal RMS" The output segments have the same RMS value. The displayed "Level" applies to all segments.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE]
on page 897

Clock
Defines the clock mode to set the clock rate of each of the multiple waveforms.

"Unchanged" Each segment has the clock rate as in its waveform file.

Note: For "Next Segment Mode" > "Next Segment Seamless", the segments require equal clock rates.

"Highest" All segments have the highest available clock rate.

Note: Trade-off between fast switch over and computing time. This mode provides short switch-over times between segments. But the computing time increases because the individual segments are resampled.

"User" All segments are output at the clock rate, the "User Clock Rate". Also, this mode is a trade-off between fast switch over and computing time.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE
on page 897

User Clock Rate
Display or sets the sample rate for multi-segment waveform output. Setting requires "Clock" > "User".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk on page 897

Segment Marker
Defines the way the marker information within the separate segments is processed, see also Section 4.9.2.4, "Impact of the marker settings", on page 206.

"Ignore" The marker information carried in the individual segment waveform files is not considered.

"Take Over" The output waveform file contains the marker information as configured in the individual waveform files.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE
on page 895

Sequence Restart
Enables/disables the generation of an extra restart marker in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered, see also Section 4.9.2.4, "Impact of the marker settings", on page 206.

"Disabled" No additional marker is generated.

"Marker 1"/"Marker 2"/"Marker 3"
Generates a restart marker signal at the beginning of the first segment of the complete multi-segment sequence.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment`
on page 895

Segment Restart
Enables/disables the generation of an extra restart marker in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered, see also Section 4.9.2.4, "Impact of the marker settings", on page 206.

"Disabled" No additional marker is generated.

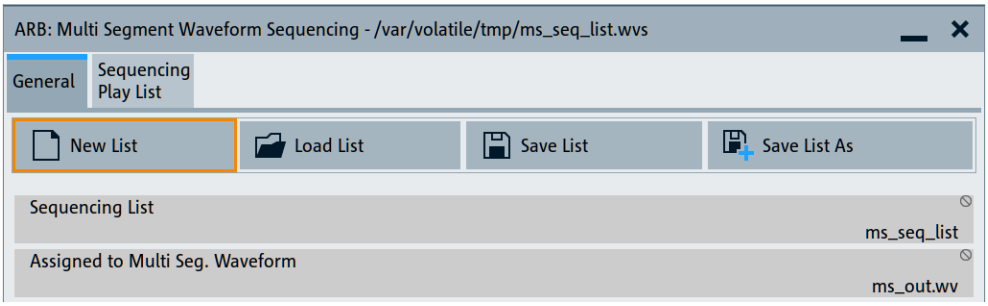
"Marker 1"/"Marker 2"/"Marker 3"
Generates a restart marker signal at the beginning of each segment. The segment start is defined by the low-high slope of the marker signal, which applies for switching between two segments and if there is a segment replay.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment`
on page 895

4.9.3.4 Multi-segment waveform sequencing

Access:

1. Select "Baseband" > "ARB" > "General" > "Create Multi Segment".
2. In the "ARB: Multi Segment" > "General" dialog, select an existing list.
3. Select "ARB: Multi Segment" > "Segment Table".
4. Configure a waveform with more than one segment.
5. Select "ARB: Multi Segment" > "Level/Clock/Marker"
6. Adjust the clock settings so that all segments use the same clock rate.
7. Select "ARB: Multi Segment" > "General"
   > **"Create Output File/Create and Load Output File"**.
8. Select "Sequencing List...".
9. Select "New" or "Load" to load a sequencing list file.

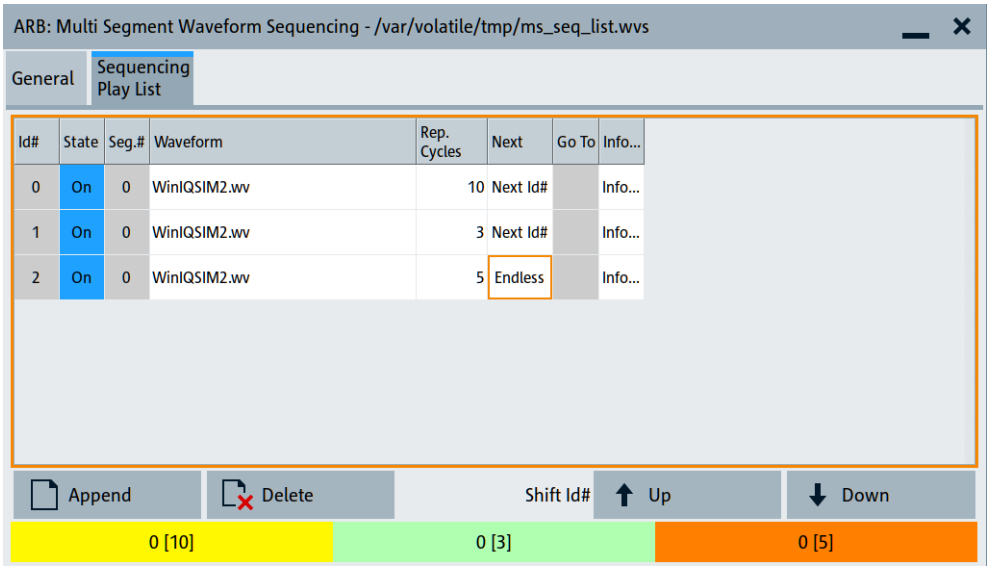


10. Select "ARB: Multi Segment Waveform Sequencing" > "Sequencing Play List" to create a "Play List".

    A new sequencing list contains no information.

11. Use the "Append"/"Delete" and "Up"/"Down" functions to configure the order of processing the segments.

    The user interface shows the configured play list in the form of a "Sequencing Graphic".



    For related settings, see "Sequencing play list settings" on page 220.

12. Select "ARB: Multi Segment Waveform Sequencing" > "General" > "Save" to save the "Play List".

13. Select "ARB: Multi Segment" > "General" > "Create and Load Output File".

14. To use the "Play List", select "ARB" > "Next Segment Waveform Options" > "Next Segment Mode" > "Sequencer".

Settings:

- General settings.....220
- Sequencing play list settings.....220

General settings

Access:

► Select "Baseband" > "ARB" > "General" > "Create Multi Segment" > "Sequencing List...".

Settings:

New Sequencing List/Load Sequencing List....220
Save List/Save List As....220
Sequencing List....220
Assigned to Multi Seg. Waveform....220

New Sequencing List/Load Sequencing List
Opens the standard "Select Sequencing List" function to define the name of the new play list file or select of an existing one.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect` on page 893

Save List/Save List As
Saves the current entries of the table in a play list file. Play list files have the file extension `*.wvs`.

The default filename of the play list file is the same as the multi-segment waveform filename, but it can be changed.

Sequencing List
Displays the name of the selected sequencing list file, i.e. the file with the “play list” settings (see Section 4.9.2.3, "File concept", on page 205).

Remote command:
n.a.

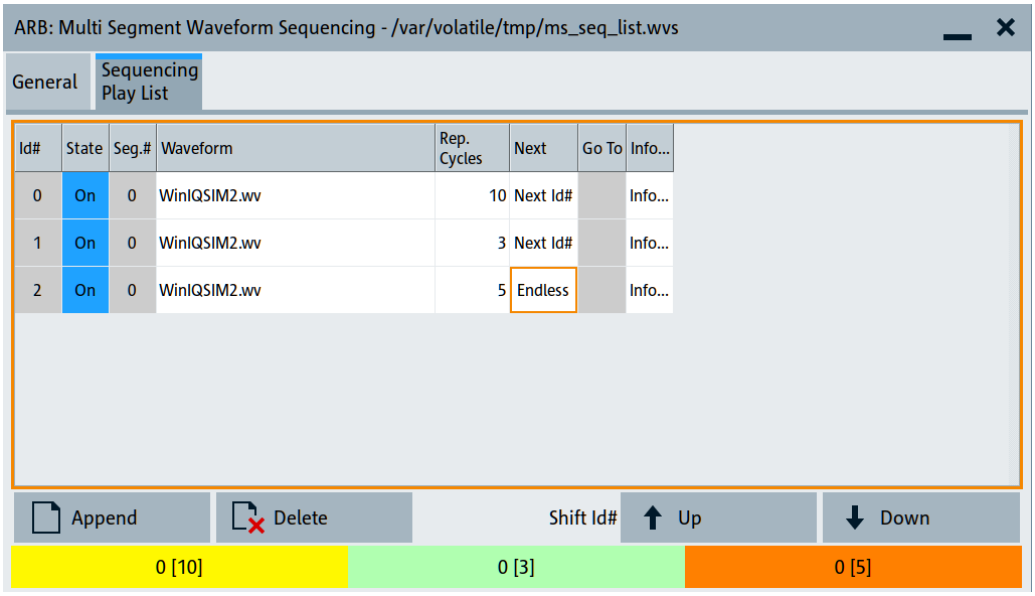
Assigned to Multi Seg. Waveform
Displays the name of the multi-segment waveform file within the current sequencing list file.

Remote command:
n.a.

Sequencing play list settings

Access:

► Select "Baseband" > "ARB" > "General" > "Create Multi Segment" > "Sequencing List..." > "Sequencing Play List".



Settings:

Sequencing Play List....221
└ Next....222
└ Append....222
└ Delete....222
└ Shift Id# Up/Shift Id# Down....222
Sequencing Graphic....222

Sequencing Play List

The "Sequencing Play List" table defines the sequence order for processing the waveform file segments. Also, you can set the repetition of individual segments.

"Id#" Indicates the row number.

"State" Enables/disables the selected row. Only active segments are processed.

"Segment#" Indicates the segment index.
The sequencing list file carries information only about the segment index. The assigned multi-segment waveform file provides the corresponding filenames.

"Waveform" Indicates the waveform file mapped to the corresponding segment.
The R&S SMM100A reads out this filename from the multi-segment waveform file.
Available are only waveform files from the pool of segments of the selected multi-segment waveform file.

"Repetition Cycles"
Sets the number of times the selected segment is cyclically repeated before the next segment in the sequence is processed.

"Info" Opens a dialog with detailed information about the currently selected waveform.

Remote command:
See "Append" on page 222.

Next ← Sequencing Play List
Determines the action after completing the current segment. For example, determines which segment the R&S SMM100A is processes after the processing the current segment.

"Next Id#"	The next active segment in the play list is processed.
"Blank"	After the processing of the current segment is completed, the signal output is stopped until a signal restart like a retrigger signal is received. A restart signal causes a complete restart of the sequencing play list.
"Endless"	The current segment is replayed until a signal restart like a retrigger signal is received and the complete sequencing play list is restarted. Only active segments are considered.
"Goto Id#"	Determines the row number of the segment to be processed next. This feature is limited to the first 32 rows.

Append ← Sequencing Play List
Inserts a new row at the end of the sequencing play list table.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect` on page 893
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend` on page 894

Delete ← Sequencing Play List
Deletes the selected row.

Shift Id# Up/Shift Id# Down ← Sequencing Play List
Rearranges the rows that means moves the selected row up and down.

Sequencing Graphic
Displays the play list graph according to the current configuration.

The graph shows the segment sequence, the segment number, and the number of times the segment is repeated; considered are only the active segments.

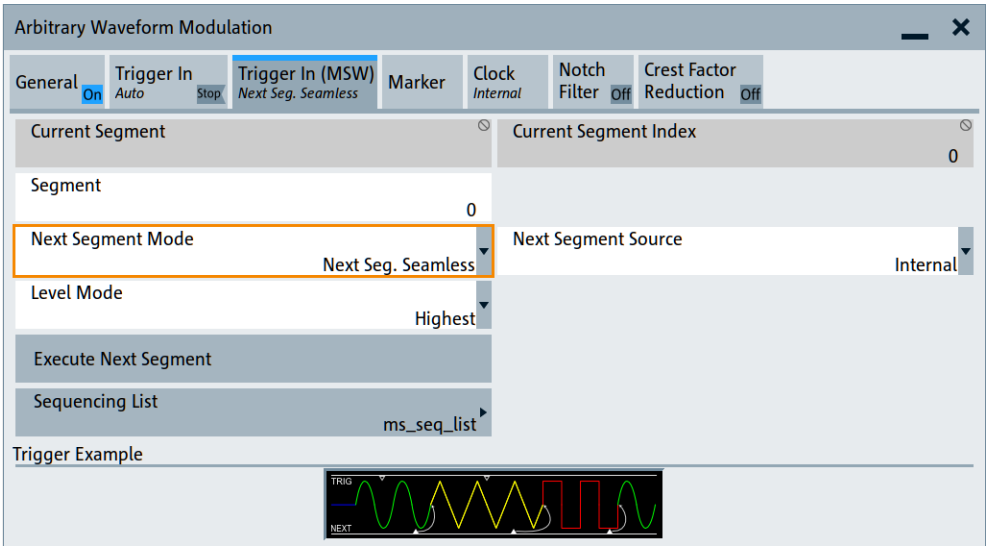
4.9.3.5 Multi-segment waveform trigger settings

The settings in the "Trigger In (MSW)" tab are visible only if a multi-segment waveform is loaded into the ARB.

Access:

1. Load a multi-segment waveform in the ARB.
   See Section 4.9.3, "Multi-segment settings", on page 209.

2. Select "Baseband" > "ARB" > "Trigger In (MSW)".



The tab provides settings to configure the trigger for switching between the segments of a multi-segment waveform. The parameters depend on the selected trigger source.

Settings:

Current Segment/Current Segment Index....223
Segment....223
Next Segment Mode....224
Next Segment Source....225
Level Mode....225
Execute Next Segment....225
Sequencing List....225
Trigger Example....225

Current Segment/Current Segment Index
Indicates the waveform segment (segment filename and index) that is output.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment?` on page 891
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME?` on page 892

Segment
Selects the waveform segment to be output after the segment indicated as "Current Segment". This parameter determines the start segment when switching on the ARB and enables switching over to any other segment.

The following events cause a switch over:
- A trigger event of an external next segment
- An internal segment trigger that is a change in the segment index in the "Segment" field

Use the parameter Next Segment Mode to define whether the new segment is generated immediately or only after the previous segment has been fully generated (wrap around). The subsequent trigger event after the last segment causes the first segment to be output again.

For more information, see Section 4.9.2.5, "Impact of the trigger settings and next segment settings", on page 207.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT` on page 892

Next Segment Mode
Defines the way the **switch over between the segments** in a multi-segment waveform is executed.

The regular trigger mode for starting the waveform generation and **triggering the whole multi-segment sequence** is set with the parameters in the "ARB > Trigger" tab. The segment currently being output is displayed at "Current Segment". The "Trigger Example" graph displays schematically the waveform output, depending on the activated trigger and the next segment settings.

For background information, refer to Section 4.9.2.5, "Impact of the trigger settings and next segment settings", on page 207.

For detailed information on how the regular trigger signal affects the multi-segment waveform processing in combination with the different values for "Next Segment Mode", refer to Section 4.9.5, "Reference to triggering of multi-segment waveforms", on page 231.

Note: The seamless switch over and the sequencer mode require segments with equal sample rate.

"Same Segment"
The processing of the multi-segment waveform file is similar to the processing of a non-multi-segment waveform. There is no switching to consecutive segments upon the receiving of a trigger event.
To trigger switching between the segments, change the segment index in the "Segment" field.

"Next Segment"
The current segment ceases to be output when a trigger event for a new segment occurs, and the new segment starts to be output after a system-imposed signal gap.

"Next Segment Seamless"
If all segments have the same sample rate, the new segment is not output until all segments are output (wrap around), i.e. the signal transition is seamless.

"Sequencer" The waveform files are processed according to the order and repetition cycles defined in the special sequencing list file (`*.wvs`) assigned to the multi-segment waveform file.
This “play list” is defined in the Multi-segment waveform sequencing dialog.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe` on page 895

Next Segment Source
Selects whether the next segment is switched upon receiving of an external trigger signal or upon executing of software next segment trigger (see Figure 4-28).

This parameter is disabled if a sequencing play list is used.

"Internal" Switch over to any segment is triggered manually with the "Execute Next Segment" function.

"External Global Next Segment"
The trigger event for switching to the next segment is input as configured on one of the User x connectors.

See also Section 11.2, "Configuring local and global connectors", on page 563.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce` on page 893

Level Mode
Sets how the instrument levels the individual segments in a multi-segment signal. The parameter is important if waveforms with different crest factors are used.

"Highest" All segments are output at the highest available crest factor.

"Unchanged" Each segment is output with the crest factor defined in its waveform file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:LMODe` on page 893

Execute Next Segment
For "Next Segment Source = Internal", triggers manually switch over to the subsequent segment in the multi-segment file. The subsequent segment can be any segment within the multi-segment file and is defined by the parameter "Segment".

This parameter is disabled if a sequencing play list is enabled.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute` on page 892

Sequencing List
Opens a dialog box for defining the “play lists”, see Section 4.9.3.4, "Multi-segment waveform sequencing", on page 218.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect` on page 893

Trigger Example
Displays an example of a multi-segment waveform. The currently enabled trigger and next segment mode are considered. After the instrument is switched on, the graph of the last loaded waveform is displayed.

Note: The curves plotted in this dialog box are textbook examples, "not measured" waveforms. They are intended to visualize the trigger and next segment settings more clearly.

Remote command:
n.a.

4.9.4 Working with multi-segment waveform files

This section provides step-by-step instructions on how to configure and use the multi-segment settings. The Figure 4-29 shows the essential stages of multi-segment waveform configuration, together with the corresponding user interface dialogs and if applicable, the corresponding file extensions. Perform the necessary settings, enable the signal generation, and provide the trigger signal.

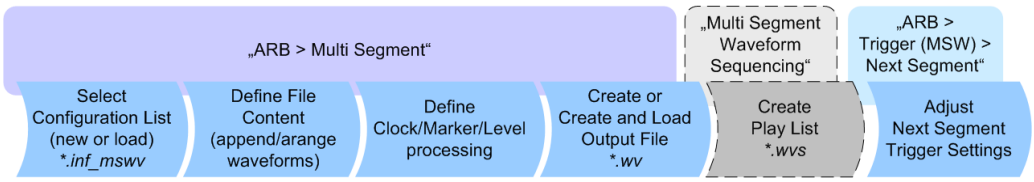


Figure 4-29: Basic workflow for generation of multi-segment waveforms

To generate a multi-segment waveform file

1. In the "ARB" > "General" > "Create Multi Segment" > "General" dialog, select "New List" to create an empty list.
2. Use the "ARB: Multi Segment" > "Segment Table" > "Append" function to add multiple waveform files.
3. In the "ARB: Multi Segment" > "Level/Clock/Marker" dialog, adjust the "Level", "Clock", and "Segment Marker" settings.
4. Select the "ARB" > "Create Multi Segment" > "General" > "Output File" to enter the filename.
5. Select "Save List" to save the configuration file.
6. Select "Create Output File" or "Create and Load Output File".
7. Select "State" > "On".

The following description emphasizes on the settings required to fulfill the particular task or achieve the desired performance; standard basic settings are not discussed.

All provided examples use the example segment sequence as shown on Figure 4-30.

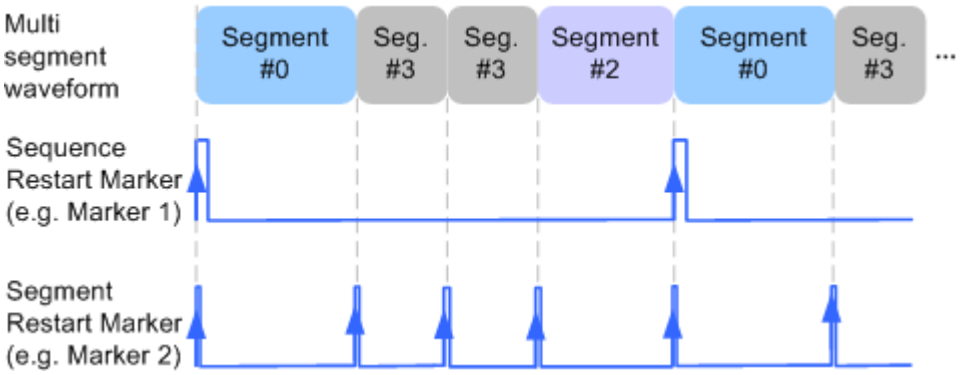


Figure 4-30: Example: multi-segment sequence with marker signals

See how to:

- "To switch output segments manually" on page 227
- "To generate a multi-segment signal without signal interruptions" on page 228
- "To enable external triggering for high-speed switch over" on page 229
- "To use the play list function" on page 230
- "To add marker signals" on page 231

To switch output segments manually

When testing a DUT using different test signals, you want to switch dynamically and flexibly between any of the test signals. For example, switching due to the outcome of the previous test. The following settings enable flexible dynamic switch over between the segments in a multi-segment waveform.

We assume that a multi-segment sequence composed of 4 segments ("Seg#0", "Seg#1", "Seg#2" and "Seg#3") is created and loaded in the ARB. See "To generate a multi-segment waveform file" on page 226). The required output order of the segments is "Seg#0", "Seg#3", "Seg#2". The instrument is operated manually, the ARB is enabled, and the instrument output is on.

1. Select "ARB" > "Trigger In (MSW)" > "Next Segment Mode" > "Next Segment".

   The transition between the segments is abrupt.

2. To enable manual next segment triggering, select "ARB" > "Trigger In (MSW)" > "Next Segment Source" > "Internal".

3. To enable manual triggering, proceed as follows:

   a) Select "ARB" > "Trigger In" > "Mode" > "Armed Auto".
   b) Select "Source" > "Internal".
   c) Tap "Execute Trigger" to trigger the signal generation.

   The "ARB" > "Trigger In (MSW)" settings display the current output segment:

"Current Segment Name = Seg#0" and "Curent Segment Index = 0". Outputs the "Seg#0" continuously.

4. Set "ARB" > "Trigger In (MSW)" > "Segment" > "3" to output the second segment in the sequence order.

   The parameter "Current Segment Index" changes to segment index 3. "Seg#3" is output continuously.

5. In the "ARB" > "Trigger In" dialog, tap "Execute Trigger" to restart "Seg#3".

6. Set "ARB" > "Trigger In (MSW)" > "Segment" > "2" to output the third segment in the sequence order.

   The sequencer outputs "Seg#2" continuously.

7. To switch over to "Seg#0", change the "ARB" > "Trigger In (MSW)" > "Current Segment Index", etc.

The ARB sequencer mode provides settings to achieve the same goal in a more convenient way, see "To use the play list function" on page 230.

Faster flexible dynamic switch over

When controlling remotely via an external computer, the following settings enable switching times of about 20 ms. These times apply for segments with the same sample rate and about 200 ms for segments with different sample rates:

- "ARB" > "Trigger In (MSW)" > "Next Segment Mode" > "Next Segment".
- "ARB" > "Trigger In" > "Mode" > "Auto"
- "ARB" > "Trigger In" > "Source" > "Internal"

To generate a multi-segment signal without signal interruptions

Testing receivers requires a continuous output of different test signals without interrupting the signal. The test signals then produce a complex total signal with no signal gaps on switch over. Control procedures can use a simulated back channel of the receiver (trigger line or remote control).

Switching times depend on the length of the segment currently being output, because the switch over to the next segment does not take place until the current segment ends.

To overcome wrap-around problems and generate multi-segment signals without signal gaps between the segments, consider the following settings:

1. Enable "ARB" > "Trigger In (MSW)" > "Next Segment Mode" > "Next Segment Seamless"
2. Select "ARB" > "Trigger In" > "Mode" > "Auto"
3. Select "ARB" > "Trigger In" > "Source" > "Internal"

4. Change the value of the parameter "ARB" > "Trigger In (MSW)" > "Segment" to select the segment index processed after completing the current one.

   The R&S SMM100A outputs a segment ("Current Segment") continuously as long as you do not change the value of the parameter "Segment".

5. The seamless transition between the segments requires waveforms with equal clock rate.
   If the waveforms feature different sample rates, select "ARB" > "Create Multi Segment" > "Level/Clock/Marker" > "Clock Mode" > "Highest" or "Clock Mode" > "User" to resample the waveforms.

To enable external triggering for high-speed switch over

Testing a DUT or a chip with different test signals at high throughput requires a fast switch over. For example, when testing ATE devices during manufacturing.

We assume that you created and loaded the required multi-segment sequence into the ARB, see "To generate a multi-segment waveform file" on page 226. The instrument outputs the segments in incremental order.

The instrument is in manual operation mode, the ARB is enabled and the instrument output is on. An external global or local trigger source is connected to the instrument and the corresponding connectors are configured.

The following settings enable switching times of about 5 us and the test signals are scrolled through with the aid of an external trigger signal:

1. Select "ARB" > "Trigger In (MSW)" > "Next Segment Mode" > "Next Segment".
2. Select "ARB" > "Trigger In (MSW)" > "Next Segment Source" > "External Global Next Segment 1".
3. Do not change the displayed segment index via "ARB" > "Trigger In (MSW)" > "Segment".
4. Select "ARB" > "Trigger In" > "Mode" > "Auto".
5. Select "Source" > "External Global Trigger"/"External Local Trigger".
6. If the waveforms in the multi-segment file feature different sample rates, select "ARB" > "Create Multi Segment" > "Level/Clock/Marker" > "Clock Mode" > "Highest" or "Clock Mode" > "Highest" to resample the waveforms.

   The switch over between the segments is triggered by the receiving of an external trigger event. The segments are output in incremental order. As long as the instrument receives a new trigger event, it outputs the "Current Segment" continuously. A new trigger event aborts the output of the current segment immediately and starts the processing of the next one in the sequence.
   Tip: To output the segments in any order, use the ARB sequencer mode, see "To use the play list function" on page 230.

See also Section 11.2, "Configuring local and global connectors", on page 563.

To use the play list function

The ARB sequencer mode requires waveform files with equal clock rate.

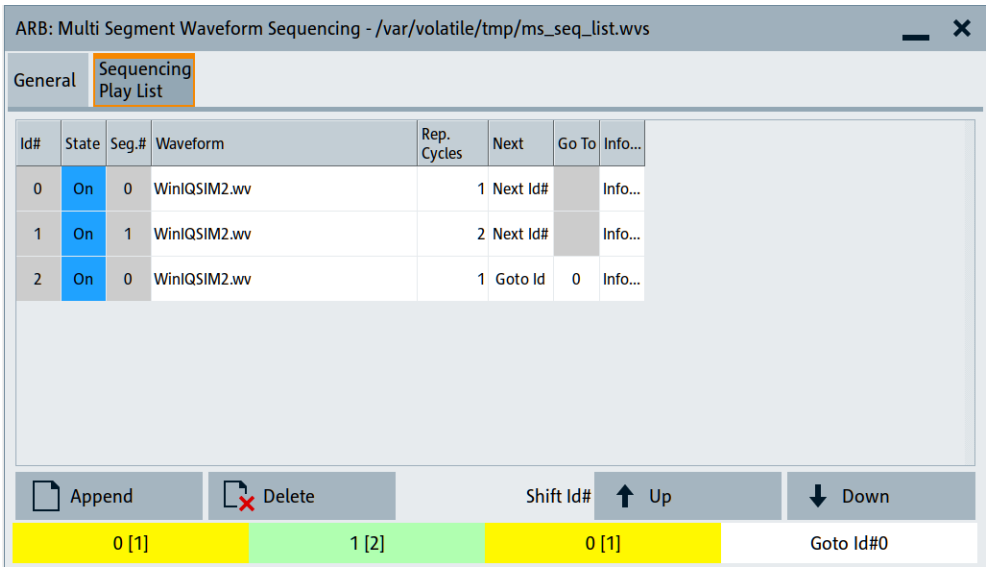
We assume that you created and loaded a multi-segment sequence with four segments into the ARB, see "To switch output segments manually" on page 227. The required output order of the segments is "Seg#0", "Seg#3" (twice) and "Seg#2". The instrument is in manual operation mode, the ARB is enabled and the instrument output is on.

The following settings show an example of how to configure this segment output order with the help of the ARB sequencing function.

1. In the "ARB: Multi Segment" dialog, select "Create and Load".
2. Select "General" > "Sequencing List".

   The "Multi Segment Waveform Sequencing" dialog opens. It displays the new play list and the current multi-segment waveform file.
3. Select "Sequencing Play List".
4. Configure the settings as follows:

   a) "Id#" = "0": "Seg#" = "0", "Rep. Cycles" = "1", "Next" = "Next Id#"
   b) "Id#" = "1": "Seg#" = "3", "Rep. Cycles" = "2", "Next" = "Next Id#"
   c) "Id#" = "2": "Seg#" = "2", "Rep. Cycles" = "1", "Next" = "Goto Id", "Go To" = "0"
   This setting creates a loop to the first segment in the sequence.



5. To save the configuration, select "General" > "Save List".
6. To use this play list, select "ARB" > "Trigger (MSW)" > "Next Segment Mode" > "Sequencer".
7. Select the trigger mode "Mode" = "Armed Auto".

8. Select the trigger source "Source" = "Internal".

   The segments are played back (output) as defined in the sequencing list. The switch over to the next segment is performed automatically according to the rules and segment order defined in the "Sequencing Play List".

To add marker signals

We assume that a multi-segment sequence composed of the segments Seg#0 [1], Seg#3 [2], Seg#2 [1] is created and loaded in the ARB (see "To use the play list function" on page 230). The multi-segment sequence starts with Seg#0 and this segment is output once. The instrument is operated manually, the ARB is enabled and the instrument output is switched on.

To add marker signals at the beginning of each segment and at the beginning of the sequence (see Figure 4-30), two additional marker signals, "Marker 2" and "Marker 1", are enabled and inserted into the multi-segment waveform.

1. Select "ARB > Marker > Mode > Marker 1/Marker2 = Unchanged" to enable taking over of the marker signals defined inside the multi-segment sequence.
   If necessary, adjust the marker delay settings.
2. Select the "Trigger/Marker/Clock" to map the "Logical Signals > Marker 1/Marker 2" to the desired connectors ("Global Connectors > User x > Direction = Output" and "Signal = Baseband Marker 1/Baseband Marker 2")
3. In the "ARB > Multi Segment > Level/Clock/Marker" dialog, select "Segment Marker = Ignore"
4. Enable "Level/Clock/Marker > Sequence Restart = Marker 1"
5. Enable "Level/Clock/Marker > Segment Restart = Marker 2"

   An extra restart marker signal is generated at the beginning of each segment and the beginning of the waveform. These restart markers *overwrite* the existing Marker 1 and Marker 2 trace signals defined in the waveforms of the individual segments.

4.9.5 Reference to triggering of multi-segment waveforms

Signal generation of multi-segment waveforms takes place differently according to the trigger selected in the "ARB > Trigger In" section. The sections provide a detailed explanation of the effect of a trigger event on the multi-segment waveform processing, depending on the enabled "Next Trigger Mode". Refer to Section 4.9.2.5, "Impact of the trigger settings and next segment settings", on page 207 for background information.

4.9.5.1 Triggering in "Next trigger mode = same segment"

Depending on the trigger setting, the currently selected segment is continuously output either immediately or after a trigger event.

Table 4-15: Waveform triggering: "Next Trigger Mode = Same Segment", "Trigger Source = Internal"

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. Trigger events are ignored. If the segment is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. Further trigger events are ignored. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.
"Retrigger"	Output starts at once and the segment is generated continuously, a trigger event causes a restart. If the segment is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Armed_Retrigger"	Output starts after the first trigger event. The segment is then generated continuously. Further trigger events cause a restart. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.
"Single"	Output starts after the first trigger event. The segment is then generated once. Further trigger events cause a restart. If the segment is changed in "Segment", signal output is not stopped. The new segment is not output until a trigger occurs.

4.9.5.2 Triggering in "Next trigger mode = next segment"

Depending on the trigger setting, the segment selected under "Segment" is output either immediately or after a trigger event. If the segment index is changed in "Segment", the new segment is not output until a trigger occurs.

Table 4-16: Waveform triggering: "Next Trigger Mode = Next Segment", "Trigger Source = Internal"

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. If the segment index is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. If the segment index is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Single"	Output starts after the first trigger event. The segment is then generated once. Further trigger events cause a restart. If the segment index is changed in "Segment", the new segment is not output until a trigger occurs.

Table 4-17: Waveform triggering: "Next Trigger Mode = Next Segment", "Trigger Source = External"

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. Further trigger events are ignored. Each next segment trigger event switches over to output the subsequent segment, following a system-imposed signal gap. If the segment index is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap. The subsequent trigger event after the last segment causes the first segment to be output again.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. Further trigger events are ignored. Each next segment trigger event switches over to output the subsequent segment, following a system-imposed signal gap. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs. The subsequent trigger event after the last segment causes the first segment to be output again.
"Single"	Output starts after the first trigger event. The segment is then generated once. Each trigger event (re-) starts the segment; each next segment trigger event switches to the output of the subsequent segment. If the segment is changed in "Segment", signal output is not stopped. The new segment is not output until a trigger occurs. The subsequent trigger event after the last segment causes the first segment to be output again.

For a description of the "Retrigger" and "Armed_Retrigger" trigger modes, see Table 4-15.

4.9.5.3 Triggering in "Next trigger mode = next segment seamless"

The segment selected under "Segment" is output. This mode is only available if all segments have the same sample rate.

Table 4-18: Waveform triggering: "Next Trigger Mode = Next Segment Seamless", "Trigger Source = Internal"

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. If the segment is changed in "Segment", the new segment is output seamlessly after the output of the current segment is complete.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.
"Single"	Output starts at once and the segment is generated continuously. Each trigger event (re-) starts the segment; each next segment trigger event switches over to outputting the subsequent segment once the output of the current segment has been completed. If the segment is changed in "Segment", the new segment is output seamlessly after the output of the current segment is complete.

Table 4-19: Waveform triggering: "Next Trigger Mode = Next Segment Seamless", "Trigger Source = External"

"Trigger Mode"	Description
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. Each trigger event (re-) starts the segment; each next segment trigger event switches over to outputting the subsequent segment once the output of the current segment has been completed. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.

For a description of the "Retrigger" and "Armed_Retrigger" trigger modes, see Table 4-15.

4.9.5.4 Triggering in "Next trigger mode = sequencer"

The waveform files are processed according to the order and repetition cycles defined in the special sequencing list file (`*.wvs`) assigned to the multi-segment waveform file.

4.10 Generating multicarrier waveform signals

To simulate complex multicarrier scenarios with different baseband signals, the R&S SMM100A provides the possibility to generate multicarrier waveforms. These waveforms can consist of up to 512 carriers, each modulated by the same or by different user-selectable baseband signal.

The multicarrier waveform is a practical solution for the generation of a complex broadband signal, for example:

- Multicarrier waveforms build from signals of different communication standards (e.g. CDMA2000 or 3GPP FDD)

- Multicarrier waveforms composed of several signals from the same communication standard as in LTE Advanced.

4.10.1 Required options

See Section 4.6.1, "Required options", on page 150.

Multicarrier waveform files require the corresponding digital standard options (R&S SMM-K2xx) of all included standards.

4.10.2 About the multicarrier waveforms

This section provides background information on the ARB functionality for generating of multicarrier signals and the impact of the provided settings. See Section 4.10.4, "Using the multicarrier function", on page 249 for information on how to use the provided settings to configure a multicarrier signal.

The multicarrier waveforms are a convenient way to configure the broadband test signals required for transmitter or receiver tests. Even complex multicarrier scenarios composed of signals from different digital standards can be created and used for these tests.

Because the multicarrier files are processed by the ARB, the composed waveform file must be created before it is loaded to and played by the ARB. The R&S SMM100A saves the created multicarrier waveform file under a user-definable name; as with the single carrier waveforms, the used file extension is `*.wv`. The instrument appends additional information to the header of the composed waveform file. When the created waveform is loaded, the graphical interface displays information on clock rate, number of samples and creation day.

Multicarrier waveforms versus multicarrier continuous wave signals

By default, the ARB multicarrier waveform application does not generate multicarrier continuous wave signals (CW) that are aligned to the center frequency. Signals generated by the digital standard "Multi Carrier CW" are aligned to the center frequency.

To generate a multicarrier CW, create a constant DC input signal, see "Create Test Signal" on page 159. Select a signal period that is matching the carrier frequency distances.

To reach a smooth transition between end and start signal, make sure that the actual carrier frequency offset is rounded: Select "Mode" > "Equidistant Carrier Spacing" to set a frequency resolution that is the inverse of the signal period of the output signal. See Section 4.10.2.1, "Defining the carrier frequency", on page 236.

General principle for composing the multicarrier signal

The following is a list of the general steps used for composing the multicarrier signal:

- In the default mode, the up to 512 carriers are equally spaced and centered toward the RF frequency or the baseband DC line.

The carrier spacing is adjustable within the total available bandwidth. Make sure that the total RF bandwidth of the composed multicarrier signal does not exceed the available RF bandwidth.

- Another possibility is to define the center frequency of each of the carrier individually, see also Section 4.10.2.1, "Defining the carrier frequency", on page 236.
- Define each carrier separately in terms of power, phase and modulated input signal.
  To define the leveling of the composed multicarrier signal, use the parameter "Power Reference", see "Power Reference" on page 241.
- Optionally, optimize the crest factor of the multicarrier output signal, see Section 4.10.2.2, "Optimizing the crest factor", on page 237.
- After all multicarrier processing steps are completed, the instrument calculates the resulting peak and RMS power over the total signal. This value is then written in the waveform file.

For more information, refer to the specifications document.

4.10.2.1 Defining the carrier frequency

There are two ways to define the carrier frequency of the individual carriers in the multicarrier signal:

- Enable the arbitrary carrier frequency distribution and specify the carrier frequency of each carrier individually.
- Use the built-in equidistant carrier spacing distribution function.

About equidistant carrier spacing

Equidistant carrier spacing implies a uniform distribution around the RF frequency. This method derives the carrier frequencies automatically from the selected number of carriers and the carrier spacing.

The maximum carrier spacing Δf_{max} is a function of the available total bandwidth f_{tot} and the selected number of carriers n. Calculate Δf_{max} as follows:

$$\Delta f_{max} = \frac{f_{tot}}{n - 1}$$

The method rounds the value of the carrier spacing Δf_{round} so that the carrier that is closest to the center RF frequency shows no phase jump. Also, this method holds for unmodulated carriers only. Rounding includes the output signal duration t_{output} and the actual carrier spacing Δf as follows:

- For an odd number of carriers:
  $$\Delta f_{round} \simeq \frac{1}{t_{output}} * [\Delta f * t_{output}]$$
- For an even number of carriers:
  $$\Delta f_{round} \simeq \frac{2}{t_{output}} * [0.5 * \Delta f * t_{output}]$$

To avoid wrap-around problems, you can slightly modify the effective applied carrier spacing. See also "Mode" on page 239.

4.10.2.2 Optimizing the crest factor

An introduction to the topic is provided in Section 4.4.1.9, "Methods for optimizing the crest factor", on page 103. This section focuses on the settings provided for and related to the multicarrier signals.

The R&S SMM100A provides a crest factor reduction by an automatic optimization upon selected values for the following parameters:

- "Crest Factor Mode":
  This mode offers multicarrier output signals with minimized or maximized target crest factor values via internal phase corrections of the single carriers. For a disabled mode ("Off"), there are no phase corrections.
- "Clipping":
  Clipping reduces the peak power of the output multicarrier signal. The clipped peak power level is the sum of the RMS level of the unclipped multicarrier signal and the parameter "Target Crest Factor".
  Because clipping also reduces the RMS level, the resulting crest factor of the clipped signal is slightly above the "Target Crest Factor".
- "Target Crest Factor":
  Sets the target crest factor. A value above the crest factor of the unclipped multicarrier signal has no effect.
- "Filter Cut Off Frequency":
  This frequency is the lowpass filter frequency. If the cutoff frequency equals half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multicarrier signal. But lowpass filtering can also increase the resulting crest factor.

4.10.3 Multicarrier settings

Access:

► Select "Baseband" > "ARB" > "General" > "Create Multi Carrier".

The "ARB: Multi Carrier" dialog opens. It provides general settings to configure the carrier distribution around the center frequency and to improve the output signal characteristics.
The tab "Carrier Table" allows selecting a waveform file per carrier. Use the "Carrier Graph" to visualize the configured signal.

The remote commands to define these settings are described in "Multicarrier commands" on page 900.

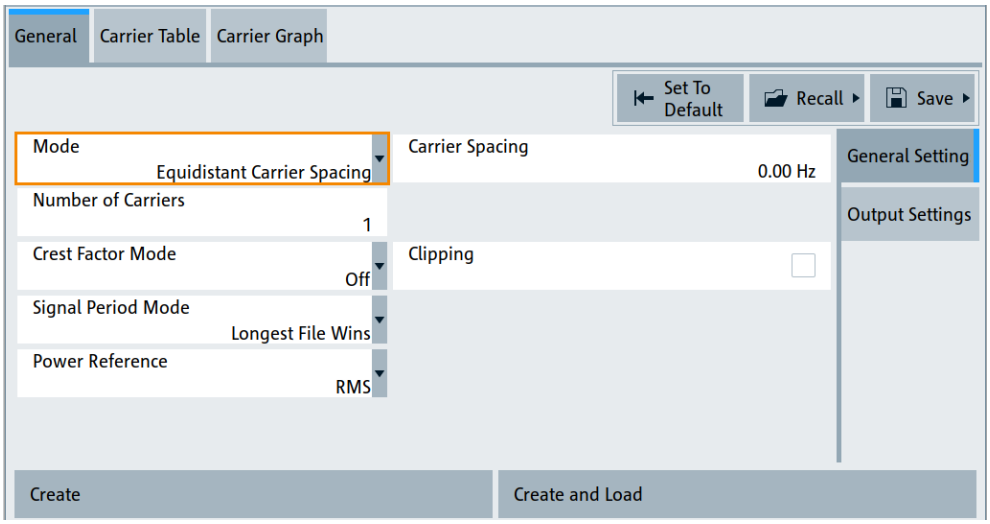
Settings:

- General settings 238
- Output settings 243
- Carrier table settings 244
- Carrier table assistant 246
- Carrier graph 249

4.10.3.1 General settings

Access:

► Select "Create Multi Carrier" > "General" > "General Settings".



This tab provides settings to select the output waveform file, to enable signal generation and to configure the distribution of the carriers.

Settings:

Set to Default 239
Save/Recall 239
Mode 239
Number of Carriers 239
Carrier Spacing 240
Crest Factor Mode 240
Clipping 240
Target Crest Factor 240
Filter Cut Off Frequency 240
Signal Period Mode 241
Signal Period Mode 241
Power Reference 241
Create/Create and Load 243

Set to Default
Calls the default settings.

Parameter	Value
"Number of Carriers"	"1"
"Carrier Spacing"	"0.00 Hz"
"Crest Factor Mode"	"Off"
"Signal Period Mode"	"Longest File Wins"

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet on page 901

Save/Recall
Opens the standard "Save"/"Recall" dialog that is the standard instrument function for saving and recalling the complete dialog-related settings.

Save multicarrier settings in files with file extension `*.arb_multcarr`. Define the file-name and the directory of the file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog? on page 901
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD on page 901
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe on page 902

Mode
Selects the way that the carriers are distributed within the available bandwidth.

"Equidistant Carrier Spacing"
Sets an equidistant carrier spacing distribution, i.e. the carriers are equally spaced and centered toward the RF frequency. The carrier frequencies are automatically calculated depending on the selected number of carriers and the carrier spacing.

"Arbitrary Carrier Frequency"
Set the carrier frequency of each carrier individually.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE on page 902

Number of Carriers
Sets the number of carriers for the multicarrier waveform. By default the multicarrier table lists one carrier. A maximum of 512 carriers can be configured and activated.

When the number of carriers is increased, new lines are added at the end of the table. If these carriers already have been defined before, the settings are preset according to the former settings. Otherwise the parameters are preset with the default values.

See also Section 4.10.2.1, "Defining the carrier frequency", on page 236.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt on page 902

Carrier Spacing
Sets the frequency spacing between adjacent carriers of the multicarrier waveform.

The distribution of the carriers is symmetric around the RF carrier. See also Section 4.10.2.1, "Defining the carrier frequency", on page 236.

For more information, refer to the specifications document.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing` on page 902

Crest Factor Mode
Selects the mode for optimizing the crest factor by calculating the carrier phases. See also Section 4.10.2.2, "Optimizing the crest factor", on page 237.

The following modes are available:

"Off"	There is no automatic setting for minimizing or maximizing the crest factor. The "Phase" setting as defined in the carrier table is in use.
"Minimize"	The crest factor is minimized by internally calculating optimized carrier phases. The phase setting displayed in the carrier table is invalid.
"Maximize"	The crest factor is maximized by internally calculating optimized carrier phases. The phase setting displayed in the carrier table is invalid.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CFACtor:MODE` on page 903

Clipping
Enables baseband signal clipping.

Clipping reduces the peak power of the resulting multicarrier signal according to the input parameter "Target Crest Factor". See also, Section 4.10.2.2, "Optimizing the crest factor", on page 237.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe]` on page 904

Target Crest Factor
Requires "Clipping" > "On".

Sets the value of the target crest factor. A "Target Crest Factor" above the crest factor of the unclipped multicarrier signal has no effect. See also Section 4.10.2.2, "Optimizing the crest factor", on page 237.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor` on page 904

Filter Cut Off Frequency
Requires "Clipping" > "On".

Sets the cutoff frequency of the lowpass filter before the output of the multicarrier signal.

See also Section 4.10.2.2, "Optimizing the crest factor", on page 237.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff` on page 904

Signal Period Mode
Defines the way the resulting signal period of the multicarrier waveform is calculated. The resulting period is always calculated for all carriers in the carrier table irrespective of their state (ON/OFF). Use the "Carrier Table" > "Info" function to obtain information on the sample rate and file length data of each carrier.

Note: Wrap-around and timing problems can occur when I/Q signals of different length are used. Thus, demodulation of a carrier can be difficult or even impossible.
We recommend that you proceed as follows:

- Consider the timing when creating the input I/Q files.
- Adjust the signal duration to the carrier which is then demodulated.
  Other carriers interfere with the signal.

These problems do not arise with signals of the same standard, for example, 3GPP signals.

The following modes are available:

"Longest File Wins"
: The longest I/Q file in the carrier table defines the resulting signal period. Shorter I/Q files are periodically repeated.

"Shortest File Wins"
: The shortest I/Q file in the carrier table defines the resulting signal period. Longer I/Q files only use the first part.

"User"
: Sets the signal period manually, see "Signal Period Mode" on page 241. Repeats shorter I/Q files periodically and uses only the first part of longer I/Q files.

"Least Common Multiple"
: The output file duration is the least common multiple of all input file durations.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME:MODE` on page 905

Signal Period Mode
Sets the signal period in signal duration mode "User". Repeats shorter I/Q files periodically and for longer I/Q files, uses only the first part.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME` on page 903

Power Reference
Sets the method of leveling individual carriers in a composed multicarrier signal. The difference between the provided modes is especially important if signals with different crest factors are composed together into a multicarrier signal.

"RMS" The individual carriers are leveled based on their RMS power and the configured "Carrier Gain".

Example:

A multicarrier signal is composed from two waveform files.

First carrier "Gain" = 0 dB

Second carrier "Gain" = -3 dB

In the resulting multicarrier signal, the *RMS power* of the second carrier signal is 3 dB lower than the RMS power of the first carrier signal.

"Peak" The individual carriers are leveled based on their peak power and the configured "Carrier Gain".

Example:

A multicarrier signal is composed from two waveform files.

First carrier "Gain" = 0 dB

Second carrier "Gain" = -3 dB

In the resulting multicarrier signal, the *peak power* of the second carrier signal is 3 dB lower than the peak power of the first carrier signal.

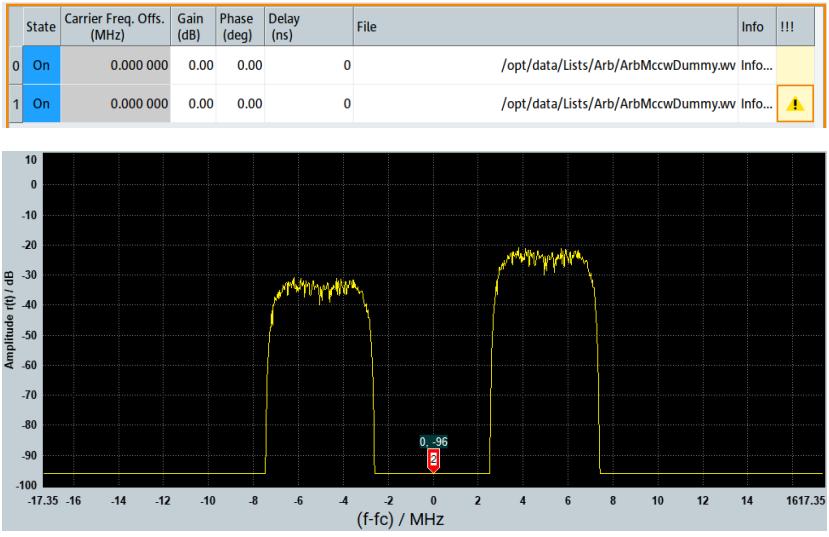
Example: Multicarrier signal composed of waveforms with different crest factor

A multicarrier signal is composed from two waveform files with the following characteristics:

3GPP FDD signals with the same "Sample Rate" but *different "Crest Factors"*.

"Peak" = 0 dBFS

"Carrier Gain" = 0 dB



The peak values of the carrier signals are equal, but the RMS values are different.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence on page 905

Create/Create and Load
Creates a multicarrier waveform defined by the multicarrier table and general setting entries.

If you start the calculation with the "Create and Load" function, the instrument creates the waveform and loads it in the ARB.

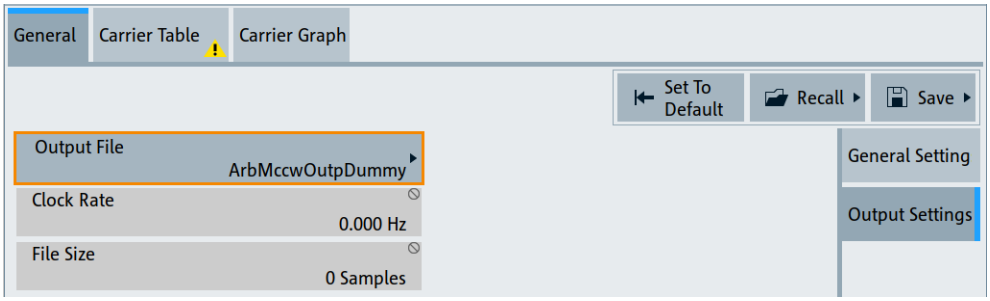
Also, saves this multicarrier waveform with filename as set in "Output File". Depending on the configuration of the multicarrier waveform, calculation can take some time. To stop the calculation, use the "Abort" function.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate on page 906
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad on page 905

4.10.3.2 Output settings

Access:

► Select "Create Multi Carrier" > "General Settings" > "Output Settings"



This tab displays settings of the output file and related output multicarrier signal. These settings include the output filename, the clock rate and the file size.

Settings:

Output File....243
Clock Rate....244
File Size....244

Output File
Opens a standard "File Select" dialog to set the output filename of the multicarrier waveform to be calculated. As with normal waveforms, the file extension is `*.wv`.

To trigger the calculation and storage of this multicarrier waveform, select "Create" or "Create and Load".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe on page 905

Clock Rate
Displays the resulting sample rate during the output of the multicarrier waveform is output at the ARB.

The output clock rate depends on the following:
- Number of carriers
- Carrier spacing
- Input sample rate of the leftmost or rightmost carriers.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk?` on page 906

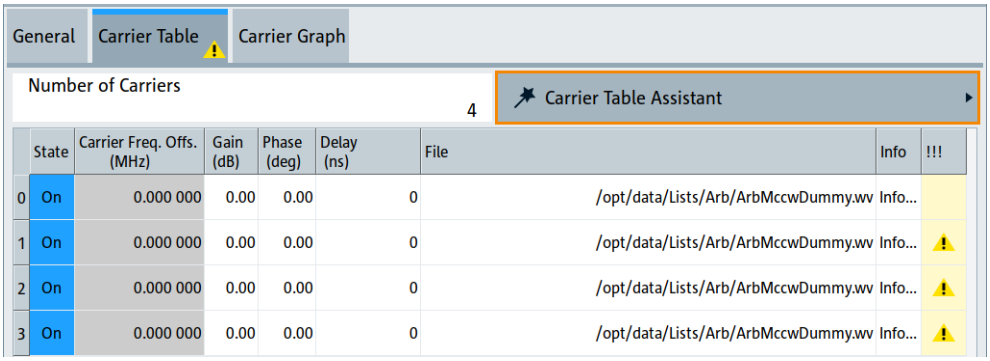
File Size
Displays the resulting number of samples of the multicarrier waveform.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?` on page 903

4.10.3.3 Carrier table settings

Access:

► Select "Create Multi Carrier" > "Carrier Table"



This tab provides the settings to configure the number of carriers and set individual carrier characteristics in a table. The number of lines equals the number of carriers. Note that valid phase settings "Phase (deg)" require disabled crest factor optimization: "Crest Factor Mode" > "Off".

Optionally, use the "Carrier Table Assistant" for simplified configuration of the individual carriers, see Section 4.10.3.4, "Carrier table assistant", on page 246. Use the "Carrier Graph" tab to visualize the configured multicarrier signal including its individual carriers, see Section 4.10.3.5, "Carrier graph", on page 249.

Settings:

Number of Carriers....245
Carrier number....245
State....245
Carrier Freq. Offs. (MHz)....245

Gain (dB)....245
Phase (deg)....245
Delay (ns)....245
File....246
Info....246
!!!....246

Number of Carriers
Defines the number of carriers of the multicarrier waveform, see "Number of Carriers" on page 239.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt` on page 902

Carrier number
Displays the number of an individual carrier. The numbering of these carriers ranges from 0 to the number of carriers - 1.

Remote command:
Set via suffix `CARRier<ch>`.

State
Enables an individual carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe` on page 906

Carrier Freq. Offs. (MHz)
Displays the carrier frequency offset. This offset indicates

Note: The carrier frequency can only be set in "Arbitrary Carrier frequency" mode. For "Equidistant Carrier Spacing", the carrier spacing is determined automatically.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency`
on page 907

Gain (dB)
Sets the gain of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer` on page 907

Phase (deg)
Sets the starting phase of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe` on page 907

Delay (ns)
Sets the starting delay of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay` on page 908

File
Opens the standard "File Select" function for selecting the input file. The input file contains the I/Q signal that is modulated onto the carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE` on page 908

Info
Opens a waveform information dialog. This dialog lists the sample rate, the number of I/Q value pairs (number of samples) and the signal period.

Remote command:
n.a.

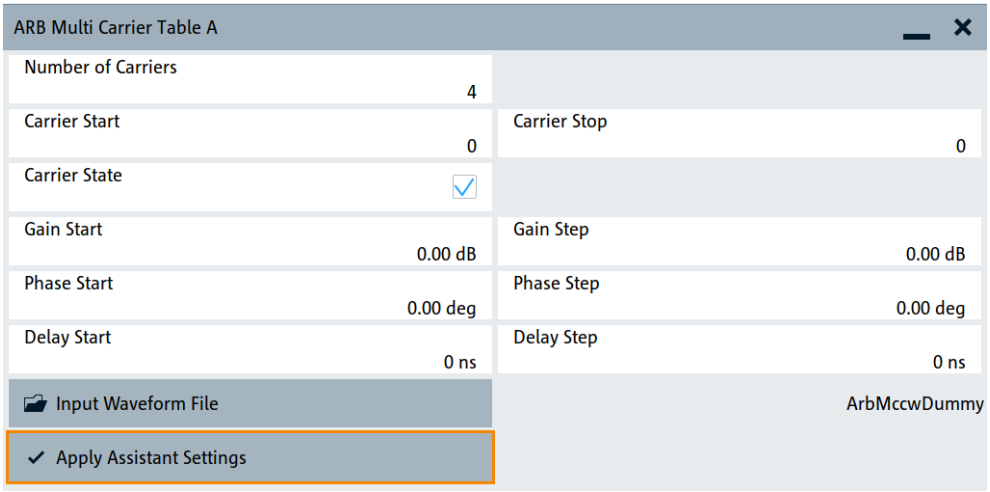
!!!
Indicates a conflict with a warning triangle. A conflict arises when the carriers overlap and is also indicated in the header of the "Carrier Table" tab.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?`
on page 908

4.10.3.4 Carrier table assistant

Access:

1. Select "Create Multi Carrier" > "Carrier Table"
2. Select "Carrier Table Assistant".



The "Carrier Table Assistant" dialog enables the configuration of a selectable subset of carrier. The provided settings are an optional way to create a multicarrier scenario within a specified carrier range.

Settings:

Carrier State....247
Carrier Start....247
Carrier Stop....247
Gain Start....247
Gain Step....247
Phase Start....248
Phase Step....248
Delay Start....248
Delay Step....248
Input Waveform File....248
Apply Assistant Settings....248

Carrier State
Enables the carriers in the range "Carrier Start" to "Carrier Stop".

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe` on page 908

Carrier Start
Sets the carrier start that is the first individual carrier for which the carrier assistant settings apply.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt` on page 909
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP` on page 909

Carrier Stop
Sets the carrier stop that is the last individual carrier for which the carrier assistant settings apply.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt` on page 909
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP` on page 909

Gain Start
Sets the gain of the carrier marked by "Carrier Start".

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer[:STARt]` on page 909

Gain Step
Sets the step size that is used to increment the gain.

The resulting carrier gain in the carrier table equals:

Gain = "Gain Start" + n"Gain Step"*.

n is a value between 0 and the difference of "Carrier Stop" and "Carrier Start".

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP` on page 909

Phase Start
Sets the phase of the carrier marked by "Carrier Start".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe[:STARt] on page 910

Phase Step
Sets the step size that is used to increment the phase.

The resulting phase in the carrier table equals:

Phase = "Phase Start" + n"Phase Step"*

n is a value between 0 and the difference of "Carrier Stop" and "Carrier Start".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP on page 910

Delay Start
Sets the delay of the carrier marked by "Carrier Start".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay[:STARt] on page 911

Delay Step
Sets the step size that is used to increment the delay.

The resulting delay in the carrier table equals:

Delay = "Delay Start" + n"Delay Step"*,

n is a value between 0 and the difference of "Carrier Stop" and "Carrier Start".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP on page 910

Input Waveform File
Opens the standard "File Select" function for selecting the input file. The input file contains the I/Q modulation signal for all carriers of the selected carrier range.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE on page 911

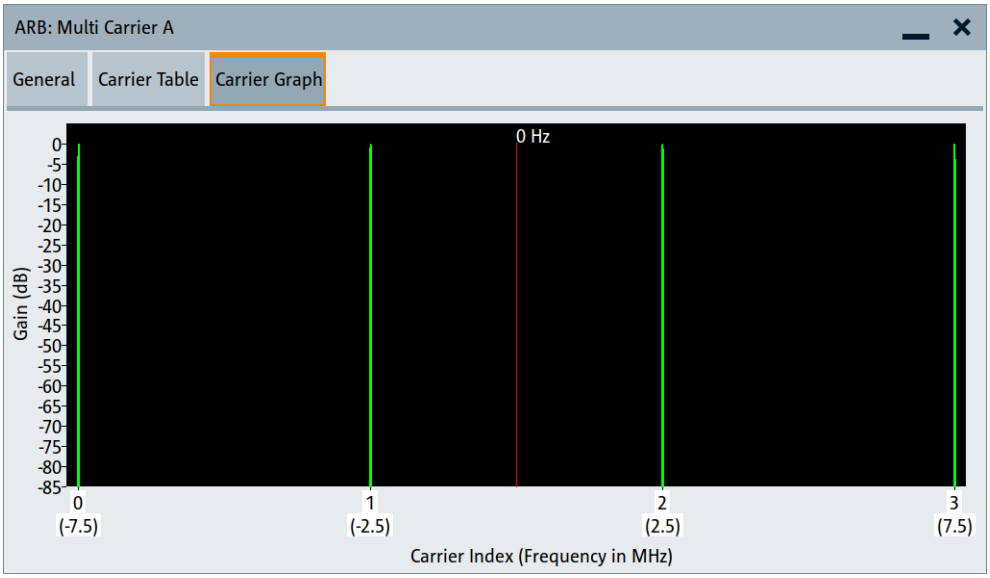
Apply Assistant Settings
Transfers the assistant settings to the carrier table.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute on page 911

4.10.3.5 Carrier graph

Access:

► Select "Create Multi Carrier" > "Carrier Graph".



The carrier graph is a graphical representation of the current multicarrier configuration in the frequency domain.
The height of the bars corresponds to the gain of each individual carrier. The bars width indicates the bandwidth of the carriers signals.

4.10.4 Using the multicarrier function

This section provides step-by-step instructions on how to configure and use the multicarrier settings.

To create a multicarrier waveform file

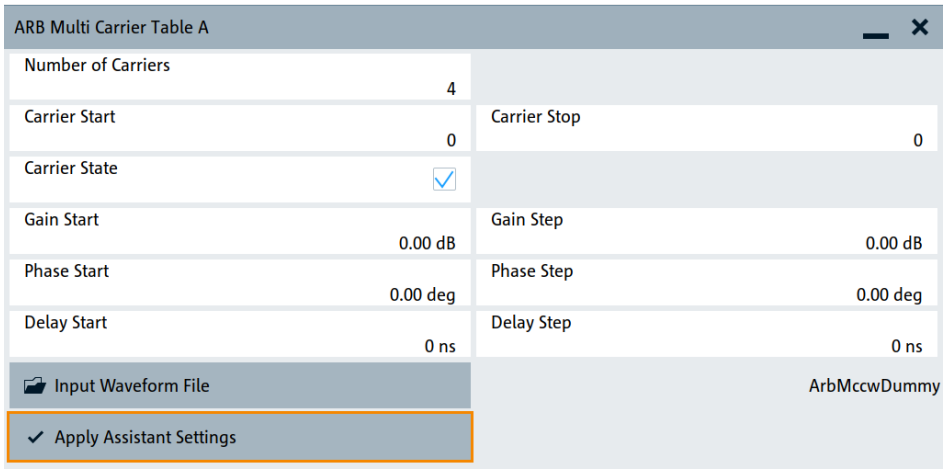
1. To configure the general settings, select "Baseband" > "ARB" > "General".
2. To configure the carrier table, select "ARB" > "Multi Carrier" > "Carrier Table"
3. To enter the filename of the multicarrier waveform, select "ARB" > "Multi Carrier" > "Output File"
4. To save or load a multicarrier waveform, select "ARB" > "Multi Carrier" > "Create" or "Create and Load".

To generate a multicarrier signal for standard transmitter tests

High-power amplifiers of multicarrier base stations face increased requirements in terms of linearity and acceptable intermodulation performance.

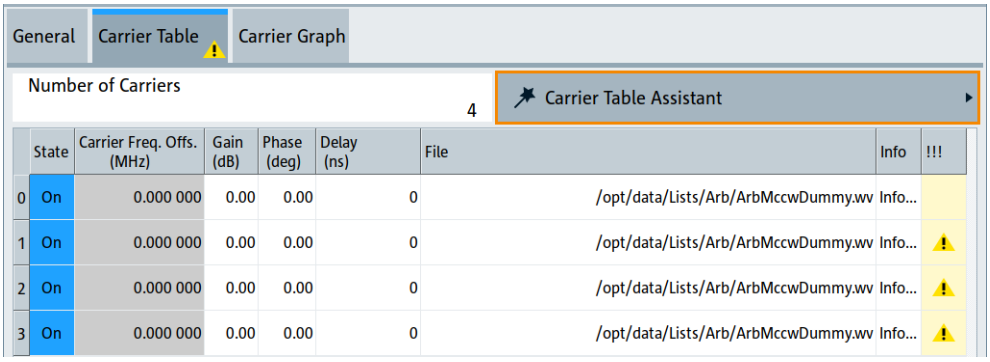
To set up a standard transmitter test, proceed as follows:

1. Open the "Baseband" > "3GPP FDD" dialog. Proceed as follows:
   a) Select "3GPP FDD" > "Basestations" > "Test Setups/Models".
   b) Select "3GPP FDD: Downlink/Test Model" > "Test_Model_1_16channels".
   c) To confirm, tap "Select".
2. To enable signal generation, select "3GPP FDD" > "General" > "On".
3. To create a 3GPP ARB file, select "3GPP FDD" > "Generate Waveform".
   Enter the name of the waveform that you want to generate, for example: `3gpp_1_16`.
4. Confirm with "Save"
5. To set up a multicarrier scenario with 4 carriers and a carrier spacing of 5 MHz, select "Baseband" > "ARB" > "Create Multi Carrier".
   Perform the following:
   a) In the "General" dialog, select "Number of Carriers" = "4" and "Carrier Spacing" = "5 MHz".
   b) To load the generated waveform file to all 4 carriers, select "Carrier Table" > "Carrier Table Assistant".
   c) Select "Carrier Start" = "0" and "Carrier Stop" = "3".
   d) To load the generated waveform file to all 4 carriers, select "ARB Multi Carrier Table" > "Input Waveform File".
   e) Select the generated waveform file `3gpp_1_16`.
   f) Select "ARB Multi Carrier Table" > "Carrier State" > "On".

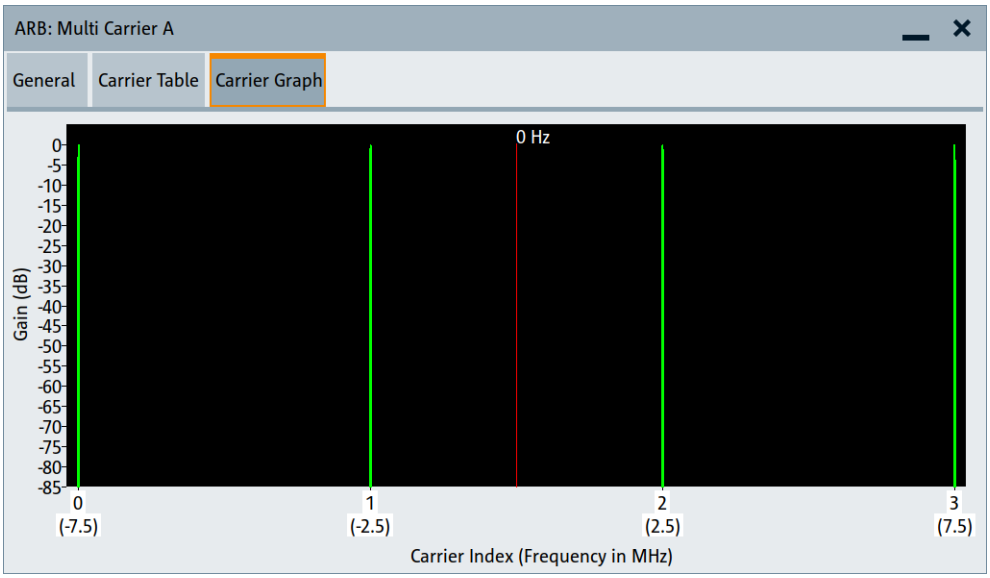


   g) Select "ARB Multi Carrier Table" > "Apply Assistant Settings".
   h) Close the dialog.

   The "ARB: Multi Carrier" > "Carrier Table" dialog confirms the configuration.



6. Select "ARB: Multi Carrier" > "Carrier Graph" to visualize the configuration.



7. Select "ARB: Multi Carrier" > "General" > "Output Settings" > "Output File".
8. Enter the name of the output file, for example `4x5MHz_3gpp_1_16`.
9. To load the waveform in the ARB, select "ARB: Multi Carrier" > "General" > "Create" or "Create and Load".
10. Select "ARB" > "General" > "Load Waveform", to select the multicarrier output file.
11. Select "ARB" > "State" > "On" to enable the ARB.

4.11 Generating multicarrier continuous wave signals

The multicarrier continuous wave (MCCW) is a firmware option that enables the R&S SMM100A to calculate up to 160001 continuous wave signals.

4.11.1 Required options

The equipment layout for processing of waveform files includes:

- Option baseband generator (R&S SMM-B9)
- Option multicarrier CW (R&S SMM-K61)

4.11.2 About MCCW

The R&S SMM100A can calculate and generate a multicarrier continuous wave (MCCW) signal that consists of up to 8192 unmodulated carriers. The carrier offset and the power level of the carriers are user-definable. The provided settings allow individual configuration of each carrier and the joint configuration of a subset of carriers. Automatic start phase setting is provided to minimize the crest factor.

The R&S SMM100A does not generate MCCW signals in real time but computes them in arbitrary waveform mode. For example, you need to accept real-time changes in the carrier settings before the instrument applies them.

The common application fields of the MCCW signals are the receiver tests with broadband test signals.

4.11.3 MCCW settings

Access:

► Select "Baseband" > "Multi Carrier CW".

The dialog provides settings to configure individual carriers directly. Also, it provides access to the carrier table and the graphical representation of the configured carriers.

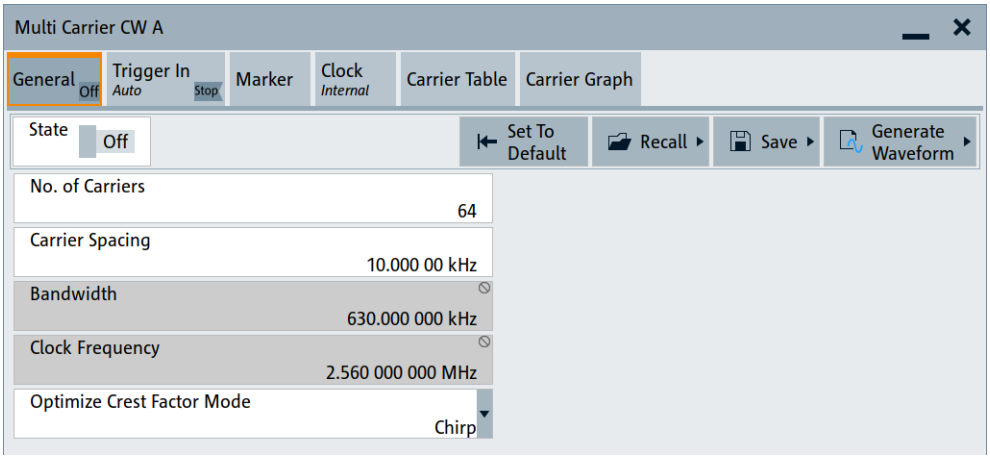
The remote commands required to define these settings are described in Section 13.17.5.4, "SOURce:BB:MCCW subsystem", on page 926.

Settings:

4.11.3.1 General settings

Access:

► Select "Baseband" > "Multi Carrier CW".



The tab povides general settings to configure multiple CW carriers.

Settings:

State....253
Set To Default....254
Save/Recall....254
Generate Waveform....254
Number of Carriers....254
Carrier Spacing....254
Bandwidth....255
Clock Frequency....255
Optimize Crest Factor Mode....255
Desired Crest Factor....255

State
Enables MCCW signal generation.

Switching on this option, turns off all the other digital standards and digital modulation modes in the corresponding signal path.

MCCW signals are computed in arbitrary waveform mode. To adopt the changes in the settings of individual carriers, select "Accept". This selection applies to the settings in the "Table Setup Assistant" section and the "Carrier Table" dialog.

Remote command:
`[:SOURce<hw>]:BB:MCCW:STATe` on page 931

Set To Default
Calls the default settings, see Table 4-20.

Remote command:
[:SOURce<hw>]:BB:MCCW:PRESet on page 931

Save/Recall
Opens the "Save/Recall" dialog that is the standard instrument function for saving and recalling the complete dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The settings are saved in a file with a predefined extension. You can define the filename and the directory, in that you want to save the file.

See also Section 10.5, "Saving and recalling settings", on page 529.

Save or recall MCCW settings in a file with the predefined extension `*.mccw_set`.

Remote command:
[:SOURce<hw>]:BB:MCCW:SETTing:LOAD on page 931
[:SOURce<hw>]:BB:MCCW:SETTing:CATalog? on page 931
[:SOURce<hw>]:BB:MCCW:SETTing:DELete on page 932
[:SOURce<hw>]:BB:MCCW:SETTing:STORe on page 932

Generate Waveform
With enabled signal generation, triggers the instrument to save the current settings of an MCCW waveform signal in a waveform file with the extension `*.wv`. You can define the filename and the directory, in that you want to save the file.

Remote command:
[:SOURce<hw>]:BB:MCCW:WAVeform:CREate on page 932

Number of Carriers
Sets the number of carriers composing the MCCW signal.

Note: Cross-reference between total bandwidth, carrier spacing, and number of carriers. The total bandwidth of the multicarrier CW signal is calculated as follows:
Total Bandwidth = ("Number of Carriers" - 1) * "Carrier Spacing"

The result must not exceed the system bandwidth of the instrument.

For more information, refer to the specifications document.

If the total bandwidth is not respected, the value selected as "Carrier Spacing" is reduced. Hence, the selected number of carriers defines the maximum carrier spacing.

By default, the multicarrier table lists 64 carriers that are preset to the settings: "State" = "On", "Power" = "0 dB", "Phase" = "0°".

If the selected number of carriers is less than the carriers in the table, the superfluous table rows are deleted. If the number of carriers exceeds the number of table rows, new rows are appended to the table.

Remote command:
[:SOURce<hw>]:BB:MCCW:CARRier:COUNt on page 932

Carrier Spacing
Sets the spacing between carriers for the MCCW signal. The carriers are arranged symmetrically around the HF carrier.

Remote command:
[:SOURce<hw>]:BB:MCCW:CARRier:SPACing on page 933

Bandwidth
Indicates the resulting occupied signal bandwidth, calculated from the selected Number of Carriers and Carrier Spacing.

Clock Frequency
Displays the clock rate.

The arbitrary waveform generator outputs the MCCW signal at this rate. The output clock rate depends on the number of carriers and the selected carrier offset.

The value indicates the resolution during the marker generation.

Remote command:
[:SOURce<hw>]:BB:MCCW:CLOCk? on page 933

Optimize Crest Factor Mode
Selects the mode for automatically minimizing the crest factor. The carrier start phases are automatically configured according to the selected mode.

Methods of reducing the crest factor differ regarding both the optimization achievable and the time required for computation. For more information, refer to Section 4.4.1.9, "Methods for optimizing the crest factor", on page 103.

"Off" — There are no automatic settings for minimizing the crest factor. Use the "Phase" parameter to set the start phase.

"Chirp" — Rapid crest factor optimization regardless of the number of carriers.

The minimal crest factor is 3 dB if the following prerequisites are fulfilled:
- All carriers in the multicarrier signal are switched on.
- All carriers have identical power.

In a configuration which differs from these prerequisites, the achievable crest factor is worse.

"Target Crest" — Optimization of the crest factor to a desired value for all carrier configurations.
The optimization time depends on the number of carriers and the desired crest factor. Computation time increases only when the number of carriers exceeds 256 and the crest factor is below 4 dB. The desired value can be entered in "Desired Crest Factor".

Note: Optimization can be canceled at any time, and the current value being displayed at that moment is then used.

Remote command:
[:SOURce<hw>]:BB:MCCW:CFACtor:MODE on page 933

Desired Crest Factor
Requires "Optimize Crest Factor Mode" > "Target Crest".

Sets the desired crest factor that is the target crest factor.

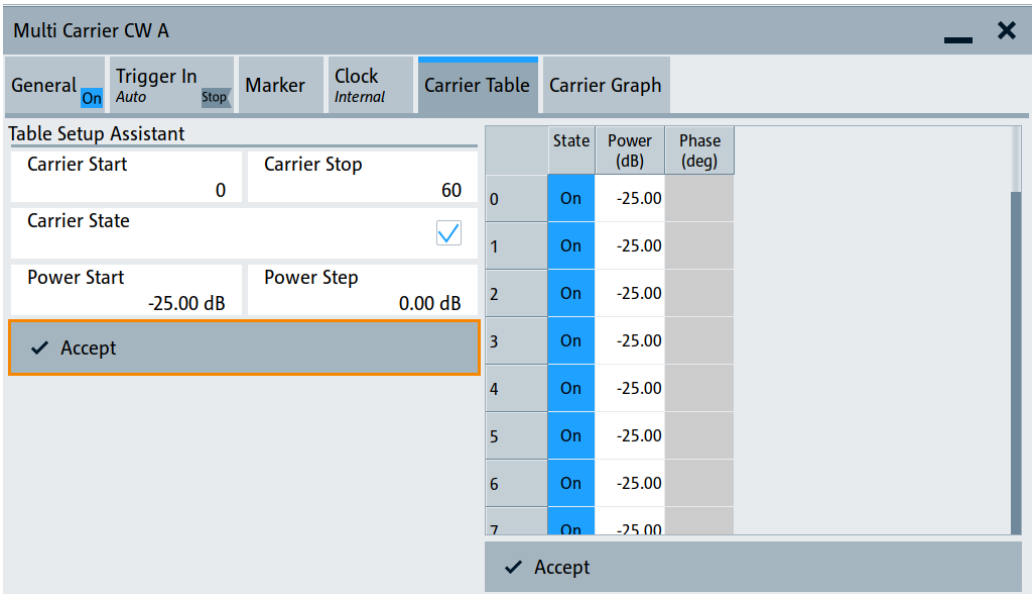
Remote command:
[:SOURce<hw>]:BB:MCCW:CFACtor on page 933

4.11.3.2 Carrier table

Access:

► Select "Baseband" > "Multi Carrier CW" > "Carrier Table".

The provided settings enable the configuration of a selectable range of carriers.



Settings:

Table Setup Assistant....256
Carrier Start/Stop....256
Carrier State....257
Power Start....257
Power Step....257
Phase Start....257
Phase Step....257
Accept....257
Carrier Table....257

Table Setup Assistant
Enables joint configuration of a selectable range of carriers.

Carrier Start/Stop ← Table Setup Assistant
Defines the start/stop index of the carrier range to which the following settings are intended to apply.

Remote command:
`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STARt` on page 938
`[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STOP` on page 938

Carrier State ← Table Setup Assistant
Switches the carriers in the carrier range on/off.

Remote command:
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STATe on page 938

Power Start ← Table Setup Assistant
Sets the power of the starting carrier.

Remote command:
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer[:STARt] on page 937

Power Step ← Table Setup Assistant
Sets the width of the step with which the power is changed from carrier to carrier.

The individual power of each carrier ("Carrier Table" > "Carrier#" > "Power") is calculated as "Power Start" + n*"Power Step".

Remote command:
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer:STEP on page 937

Phase Start ← Table Setup Assistant
If "Optimize Crest Factor Mode" > "Off", sets the phase of the starting carrier.

Remote command:
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe[:STARt] on page 937

Phase Step ← Table Setup Assistant
If "Optimize Crest Factor Mode" > "Off", sets the width of the step with which the phase is changed from carrier to carrier.

The individual phase of each carrier ("Carrier Table" > "Carrier#" > "Power") is calculated as "Phase Start" + n*"Phase Step".

Remote command:
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe:STEP on page 937

Accept ← Table Setup Assistant
Adopts the carrier range setting into the "Carrier Table".

Remote command:
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:EXECute on page 938

Carrier Table
A table with settings for the configuration of the individual carriers.

The MCCW signal is only computed when the "Accept" function is triggered. Whenever the carrier table contains settings that have not yet been adopted with the "Accept" function, the background is yellow.

Note: The phase/deg settings are only valid if optimization of the crest factor is disabled ("Optimize Crest Factor" > "Off").

Tip: Use the Carrier graph function to display the current carrier configuration.

"No." Carrier index.

"State" Switches a carrier on/off.

"Power" Sets the power of a carrier.
If you use the Table Setup Assistant settings to fill the individual carrier powers, the power of a carrier is calculated as follows:
"Power Start" + n*"Power Step".

"Phase" Sets the starting phase of a carrier.
If you use the Table Setup Assistant settings to fill the individual carrier phases, the phase of a carrier is calculated as follows:
"Phase Start" + n*"Phase Step".

"Accept" Transfers the settings in the carrier table into the instrument.

Remote command:
`[:SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe` on page 934
`[:SOURce<hw>]:BB:MCCW:CARRier:STATe` on page 934
`[:SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer` on page 936
`[:SOURce<hw>]:BB:MCCW:CARRier:POWer` on page 936
`[:SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe` on page 935
`[:SOURce<hw>]:BB:MCCW:CARRier:PHASe` on page 935

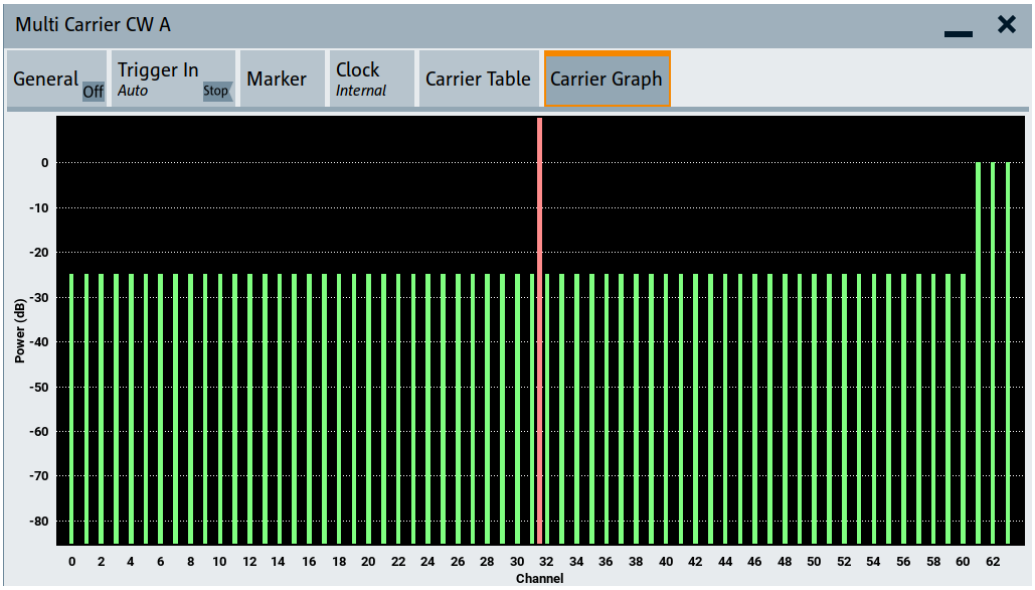
4.11.3.3 Carrier graph

Access:

► Select "Baseband" > "Multi Carrier CW" > "Carrier Graph".

The "Carrier Graph" tab is a graphical representation of the current carrier configuration.

The carriers are on the X-axis and the colored bars represent those carriers which are in the active state. Power is on the Y-axis, and the height of the bars corresponds to the chosen power of each individual carrier.



4.11.3.4 Trigger, marker and clock settings

These tabs provide standard settings.

For detailed description, see:

- Section 4.4.2.1, "Trigger settings", on page 106
- Section 4.4.2.2, "Marker settings", on page 111
- Section 4.4.2.3, "Clock settings", on page 113
- Section 4.4.2.4, "Local and global connectors settings", on page 114

4.11.4 Using MCCW signals

This section provides examples on how to use the multicarrier continuous wave function in some general test cases.

To generate a signal to test the frequency response

If the test case requires a signal for DUT testing, like power amplifier or filter with a bandwidth of 80 MHz, proceed as follows:

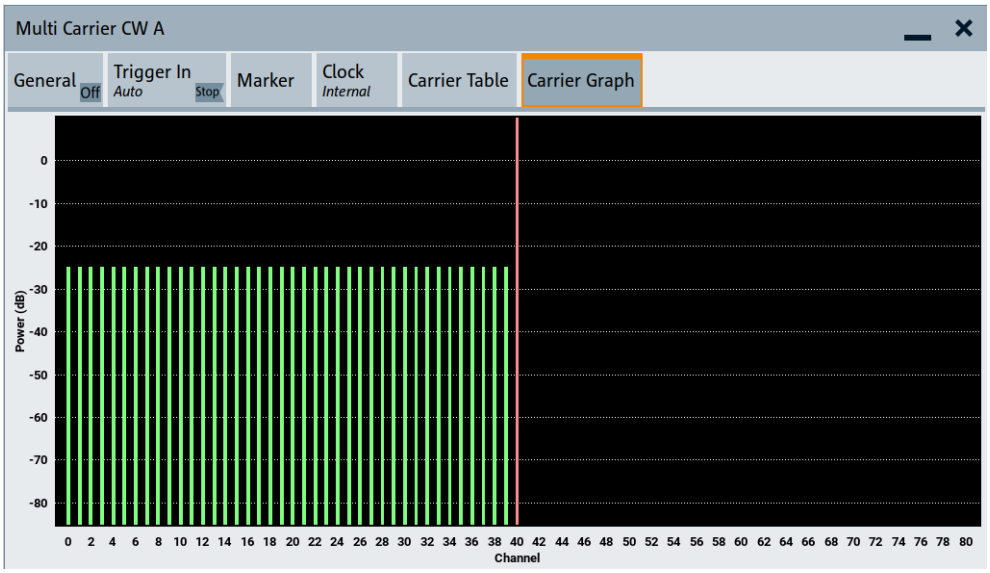
1. Connect the DUT to the output connectors of the instrument.
2. Connect a suitable measurement equipment, like a signal analyzer to the DUT.
3. Select "Baseband" > "Multi Carrier CW".
4. Adjust further settings, for example, trigger settings, as required.
5. Set "Multi Carrier CW" > "State" > "On".
6. Set "RF" > "On" to enable the signal output.
7. On the connected signal analyzer, execute the required measurement tasks. Measure the frequency response at the outputs of the DUT.

To generate a single sideband signal to test the image rejection

If a single sideband test signal for testing the image rejection capabilities of DUT is required, proceed as follows:

1. Connect the DUT to the output connectors of the instrument.
2. Connect a suitable measurement equipment, like a signal analyzer to the DUT.
3. Select "Baseband" > "Multi Carrier CW" > "General":
   a) Enable "No. of Carriers" = "81".
   b) Set "Carrier Spacing" = "1 MHz".
4. Select "Multi Carrier CW" > "Carrier Table":
   a) Set "Carrier Start" = "40".
   b) Set "Carrier Stop" = "80".
   c) Set "Carrier State" = "Off".
   d) Confirm with "Accept".

Open the "Multi Carrier CW" > "Carrier Graph" to visualize the configured single sideband signal.



5. Adjust further settings, for example, trigger settings, as required.
6. Set "Multi Carrier CW" > "State" > "On".
7. Set "RF" > "On" to enable the signal output.
8. On the connected signal analyzer, execute the required measurement tasks. Measure the frequency response at the outputs of the DUT.

4.11.5 References

Table 4-20: MCCW default values

Parameter	**Value**
State	Not affected by "Set to Default"
Carrier Setup	
Number of Carriers	64
Carrier Spacing	10 kHz
Optimize Crest Factor	Chirp
Desired Crest Factor	3 dB
Trigger	
Mode	Auto
Source	Internal
Ext. Delay	0
Ext. Inhibit	0

Parameter	Value
Marker	
Channel 1...4	Restart
Clock	
Source	Internal
Multichannel Setup	
Start Carrier	0
Stop Carrier	0
State	on
Power	0 dB
Power Step	0 dB
Initial Phase	0°
Phase Step	0°
Channel Setup	
State	ON
Phase	0°
Power	0 dB

4.12 Shifting the baseband signal

The R&S SMM100A provides settings to offset the frequency or phase of a baseband signal.

4.12.1 About baseband offsets

The applied baseband frequency and phase offset and path gain affect the signal on the output of the corresponding block, "Baseband" or "BB Input". The shifting of the central frequency of the baseband signal is one of the tasks of the resampler.

4.12.1.1 Impact of the frequency offset

For some applications, it is helpful to shift the baseband signal with a user-defined baseband frequency offset to a different center frequency to improve signal characteristics.

The frequency-offset function shifts the center frequency of the wanted baseband signal. The function also provides a quick way to shift the used frequency band in the RF frequency domain without modifying the RF settings.

See Section 4.12.3, "Improving signal characteristics by shifting the baseband signal", on page 264.

Limitations

The complex I/Q bandwidth of the shifted signal cannot exceed the total available baseband bandwidth. The setting range of the frequency offset is then calculated as follows:

$-(TotalBasebandBandwidth/2) + f_{use}/2 \leq f_{offset} \leq (TotalBasebandBandwidth/2) - f_{use}/2$, where the following applies:

f_{use} is the complex useful bandwidth of the I/Q signal before the offset

f_{offset} is the frequency offset

The Figure 4-31 illustrates the setting range of the frequency offset.

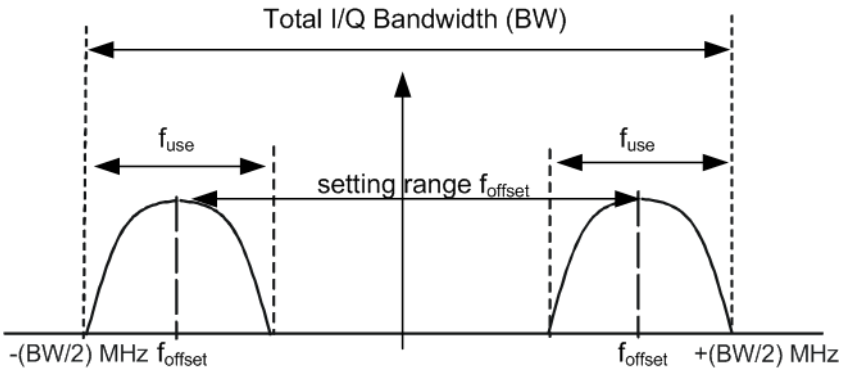


Figure 4-31: Setting range of frequency offset

For more information, refer to the specifications document.

Example: To calculate the maximum frequency offset

This example uses the following signal:

- Standard: "Baseband" > "Custom Digital Mod"
- "Set according to Stanard" > "WCDMA-3GPP"
- "Symbol Rate" = "3.84 Msym/s" or 3.84 MHz
- "Filter" > "Root Raised Cosine (RRC)"
- "Roll Off Factor" = "0.22"

The complex useful bandwidth of a filtered signal is calculated as follows (see "Impact of the filter parameters" on page 102):

- f_{use} = *(1 + "Roll Off Factor") * "Symbol Rate"*
- f_{use} = (1+ 0.22) * 3.84 MHz = 4.6848 MHz

For an instrument with a total available I/Q bandwidth of 160 MHz, the valid range of values for the frequency offset is then:

- -160 MHz/2 + 4.6848 MHz/2 ≤ f_{offset}≤ 160 MHz/2 - 4.6848 MHz/2 or
- -77.6576 MHz ≤ f_{offset}≤ 77.6576 MHz

To observe the effect of offsetting the frequency

Use the built-in real-time graphical display. Select "System Config" > "Graphics" > "Power Spectrum" and observe the power spectrum of the signal with and without frequency offset.

See "To set and verify a baseband frequency offset" on page 470.

4.12.1.2 Impact of the phase offset

The "Phase Offset" determines the phase offset between the different baseband signals. A phase offset rotates each point of an I/Q constellation diagram by the specified phase offset.

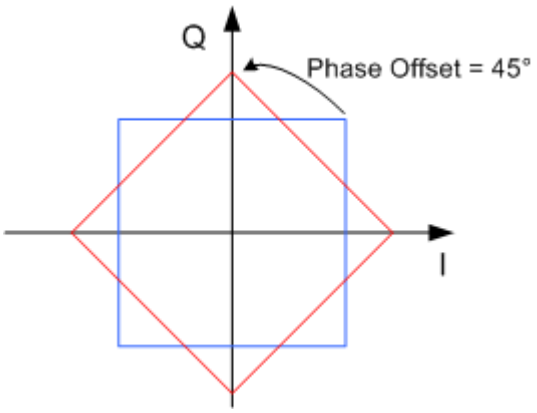


Figure 4-32: I/Q constellation diagram: Effect after offsetting the phase by an angle of 45 °

To observe the effect of offsetting the phase

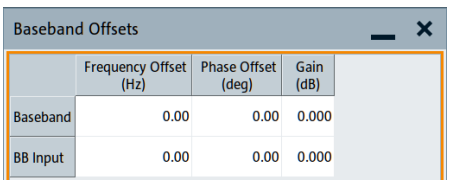
Use the built-in real-time graphical display. Select "System Config" > "Graphics" > "Constellation" and observe that the points on the I/Q constellation diagram are turning counterclockwise.

See Section 8, "Monitoring baseband signal characteristics", on page 454.

4.12.2 Baseband offset settings

Access:

► Select "Baseband"/"BB Input" > "Baseband Offsets".



The "Baseband Offsets" dialog provides settings to offset the frequency or phase of the baseband signal.
Also, you can add a relative gain to the baseband signal.

The block diagram shows an icon Δf on the signal path. This icon indicates an enabled frequency offset.

Settings:

Frequency Offset
Sets the frequency offset of the baseband signal and shifts the useful baseband signal in the center frequency.

Use this function, for example, to shift the baseband signal relative to an AWGN signal.

See also the following sections:
- Section 4.12.3, "Improving signal characteristics by shifting the baseband signal", on page 264
- Section 4.12.3, "Improving signal characteristics by shifting the baseband signal", on page 264

Remote command:
`[:SOURce<hw>]:BB:FOFFset` on page 843
`[:SOURce<hw>]:BBIN:FOFFset` on page 843

Phase Offset
Sets the phase offset for a baseband signal. This phase offset affects the signal after the "Baseband" block.

Use this parameter, for example, to change the start phase of the baseband signal.

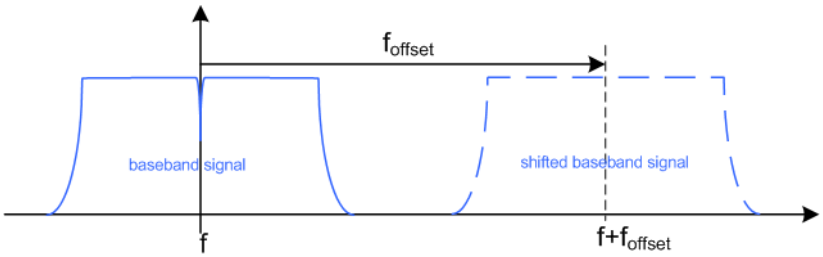
See also Section 4.12.1.2, "Impact of the phase offset", on page 263.

Remote command:
`[:SOURce<hw>]:BB:POFFset` on page 844
`[:SOURce<hw>]:BBIN:POFFset` on page 844

4.12.3 Improving signal characteristics by shifting the baseband signal

Shifting of the generated baseband signal is useful in the following cases:

- You analyze the generated signal with a signal analyzer and the displayed signal spectrum indicates a carrier leakage (a signal drop) at the current RF frequency.



Shifting the baseband signal to a different center frequency can eliminate the carrier leakage problem.

Alternatively, apply an I and/or Q offset and vary the settings until the observed signal drop disappears, see "To optimize the carrier leakage suppression" on page 287.

In the following examples, we assume that:

- The R&S SMM100A generates a baseband signal
- A spectrum analyzer is connected to the R&S SMM100A, the analyzed is configured and measures the required signal characteristics.

To shift the generated baseband signal

1. Select "Baseband" > "Baseband Offsets".
2. To apply an offset to the baseband signal, select for example "Frequency Offset" = "10 MHz".

To verify characteristics of the generated signal

► Use the built-in real-time graphical display.
Section 3.3.5, "Visualizing the generated signal", on page 57

To observe the effect of applied frequency offset and gain

► Use the built-in real-time graphical display.
Section 3.3.5, "Visualizing the generated signal", on page 57

5 Adding noise, predistorting and impairing the signal

The test case scenarios in accordance with the specifications often require not a "clean" signal but rather a signal that is impaired or interfered. To fulfill such requirements, the R&S SMM100A is equipped with a noise generator and provides the possibility to impair and predistort the digital I/Q signal.

This section describes the following functions:

- Adding noise to the signal....266
- Impairing the signal....280
- Applying digital predistortion....287

5.1 Adding noise to the signal

This section introduces the concept of the AWGN generator (Additive White Gaussian Noise). The section also describes the settings for generation of noise, sine wave interferer, and adding noise to the generated signal.

5.1.1 Required options

The equipment layout for generating an AWGN signal includes:

- Option Wideband Baseband Generator (R&S SMM-B9)
- Option Noise Generator (R&S SMM-K62)

5.1.2 About the AWGN generator

Provided the required options are installed, the R&S SMM100A allows you to superimpose noise on the generated signal. The built-in internal noise generator generates an AWGN signal (Additive White Gaussian Noise) with selectable bandwidth and adds it to the digital baseband signal. The main characteristic of this kind of noise signal is the normal distribution of the noise power density and uniform frequency distribution.

AWGN signal

The Gaussian noise is generated with a feedback shift register with a subsequent probability transformation. The switching configuration is such that ideal statistical characteristics are achieved:

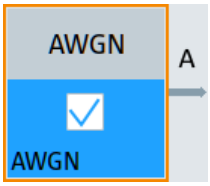
- I and Q paths are decorrelated from each other.
- Small probabilities are ensured via the crest factor of ~15 dB.
- The period of the noise signal is relatively long and depends on the selected system bandwidth.

- Scalable lowpass filters are used to produce a noise level with both a broad dynamic range and a broad bandwidth range.

AWGN modes

The AWGN generator generates signals in one of the following different modes:

- **"Additive Noise":** the generated noise signal superimposes the interference-free wanted signal



- **"Noise Only":** a pure noise signal is generated and modulated to the carrier; the connection to the baseband is interrupted.

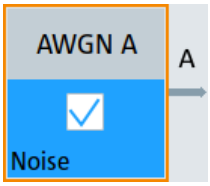
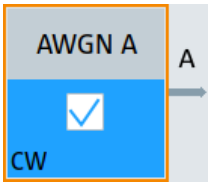


Figure 5-1: AWGN block for noise only signal

- **"CW Interferer":** a sinusoidal signal with an adjustable frequency offset and carrier-to-interferer (C/I) power ratio is added to the baseband signal.



Signal and noise parameters

The figure Figure 5-2 illustrates the relation between the signal and noise parameters.

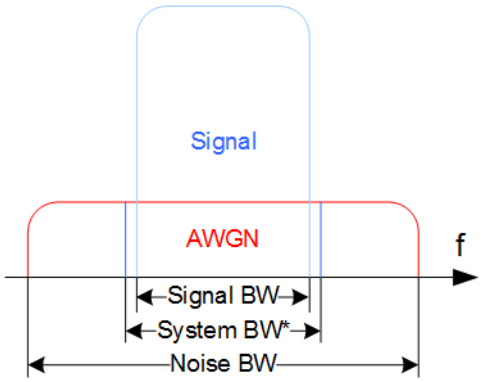


Figure 5-2: AWGN signal: System bandwidth and noise bandwidth (Min Noise/System BW = 2)

System BW* = Occupied BW

The **system bandwidth** is a measure for the transmitted RF bandwidth. The selected value is usually the occupied bandwidth and is therefore a value greater than the pure signal bandwidth.

In the most test cases, the signal and the noise power are not defined directly but with the target signal-to-noise ratio (SNR) or **carrier/noise ratio**.

The **carrier power** is a measure for the *signal without the noise distribution*. This indication corresponds to the "Level" value in the "Status bar" (see Figure 5-3).

To ensure flat noise within the selected system bandwidth, the **noise bandwidth** has to be larger than the system bandwidth. The minimum noise bandwidth is sometimes part of the specifications and is calculated as follows:

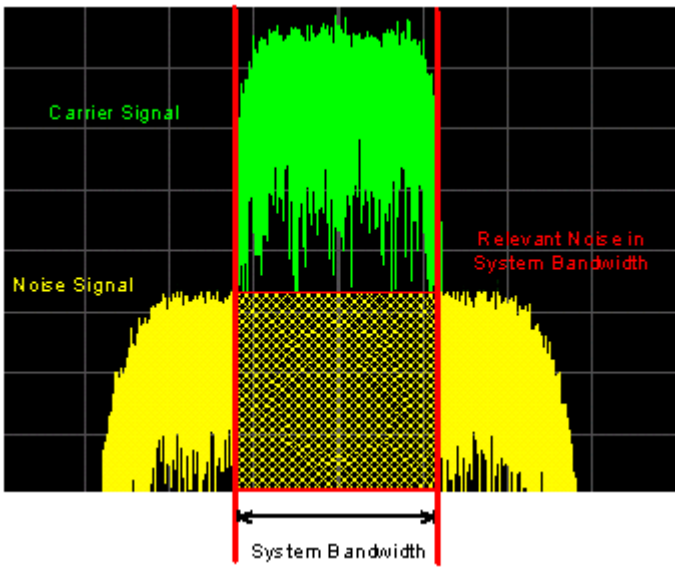
"Noise Bandwidth" = "System Bandwidth" x "Minimum Noise/System Bandwidth Ratio"

Logically, the calculated noise bandwidth does not exceed the total available bandwidth of the instrument.

For more information, refer to the specifications document.

By default, the **noise power** within the system bandwidth is not defined directly but calculated depending on the selected system bandwidth and the desired SNR. The noise power over the noise bandwidth is calculated respectively.

The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth, which means that the total measurable noise power usually exceeds the displayed value "Noise Power".



For a correct measurement of the noise power within the system bandwidth, we recommend that you measure the channel power with a signal analyzer.

In the "Additive Noise" mode, the output signal is the *signal with the noise distribution*. Hence, the power level at the RF output corresponds to the **carrier+noise power** (see Figure 5-3).

The noise power of digitally modulated signal is characterized by the parameter **E_b/N_0** indicating the ratio of bit energy to noise power density. The correlation to the SNR is as follows:

C/N or S/N = $(E_b/N_0)*(f_{bit}/B_{sys})$, where B_{sys} is the system bandwidth.

Bit Rate f_{bit} = "Symbol Rate" * Modulation Value

Where the bit rate value is retrieved from?

The parameter bit rate indicates the value used by the C/N or E_b/N_0 calculation. The value is retrieved automatically depending on the configured baseband signal:

- For custom digital modulation signals, the bit rate is determined by the selected standard.
  See "Custom Dig Mod" > "General" > "Symbol Rate" and "Modulation Type").
- For signals generated in accordance to a digital standard, the bit rate is often a standalone parameter.
  Some test cases however, for example the 3GPP base station tests (TS 25.141), specify the E/N settings that apply to channel-coded data or block segments. Set the parameter "Bit Rate" to the required value, e.g. the bit rate before or after channel coding.

Understanding the displayed information

The following example explains the impact of the AWGN settings on the signal and noise parameters.

See Figure 5-3 for an example of an AWGN generation with the following configuration:

- "Baseband"
  - "Custom Digital Mod" > "Set according to Standard" > "WCDMA-3GPP"
  - "State" > "On".
  - "Symbol Rate" = "3.840 Msym/s"
- "AWGN"
  - "General" > "Mode" > "Additive Noise"
  - "General" > "Min Noise/System Bandwidth Ratio" = "3"
  - "General" > "State" > "On"
  - "Noise Power / Output Results" > "Show Powers For Output" > "RF"
  - "Noise Power / Output Results" > "Reference Mode" > "Carrier"
  - "Noise Power / Output Results" > "Carrier/Noise Ratio" = "10 dB"
- "RF" > "On"

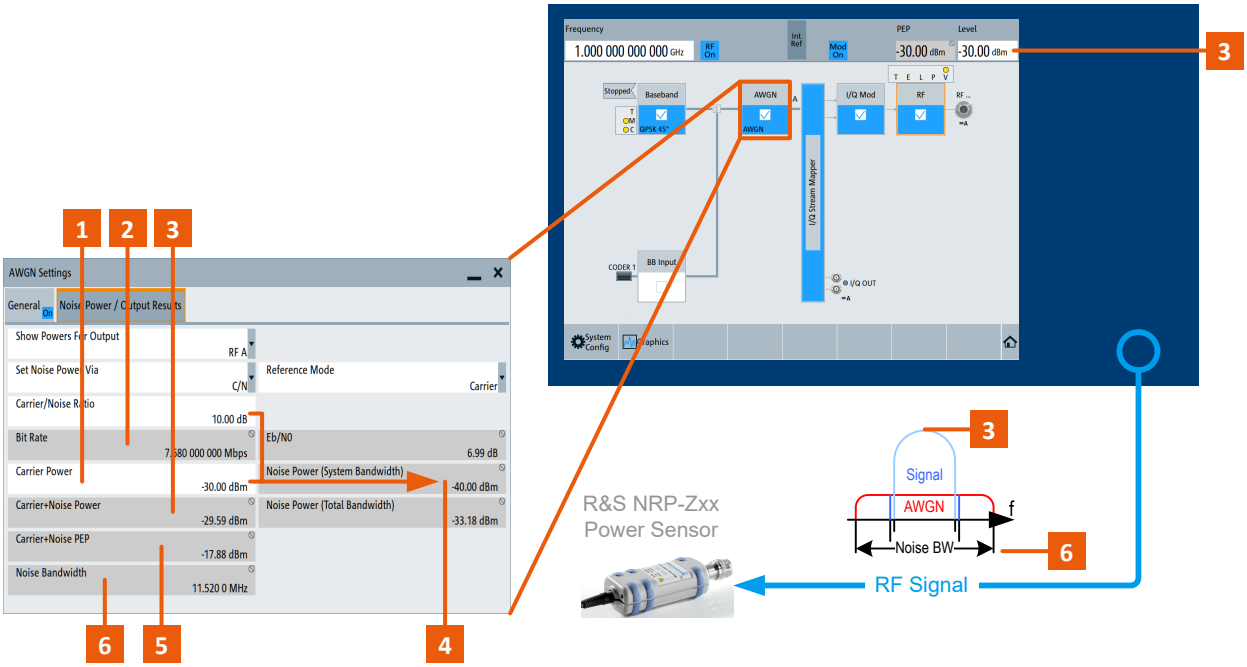


Figure 5-3: AWGN settings and test setup

1 = Bit Rate as a result from the selected symbol rate "3.840 Msym/s"
2 = Selected Carrier/Noise Ratio
3 = Noise Power calculated from the "Carrier Power" and the "Carrier/Noise Ratio" = -30 dBm - 10 dB = -40 dBm
4, 7, 10 = Carrier Power = Status bar > Level = -30 dBm
5, 8 = Carrier+Noise Power = power at the RF output that you measure with a connected power meter.
6, 9 = Noise Bandwidth = System Bandwidth*Min Noise/System Bandwidth Ratio = 3.840 MHz*3 = 11.520 MHz

Use the built-in graphical signal monitoring function of the instrument to display the signal characteristics in real-time, see "To observe the effect of enabled additive noise (AWGN)" on page 473.

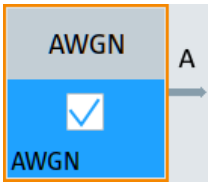
Application fields

Typically, the following tests require a noise generator:

- In receiver sensitivity tests with the predefined signal-to-noise ratio of the receiver.
- In bit error or block error measurements, depending on the set signal-to-noise ratio (SNR)
- In setups that require a pure noise signal.

See also "To configure the AWGN for receiver sensitivity tests" on page 278.

5.1.3 AWGN block

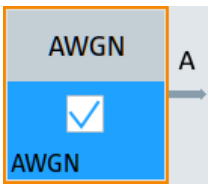


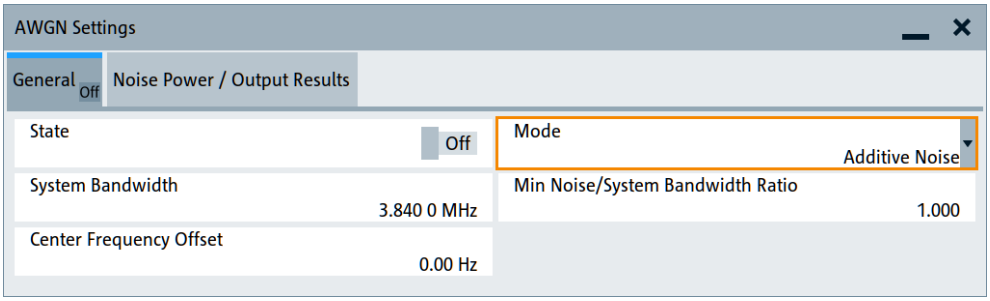
The "AWGN" block provides access to the settings for the **AWGN generator**, see Section 5.1.4, "AWGN settings", on page 271. The label in the AWGN block indicates the AWGN mode that is activated. The quickest way to activate or deactivate the AWGN generator is the "On/Off" switch in the AWGN block.

5.1.4 AWGN settings

Access:

1. In the block diagram, select "AWGN".





The dialog contains the settings for noise level configuration and CW interfering parameters.

2. In the block diagram, select "AWGN" > "On" to activate the AWGN generator.

   The remote commands required to define these settings are described in Section 13.17.2, "SOURce:AWGN subsystem", on page 806.

Settings:

5.1.4.1 General settings

Access:

► In the block diagram, select "AWGN".

Settings:

State....272
Mode....272
System Bandwidth....272
Min Noise/System Bandwidth Ratio....272
Center Frequency Offset....273
Target CW Frequency Offset....273

State
Activates/deactivates the generation of an AWGN signal. The interferer (AWGN or CW interferer, depending on the selected mode) is generated after the generator is activated.

Remote command:
`[:SOURce<hw>]:AWGN:STATe` on page 809

Mode
Selects the AWGN mode. You can add noise to the baseband signal, output a pure noise signal or add an interferer signal.

"Additive Noise"
The AWGN noise signal with selectable system bandwidth is added to the baseband signal.

"Noise Only"
The pure AWGN noise signal with selectable system bandwidth is modulated to the carrier. The connection to the baseband is interrupted.

"CW Interferer"
A sine with a defined frequency offset is added to the baseband signal.
This mode is disabled in "System Configuration" with more than 4 input streams.

Remote command:
`[:SOURce<hw>]:AWGN:MODE` on page 809

System Bandwidth
For the modes "Additive Noise" and "Noise Only", sets the RF bandwidth to which the set carrier/noise ratio relates.

Within this frequency range, the signal is superimposed with a noise signal which level corresponds exactly to the set C/N or S/N ratio.

For more information, refer to the description of Figure 5-2.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth` on page 809

Min Noise/System Bandwidth Ratio
For the modes "Additive Noise" and "Noise Only", sets the ratio of minimum noise bandwidth to system bandwidth, as required by some standards.

"Noise Bandwidth" = "System BW" x "Min Noise/System BW Ratio"

The parameter Noise Bandwidth displays the resulting noise bandwidth. Because the noise power density is a constant value, increasing the noise/system bandwidth ratio increases the noise bandwidth.

The calculation of level from the selected carrier-to-noise ratio C/N or signal-to-noise ratio in relation to system bandwidth is not influenced.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:RATio` on page 809

Center Frequency Offset
Requires "Mode" > "Additive Noise" or "Noise Only".

Sets the frequency offset of the noise signal relative to the carrier center frequency. Use the setting to shift noise signals relative to the output RF signal.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:CENTer:OFFSet` on page 813

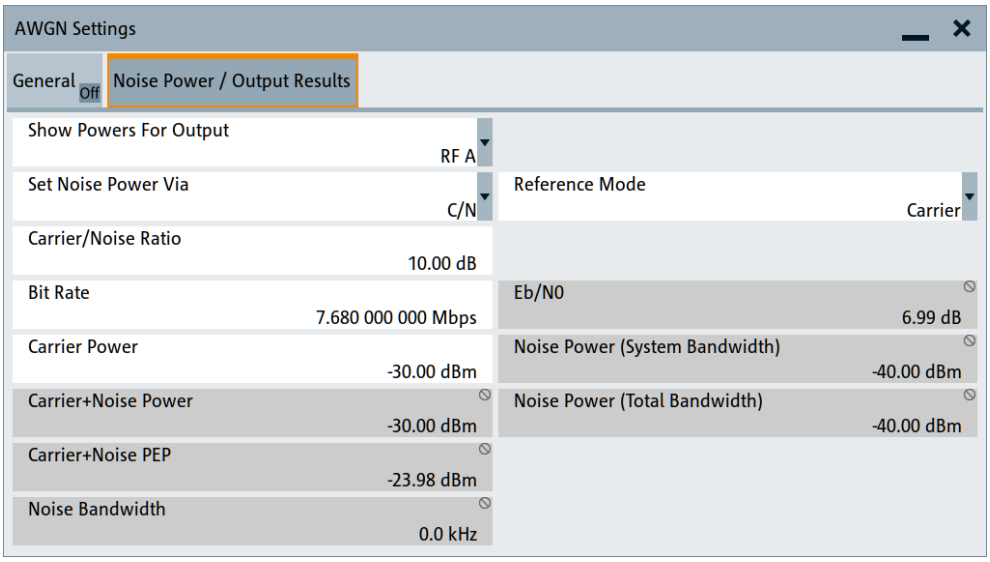
Target CW Frequency Offset
In "CW Interferer" mode, this offset sets the desired frequency of the sine wave.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:TARGet` on page 814

5.1.4.2 Noise power/output results settings

Access:

► Select "AWGN" > "Noise Power / Output Results".



The available settings depend on the selected Mode.

Settings:

Show Powers For Output....274
Set Noise Power Via....274
Reference Mode....274
Bit Rate....275
Carrier/Noise Ratio/Signal/Noise Ratio....275
Eb/N0....275
Carrier Power/Signal Power....276
Noise Power (System Bandwidth)/Interferer Power....276
Noise Power (Total Bandwidth)....277
Carrier + Noise Power/Signal + Noise Power (System Bandwidth)/Carrier + Interferer Power/Signal + Interferer Power....277
Carrier + Noise PEP/Signal + Noise PEP (Total Bandwidth)/Carrier + Interferer PEP/Signal + Interferer PEP....278
Noise Bandwidth....278
Resulting CW Frequency Offset....278

Show Powers For Output
Sets the output to which the displayed settings are related to.

This setting also influences:
- The way the interfering parameters are displayed, e.g. if the SNR value is defined as C/N or as S/N.
- The value units:
  – The values related to the RF outputs are displayed in dBm.
  – The values related to the baseband outputs - in dB

Remote command:
`[:SOURce<hw>]:AWGN:DISP:MODE` on page 810

Set Noise Power Via
Requires AWGN mode "Additive Noise". In this mode, sets the mode to determine the noise power. The following correlation applies:

"C/N" or "S/N"= ("Eb/N0")(f_{bit}/B_{sys})*, where:
- "C/N" or "S/N" is the carrier-to-noise ratio or signal-to-noise ratio.
- "Eb/N0" is the ratio of bit energy to noise power density.
- "Bit Rate" f_{bit}= "Symbol Rate" x Modulation Value
- B_{sys} is the system bandwidth.

See also Section 5.1.2, "About the AWGN generator", on page 266.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:MODE` on page 810

Reference Mode
Selects whether the carrier or the noise power is kept constant if the C/N or Eb/N0 ratio is changed.

In the common case, the instrument keeps the carrier power and adjusts the noise power accordingly. Some test cases however, for example the 3GPP base station tests (TS 25.141), specify explicitly the noise power. These test cases require that the noise power is permanently set as a function of the base station power class, whereas the carrier power is variable.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:RMODe` on page 811

Bit Rate
In "Additive Noise" mode, indicates the bit rate used for converting C/N or S/N to E_b/N_0.

Tip: For digitally modulated signals, select the bit rate before or after channel coding, as required.

See also Section 5.1.2, "About the AWGN generator", on page 266.

Remote command:
`[:SOURce<hw>]:AWGN:BRATe` on page 811

Carrier/Noise Ratio/Signal/Noise Ratio
In the modes "Additive Noise" and "CW Interferer", sets the carrier/noise, signal/noise or signal/interferer ratio.

Whether a configuration of C/N or S/N is enabled, depend on the selected output Show Powers For Output.

- In "Reference Mode" > "Carrier": sets the noise power. It does not affect the power of the wanted signal, i.e. the carrier power remains constant.
  Thus the power of the carrier + noise signal or the *power of the output signal* changes.
- In "Reference Mode" > "Noise", sets the *power of the wanted signal*, i.e. the carrier power.
  The power of the output signal remains constant.
- The power of the noise signal is derived from the entered C/N or S/N value and displayed with the parameter "Noise Power" in the units of the wanted signal.
- The power of the wanted signal is displayed with the parameter "Carrier Power" and can also be changed there. This indication corresponds to the "Level" value in the "Status bar".
- The power of the output signal is displayed as "Carrier + Noise Power".

See also Figure 5-3.

Remote command:
`[:SOURce<hw>]:AWGN:CNRatio` on page 811

Eb/N0
Requires "Mode" > "Additive Noise"

Sets the ratio of bit energy to noise power density.

- In "Reference Mode" > "Carrier": sets the noise power that is the power of the carrier and noise signal.
  It does not affect the power of the wanted signal, i.e. the carrier power is kept constant.
- In "Reference Mode" > "Noise": sets the power of the wanted signal that is the carrier power.

The noise power is kept constant.

- The power of the noise signal is derived from the selected E_b/N_0 and displayed with the parameter "Noise Power" in the units of the wanted signal.
- The power of the wanted signal is displayed with the parameter "Carrier Power". This indication corresponds to the "Level" value in the "Status bar".
- The power of the output signal is displayed as "Carrier + Noise Power".

See also Figure 5-3.

Remote command:
`[:SOURce<hw>]:AWGN:ENRatio` on page 811

Carrier Power/Signal Power
Requires "Mode" > "Additive Noise" and "CW Interferer".

The name of this parameter depends on the selected output Show Powers For Output.

- In "Reference Mode" > "Carrier": sets the carrier power. This indication corresponds to the "Level" value in the status bar.
  The power of the noise signal is derived from the selected C/N or S/N value and displayed with the parameter "Noise Power" in the units of the wanted signal.
- In "Reference Mode" > "Noise", indicates the carrier power as derived from the entered C/N or S/N value. This indication corresponds to the "Level" value in the "Status bar".
  The noise power can be set with the parameter "Noise Power".

Note: The peak envelope power (PEP) displayed in the status bar corresponds to the PEP value of the carrier. The parameter "Carrier+Noise PEP" indicates the PEP value of the overall signal.

See also Figure 5-3.

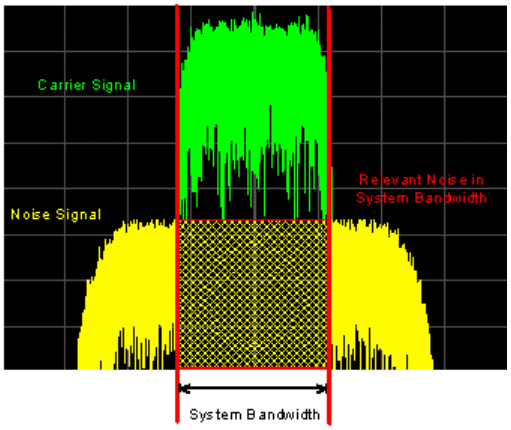
Remote command:
`[:SOURce<hw>]:AWGN:POWer:CARRier` on page 812

Noise Power (System Bandwidth)/Interferer Power
Displays the power of the noise signal in the system respectively the total bandwidth in "Noise Only" and "Additive Noise" mode.

- "Noise Only" mode
  Sets the power of the noise signal. This indication corresponds to the "Level" value in the "Status bar".
- "Additive Noise" mode
  - "Reference Mode" > "Noise"
    Sets the power of the noise signal. The power of the carrier is derived from the entered C/N or S/N or Eb/N0 value.
  - "Reference Mode" > "Carrier"
    Displays the power of the noise signal in the system bandwidth. The power of the noise signal is derived from the entered C/N or S/N or Eb/N0 value.
    The carrier power is selected with "Carrier Power"; respectively the signal power is displayed by "Signal Power".
- "CW Interferer" mode
  - "Reference Mode" > "Noise"
    Sets the power of the interference signal. The power of the carrier is derived from the entered C/I value.
  - "Reference Mode" > "Carrier"

Displays the power of the interference signal. The power of the interference signal is derived from the entered C/N or S/N value. The carrier power is entered under "Carrier Power".

Note: The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth. The occurrence means that the total measurable noise power usually exceeds the value displayed here. For correct measurement of the noise power within the system bandwidth, we recommend that you measure the channel power with a signal analyzer.



See also Figure 5-3.

Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe on page 812

Noise Power (Total Bandwidth)
Displays the power of the noise signal in the total bandwidth in "Noise Only" and "Additive Noise" mode.

See also Figure 5-3.

Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal? on page 812

Carrier + Noise Power/Signal + Noise Power (System Bandwidth)/Carrier + Interferer Power/Signal + Interferer Power
In the modes "Additive Noise" and "CW Interferer", displays the overall power of the noise signal or interferer signal and the wanted signal.

The output selected with the parameter Show Powers For Output determines:

- The name of this parameter
- The units the overall power is measured in, dBm or dB (full-scale)

See also Figure 5-3.

Remote command:
[:SOURce<hw>]:AWGN:POWer:SUM? on page 813

Carrier + Noise PEP/Signal + Noise PEP (Total Bandwidth)/Carrier + Interferer PEP/Signal + Interferer PEP
In "Additive Noise" and "CW Interferer" mode, displays the peak envelope power (PEP) of the overall signal comprised of noise signal plus wanted signal.

The output selected with the parameter Show Powers For Output determines:
- The name of this parameter
- The units the overall power is measured in, dBm or dB (full-scale)

Note: The peak envelope power ("PEP") displayed in the "Status bar" corresponds to the PEP value of the carrier.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:SUM:PEP?` on page 813

Noise Bandwidth
For the modes "Additive Noise" and "Noise Only" and enabled AWGN signal generation, indicates the real noise bandwidth.

See also Figure 5-2.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:NOISe?` on page 810

Resulting CW Frequency Offset
In "CW Interferer" mode, indicates the resulting frequency offset of the sine wave.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:RESult?` on page 814

5.1.5 Configuring AWGN for receiver tests

This section shows you how to configure the noise generator for receiver tests, for example the tests specified in the 3GPP test specification TS 36.141, chapter 7.

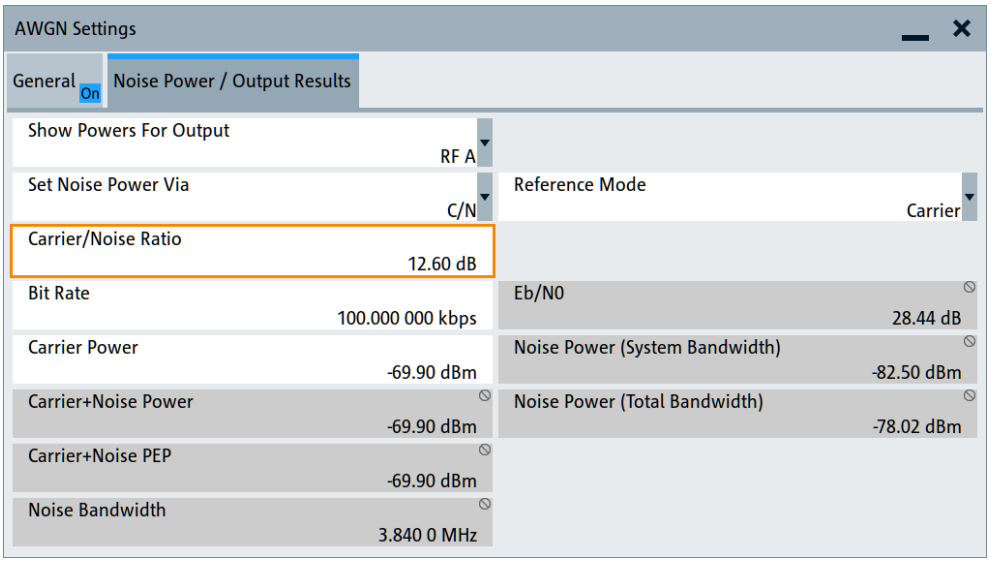
For the following example, we assume that the R&S SMM100A generates an uplink EUTRA/LTE signal with the following characteristics:
- "EUTRA/LTE" > "Duplexing" = "FDD", "Link Direction" = "Uplink"
- "EUTRA/LTE" > "General Uplink Setting" > "Channel Bandwidth" = "5 MHz" and "Occupied Bandwidth" = "4.5 MHz"
- "EUTRA/LTE" > "Frame Configuration" > "UE1" > "FRC" > "FRC State" = "On" and "FRC" = "TS 36.141: A2-3"
- "EUTRA/LTE" > "State" = "On"
- In the status bar: "Frequency" = "1.95 GHz" and "Level" = "-69.9 dBm"
- "RF" > "On"

To configure the AWGN for receiver sensitivity tests

We assume that an AWGN interference signal with the following characteristics is required:

The mean power of the interference signal is -82.5 dBm/BW and C/N = 12.6 dB.

1. Select "AWGN".
2. Set AWGN general settings:
   - "Mode" > "Additive Noise"
   - "System Bandwidth" = "4.5 MHz"
     The definition of the interference signal mean power is dBm/*BW*, where BW is the system bandwidth. The system bandwidth of the LTE signal is the occupied bandwidth.
     See also Figure 5-2.
   - "Min Noise/System Bandwidth Ratio" = "1.5"
3. Select "Noise Power/Output Results".
4. Set AWGN noise power settings:
   - "Set Noise Power Via" = "C/N"
   - "Reference Mode" = "Carrier"
   - "Carrier/Noise Ratio" = "12.6 dB"



   The dialog confirms the required mean power of the interference signal "Noise Power (System Bandwidth)"d = "-82.5 dBm".
5. In the block diagram, set "AWGN" > "On".

To generate a CW interference signal

For the following example, we assume that two interference signals are required, a 5 MHz uplink LTE signal and a CW signal. The signals are transmitted at -52 dBm; the LTE signal at 1.96 GHz and the CW signal 10 MHz below it. Signals with equal (or similar) RF levels and at frequencies spaced within the max. RF bandwidth can be generated by the same path.

To configure the instrument:

1. Enable the required LTE signal:
   a) Select "EUTRA/LTE" > "General Uplink Setting" > "Channel Bandwidth" = "5 MHz" and "EUTRA/LTE" > "State" = "On"
   b) In the status bar, select "Frequency" = "1.96 GHz" and "Level" = "-52 dBm".
2. Enable the required interference signal:
   a) Select "AWGN" > "General" > "Mode" > "CW Interferer"
   b) Select "Target CW Frequency Offset" = "10 MHz".
   c) Select "Noise Power/Output Results" > "Reference Mode" = "Noise".
   d) Select "Interferer Power" = "-52 dB".
   e) Select "AWGN" > "General" > "State" > "On".
3. Select "RF" > "On".

5.2 Impairing the signal

In the R&S SMM100A, *analog and digital linear impairments* such as I/Q imbalance and quadrature error can be added to the generated signal.

The instrument can also simulate the effect of nonlinear memoryless effects like AM/AM and AM/PM conversion.

See the user manual R&S SMM-K540, R&S SMM-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

5.2.1 Required options

The base unit is sufficient for impairing I/Q signals. Impairing these signals does not require additional options.

5.2.2 About the linear I/Q impairments

I/Q signal impairments are well-defined arithmetic modifications of the data. Every data sample is modified in the same way.

About adding linear impairments

Adding linear impairments to the data stream is provided for the following purpose:

- To simulate frequent sources of distortions in a real signal processing chain as, it is required for tests with dirty transmitter conditions (receiver tests)
- To compensate the faults of the I/Q demodulator in the receiver

Key features

The R&S SMM100A offers functions to impair an internal I/Q signal or external I/Q signal linearly.

These functions feature the following:

- Impair I/Q samples for each I/Q stream.
- Add impairments to an analog I/Q input signal.
  The instrument adds these impairments before the I/Q samples are passed to the I/Q modulator.
- Impair analog and digital I/Q signals twice.
  If you apply both impairments, they superimpose each other at the impaired signal.

Related step-by-step instructions

For adding impairments to I/Q samples, see Section 5.2.4, "Optimizing carrier leakage and sideband suppression", on page 287.

For correcting impairments of I/Q samples at the I/Q modulator, see "To correct systematic I/Q modulation errors" on page 291.

Settings:

- Gain and gain imbalance 281
- I and Q offset 282
- Quadrature offset 283

5.2.2.1 Gain and gain imbalance

An I/Q gain is a multiplication of all I/Q amplitudes by a common factor. The effect is equivalent to two identical I and Q gain factors. The effect of an increased gain factor in the I/Q constellation diagram is shown on Figure 5-4.

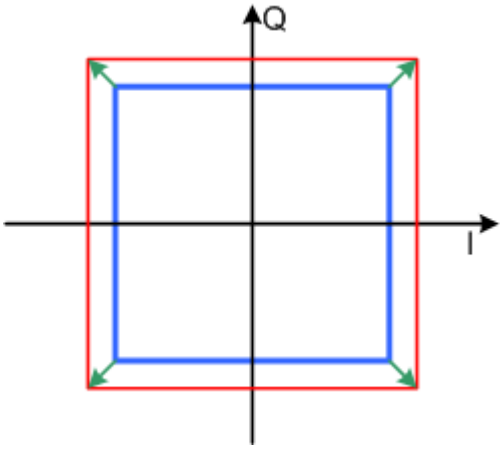


Figure 5-4: Effect of an increased amplitude in the I/Q constellation diagram

An I gain multiplies the I amplitudes by a factor, leaving the Q amplitudes unchanged. A Q gain has the opposite effect. Different I and Q gain factors result in an I/Q imbal-

ance, which is due to different gains of the amplifiers in the I and Q channels of the I/Q modulator. The effect of a positive and negative gain imbalance is shown on Figure 5-5.

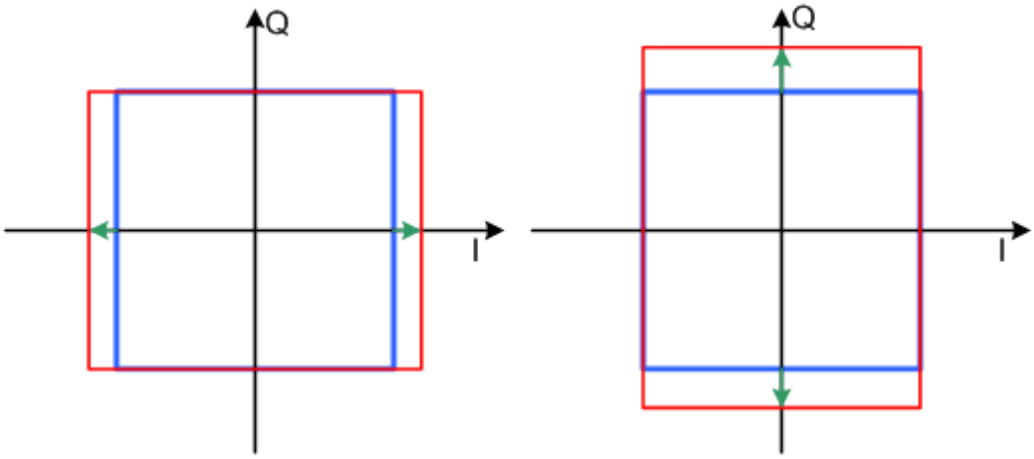


Figure 5-5: Negative gain imbalance (left) and positive gain imbalance (right) in the I/Q constellation diagram

5.2.2.2 I and Q offset

An I offset adds a constant value to all I amplitudes, leaving the Q amplitudes unchanged. A Q offset has the opposite effect. A combination of I and Q values results in an I/Q offset, which is due to carrier feedthrough in the I/Q modulator. Possible reasons are interfering signals at the RF carrier frequency, e.g. an unsuppressed RF carrier subchannel. The effect of a positive I and Q offset in the I/Q constellation diagram is shown on Figure 5-6.

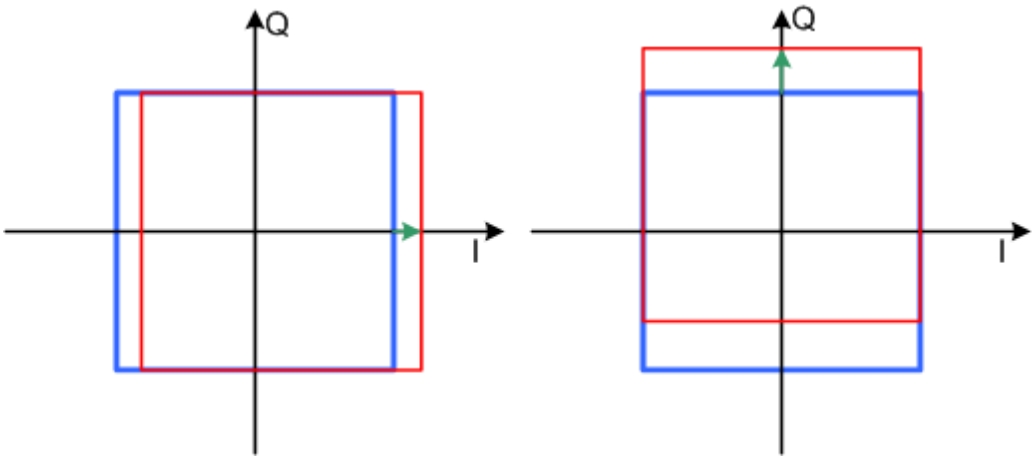


Figure 5-6: I offset (left) and Q offset (right) in the I/Q constellation diagram

5.2.2.3 Quadrature offset

Changes the phase angle between the I and the Q vectors from the ideal 90 degrees, while the amplitudes are maintained. A positive quadrature offset results in a phase angle greater than 90 degrees. The effect of a positive quadrature offset in the I/Q constellation diagram is shown on Figure 5-7.

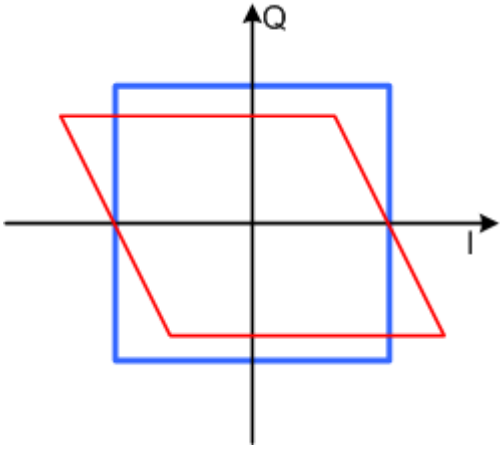


Figure 5-7: Positive quadrature offset in the I/Q constellation diagram

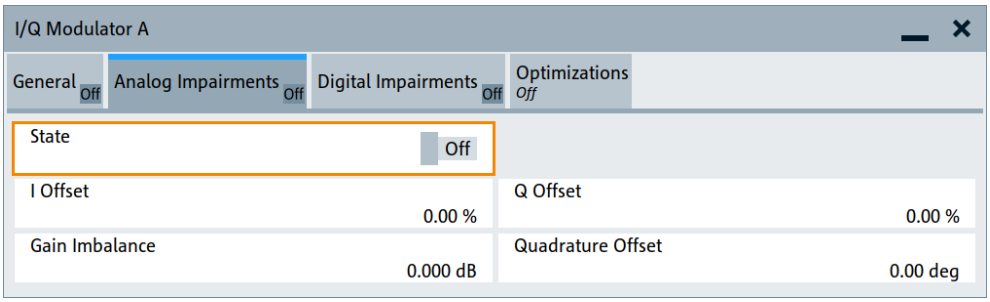
5.2.3 Analog and digital impairments settings

You can add digital impairments to each internal generated I/Q stream and analog impairments to internal generated or externally supplied analog I/Q signals.

See also Section 5.2.2, "About the linear I/Q impairments", on page 280.

Accessing analog impairments settings

► Select "I/Q Mod" > "I/Q Analog Impairments".

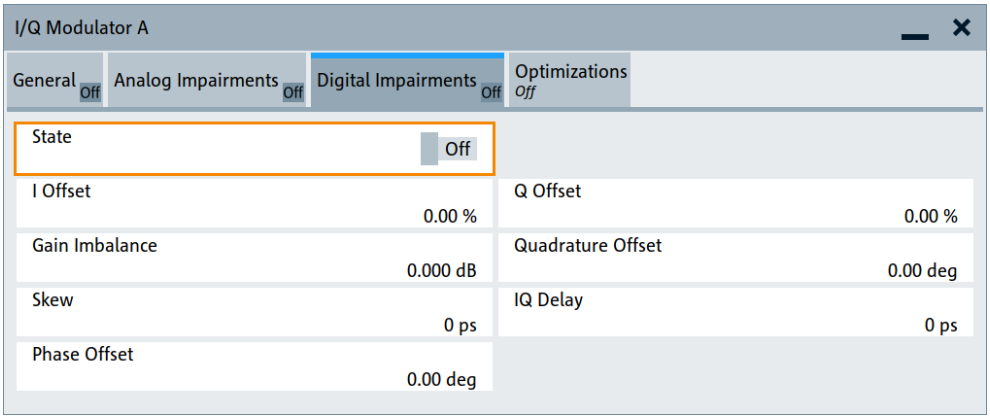


The dialog provides settings to configure I/Q analog impairments, like carrier leakage, imbalance and quadrature offset.

Accessing digital impairments settings

1. Select "I/Q Mod" > "I/Q Digital Impairments" for digital impairing I/Q signals at the I/Q modulator to the RF output.

2. For analog I/Q outputs, select "I/Q Analog" > "I/Q Digital Impairments".



The dialog provides settings to configure I/Q digital impairments, like carrier leakage, imbalance, quadrature offset and I/Q delays.

The remote commands required to define these settings are described in:

- Section 13.17.5.5, "SOURce:BB:IMPairment subsystem", on page 945.
- Section 13.17.10, "SOURce:IQ subsystem", on page 982.

The instrument can also simulate nonlinear effects like AM/AM and AM/PM conversion.

See the R&S SMM100A Envelope Tracking and AM/AM, AM/PM Predistortion user manual.

Settings:

State....284
I Offset/Q Offset....285
Gain Imbalance....285
Quadrature Offset....285
Skew....286
IQ Delay....286
Phase Offset....286

State
Enables adding impairments to the I/Q signal.

If enabled, the R&S SMM100A applies the settings for I/Q offset, gain imbalance and quadrature offset.

Remote command:
For analog impairments: `[:SOURce<hw>]:IQ:IMPairment[:STATe]` on page 948
For digital impairments:
`[:SOURce]:BB:IMPairment:BBMM<ch>:STATe` on page 948
`[:SOURce]:BB:IMPairment:IQOutput<ch>:STATe` on page 948
`[:SOURce]:BB:IMPairment:RF<ch>:STATe` on page 948

I Offset/Q Offset
Sets a carrier offset (in percent) of the amplitudes (scaled to the peak envelope power (PEP)) for the I and/or Q signal component. An ideal I/Q modulator suppresses the carrier offset completely (offset = 0 percent).

For more information, see the following sections:
- Section 5.2.2.2, "I and Q offset", on page 282
- "To optimize the carrier leakage suppression" on page 287

Remote command:
For analog impairments:
`[:SOURce<hw>]:IQ:IMPairment:LEAKage:I` on page 947
`[:SOURce<hw>]:IQ:IMPairment:LEAKage:Q` on page 947
For digital impairments:
`[:SOURce]:BB:IMPairment:BBMM<ch>:LEAKage:I` on page 947
`[:SOURce]:BB:IMPairment:BBMM<ch>:LEAKage:Q` on page 947
`[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:I` on page 947
`[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:Q` on page 947
`[:SOURce]:BB:IMPairment:RF<ch>:LEAKage:I` on page 947
`[:SOURce]:BB:IMPairment:RF<ch>:LEAKage:Q` on page 947

Gain Imbalance
Sets the imbalance of the I and Q vector.

The entry is made in dB (default) or %, where 1 dB offset is roughly 12% according to the following:

Imbalance [dB] = 20log (| GainQ | / | GainI |)

Positive values mean that the Q vector is amplified more than the I vector by the corresponding percentage. Negative values have the opposite effect.

For more information, see the following sections:
- Section 5.2.2.1, "Gain and gain imbalance", on page 281
- "To optimize sideband suppression" on page 287

Remote command:
For analog impairments: `[:SOURce<hw>]:IQ:IMPairment:IQRatio[:MAGNitude]` on page 946
For digital impairments:
`[:SOURce]:BB:IMPairment:BBMM<ch>:IQRatio[:MAGNitude]` on page 946
`[:SOURce]:BB:IMPairment:IQOutput<ch>:IQRatio[:MAGNitude]` on page 946
`[:SOURce]:BB:IMPairment:RF<ch>:IQRatio[:MAGNitude]` on page 946

Quadrature Offset
Sets the quadrature offset.

For more information, see the following sections:
- Section 5.2.2.3, "Quadrature offset", on page 283
- "To optimize sideband suppression" on page 287

Remote command:
For analog impairments: [:SOURce<hw>]:IQ:IMPairment:QUADrature[:ANGLe] on page 947
For digital impairments:
[:SOURce]:BB:IMPairment:BBMM<ch>:QUADrature[:ANGLe] on page 947
[:SOURce]:BB:IMPairment:IQOutput<ch>:QUADrature[:ANGLe] on page 947
[:SOURce]:BB:IMPairment:RF<ch>:QUADrature[:ANGLe] on page 947

Skew
Sets or displays the delay between the Q vector and the I vector of the corresponding stream.

Setting this delay is possible for I/Q samples in the I/Q modulator ("I/Q Mod" > "I/Q Digital Impairments") and at the I/Q analog output interfaces ("I/Q Analog" > "I/Q Digital Impairments" dialog.

Remote command:
[:SOURce]:BB:IMPairment:BBMM<ch>:SKEW on page 948
[:SOURce]:BB:IMPairment:IQOutput<ch>:SKEW on page 948
[:SOURce]:BB:IMPairment:RF<ch>:SKEW on page 948

IQ Delay
Sets or displays the time delay of both I and Q vectors relative to the selected trigger and marker. A positive value means that the I and Q vectors delay relative to the marker or trigger. A negative delay implies the other way around.

Setting this time delay is possible for I/Q samples in the I/Q modulator ("I/Q Mod" > "I/Q Digital Impairments") and at the I/Q analog output interfaces ("I/Q Analog" > "I/Q Digital Impairments").

See also Section 9.2.1, "Connecting multiple instruments in primary-secondary instrument mode", on page 476.

Remote command:
[:SOURce]:BB:IMPairment:BBMM<ch>:DELay on page 946
[:SOURce]:BB:IMPairment:IQOutput<ch>:DELay on page 946
[:SOURce]:BB:IMPairment:RF<ch>:DELay on page 946

Phase Offset
Adds a phase offset after the stream mapper.

You can shift the signal phase at the different stages in the signal generation flow:
- For "Baseband Offsets" > "Phase Offset", see "Phase Offset" on page 264.
- For "I/Q Stream Mapper" > "Phase Offset", see "Phase Offset" on page 492.

Remote command:
[:SOURce]:BB:IMPairment:BBMM<ch>:POFFset on page 949
[:SOURce]:BB:IMPairment:IQOutput<ch>:POFFset on page 949
[:SOURce]:BB:IMPairment:RF<ch>:POFFset on page 949

5.2.4 Optimizing carrier leakage and sideband suppression

Applying linear I/Q impairments helps to improve signal quality in the following cases:

- To suppress a carrier leakage at the current RF frequency
- To improve the attenuation of the unwanted sidebands

In the following examples, we assume that:

- The R&S SMM100A generates a baseband signal
- A spectrum analyzer is connected to the R&S SMM100A, the analyzer is configured, and measures the required signal characteristics.

To optimize sideband suppression

For a given baseband signal, perform the following iterative steps:

1. In the block diagram, select "I/Q Mod" > "I/Q Digital Impairments".
2. Set the values of the parameters "Gain Imbalance" and "Quadrature Offset" to adjust the relative amplitude and phase relationship of the baseband signal.
3. Select "State" > "On".
4. On a connected signal analyzer, monitor the power spectrum.
5. Vary the values of the parameters "Gain Imbalance" and "Quadrature Offset" until the maximal sideband suppression is achieved.

To optimize the carrier leakage suppression

For a given baseband signal, perform the following iterative steps:

1. In the block diagram, select "I/Q Mod" > "I/Q Digital Impairments".
2. Set the parameters "I Offset" and "Q Offset".
3. Select "State" > "On".
4. On a connected signal analyzer, monitor the power spectrum.
5. Vary the I/Q offset until the maximal carrier leakage suppression is achieved.

   Adjusting the I and Q offsets is one of the possible ways to control carrier leakage.

See also Section 4.12.3, "Improving signal characteristics by shifting the baseband signal", on page 264.

5.3 Applying digital predistortion

Digital predistortion (DPD) is one of the methods to improve the efficiency of RF power amplifiers. In the R&S SMM100A, the generated digital signal can be deliberately AM/AM and AM/PM predistorted.

See the user manual R&S SMM-K540, R&S SMM-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

6 Applying I/Q vector modulation

The R&S SMM100A offers I/Q modulation with an external analog I/Q signals, external digital signals, and the internally generated digital signal.

For a description on applying digital impairments and applying nonlinear effects, see the following sections:

- Section 5.2, "Impairing the signal", on page 280
- Section 6.4.2, "Optimizations settings", on page 303

See the user manual R&S SMM-K540, R&S SMM-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

See the user manual "R&S SMM-K544 User-Defined Frequency Response Correction".

- Required options 289
- About the I/Q modulator 289
- Optimizing I/Q modulation performance 291
- I/Q modulator settings 297

6.1 Required options

The equipment layout for I/Q modulation includes:

- Frequency option (e.g. R&S SMM-B1006)
  Sufficient for I/Q modulation with an internal digital signal, an external digital signal or an external analog signal.
- Optional option RF linearization (R&S SMM-K575)
  Required for optimized wideband I/Q modulation with a linearized RF output signal.

6.2 About the I/Q modulator

The R&S SMM100A offers I/Q modulation with the internally generated digital signal, the external digital signals (when separately processed), and an external analog I/Q signal. The maximum available RF bandwidth of an externally applied wideband analog signal is higher than the bandwidths of the internal or external digital signal.

For more information, refer to the specifications document.

6.2.1 Input signals of the I/Q modulator

The table Table 6-1 provides an overview of the possible input signals and input connectors. Any of the specified input signals is processed by the I/Q modulator and output at the RF output.

Table 6-1: Physical input signals of the I/Q modulator

Input signal	Input connector	GUI element
Internal digital	-	"I/Q Mod" > "I/Q Modulator Input" > "Internal Baseband" and "Baseband" > "On"
External digital	CODER	"I/Q Mod" > "I/Q Modulator Input" > "Internal Baseband" and "BB Input" > "On"
External analog wideband	I/Q	"I/Q Mod" > "I/Q Modulator Input" > "Analog Wideband I/Q Input"

Restrictions to analog I/Q input signals

Analog I/Q input signals are directly applied to the analog I/Q modulation circuit, and are not routed through the baseband section of the R&S SMM100A.

For I/Q modulation with an analog I/Q input signal, you cannot use the following functions or input signals simultaneously:

- Amplitude modulation (AM) of the modulated signal at the RF signal block
- The internal digital baseband signal including digital modulation, ARB, multicarrier CW and the average white Gaussian noise generator (AWGN).
- An external digital input signal.

6.2.2 About I/Q modulation optimizations

Option R&S SMM-K575 allows you to optimize the I/Q modulation with internal calibration data by applying an automatic AM/AM predistortion and AM/PM predistortion to the RF chain of the instrument.

Option R&S SMM-K541 allows you to optimize the I/Q modulation manually by measuring the AM/AM predistortion for the current RF settings. For optimization, the option supplies the mode "Linearize RF" > "Manual".

Installing option R&S SMM-K575

New R&S SMM100A instruments are shipped with the option R&S SMM-K575 and the instrument has calibration data available. If calibration data is missing, contact Rohde & Schwarz.

If you already have an R&S SMM100A and want to equip it with option R&S SMM-K575, contact Rohde & Schwarz.

Related step-by-step instructions

See the following sections:

- "To optimize I/Q modulation for best EVM performance" on page 292
- "To reduce LO leakage via an automatic carrier offset" on page 293
- "To linearize the RF signal automatically" on page 293
- "To linearize the RF signal manually" on page 295
- "To apply other user-defined optimization characteristics" on page 295

Related settings

See Section 6.4.2, "Optimizations settings", on page 303.

6.3 Optimizing I/Q modulation performance

In the following sections, we assume that:

- The R&S SMM100A generates a baseband signal.
- A spectrum analyzer is connected to the R&S SMM100A, the analyzer is configured, and measures the required signal characteristics.

- General I/Q modulation tasks....291
- Using optimization characteristics....292
- Improving the output signal quality....296

6.3.1 General I/Q modulation tasks

The following step-by-step instructions help you to execute general I/Q modulation tasks with dedicated I/Q modulator settings:

- "To use the default settings" on page 291
- "To generate a wideband modulation signal" on page 291
- "To correct systematic I/Q modulation errors" on page 291

To use the default settings

► In the block diagram, select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator" > "On".

The I/Q modulator is enabled. Modulated is the internal baseband signal.

The I/Q modulator provides a vector-modulated signal that is optimized for time-sensitive measurements and lower noise at high switching speeds.

To generate a wideband modulation signal

1. In the block diagram, select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator" > "On".

   The I/Q modulator is enabled. Modulated is the internal baseband signal.

2. Select "I/Q Wideband" > "On".

   The R&S SMM100A shifts the switching frequencies of the lowpass filters in the output section and generates a signal with a higher I/Q modulation bandwidth. The harmonic suppression, however, degrades.

To correct systematic I/Q modulation errors

Adjust the I/Q modulator for a given carrier frequency to correct systematic errors, for example temperature fluctuations of several degrees. These corrections ensure precise and repeatable measurements.

1. Select "System Config" > "Setup" > "General" > "Internal Adjustments".

2. Select "Adjust I/Q Modulator Current Frequency".

See also Section 16.3.4.3, "How to use the internal adjustments", on page 1129.

6.3.2 Using optimization characteristics

The following step-by-step instructions help you to optimize I/Q modulation to achieve an optimized value of a certain measure or signal parameter:

- "To enable modulation with the baseband signal" on page 292
- "To optimize I/Q modulation for best EVM performance" on page 292
- "To reduce LO leakage via an automatic carrier offset" on page 293
- "To linearize the RF signal automatically" on page 293
- "To check if calibration data is available" on page 294
- "To linearize the RF signal manually" on page 295
- "To apply other user-defined optimization characteristics" on page 295

To enable modulation with the baseband signal

All step-by-step instructions in this section require the signal from the baseband domain as the modulation source. This signal can be the internal baseband signal or an external digital I/Q signal.

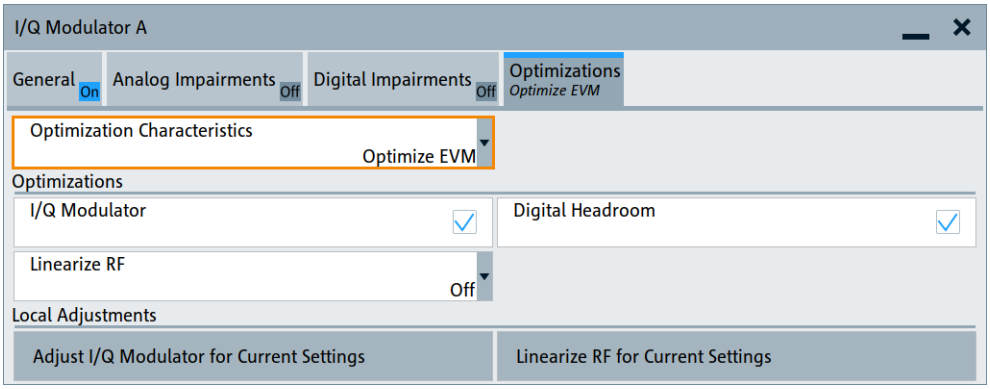
1. Select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator".
2. Select "General" > "Source" > "Internal Baseband".
3. Select "State" > "On".

   The I/Q modulator is enabled. The modulation source is the signal from the baseband domain.

To optimize I/Q modulation for best EVM performance

If your test setup requires the lowest EVM values, use the "Optimize EVM" function of the R&S SMM100A. For example, if you need to generate 5G NR signals, LTE signals or IEEE 802.11 signals that require best EVM performance.

1. Use the signal from the baseband domain as a modulation source.
   See "To enable modulation with the baseband signal" on page 292.
2. Select "I/Q Mod" > "I/Q Settings" > "Optimizations".
3. Select "Optimization Characteristics" > "Optimize EVM".



If enabled, the frequency section of the status bar displays the enabled EVM optimization state as in Figure 6-1.

Figure 6-1: Optimize EVM enabled

4. On a connected signal analyzer, monitor the signal characteristics.

To reduce LO leakage via an automatic carrier offset

If your test setup requires reduced local oscillator (LO) leakage, apply an automatic carrier offset. You can apply this offset for digital I/Q input signals or analog I/Q input signals.

1. Select "I/Q Mod" > "I/Q Settings" > "Optimizations".
2. Select "Carrier Offset" > "On" to enable the carrier offset of the RF signal.

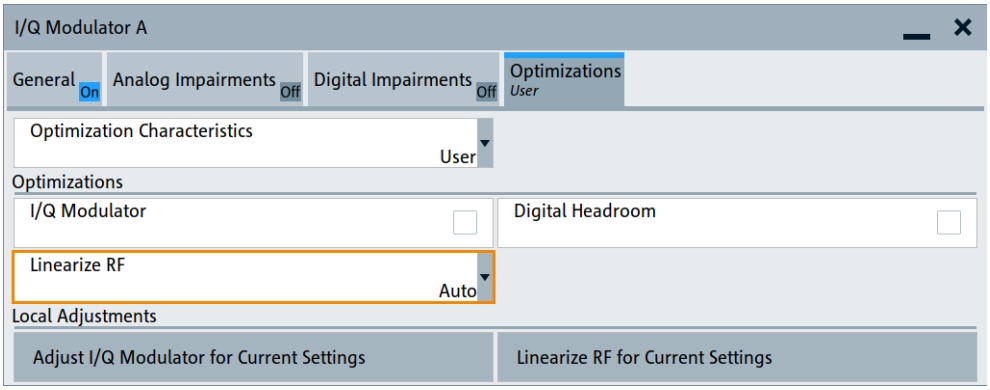
   The R&S SMM100A adjusts the carrier offset to the shift LO leakage. The carrier offset f_{c_offset} relates to the bandwidth b_{signal} of the I/Q signal as follows:
   $f_{c_offset} = 20\ MHz + b_{signal}/2$
   If no signal bandwidth is available, the carrier offset calculation uses the sample rate r_{sample} instead of the bandwidth:
   $f_{c_offset} = 20\ MHz + r_{sample}/2$

The parameter "Optimization Characteristics" > "User" indicates a user-defined setting. For other user-defined I/Q optimizations, see "To apply other user-defined optimization characteristics" on page 295.

To linearize the RF signal automatically

Linearizing the RF signal automatically requires R&S SMM-K575.

1. Use the signal from the baseband domain as a modulation source.
   See "To enable modulation with the baseband signal" on page 292.
2. Select "I/Q Mod" > "I/Q Settings" > "Optimizations".
3. Select a suitable mode to linearize your RF signal:



a) Select "Linearize RF" > "Auto" to linearize the RF signal automatically at high output power.
   In this mode, the firmware loads the factory calibration data depending on the current PEP value and the predistortion data.
b) Select "Linearize RF" > "On" to linearize the RF signal over the whole RF level range.
   Note that at lower output power levels, applying factory calibration data can lead to worse EVM and ACLR performance.

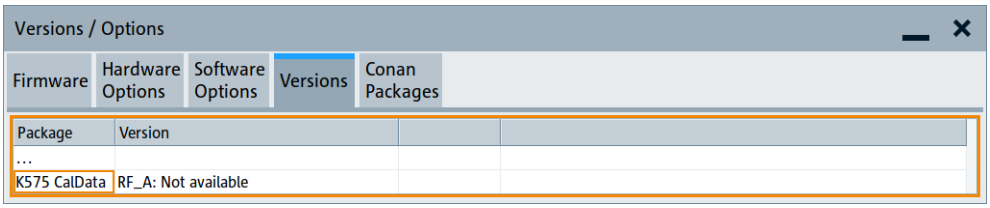
The instrument uses the AM/AM and AM/PM predistortion data from a factory calibration. If you cannot select "Auto" or "On", the calibration data is not available on your instrument. See "To check if calibration data is available" on page 294.

4. On a connected signal analyzer, monitor the signal characteristics.

To check if calibration data is available

If you cannot select the automatic RF linearization functionality ("Linearize RF" > "Auto"), check if your instrument has calibration data:

1. Select "Setup" > "Instrument Assembly" > "Versions / Options".
2. Select the "Versions" tab.
3. In the column "Package", check the line "K575 CalData".



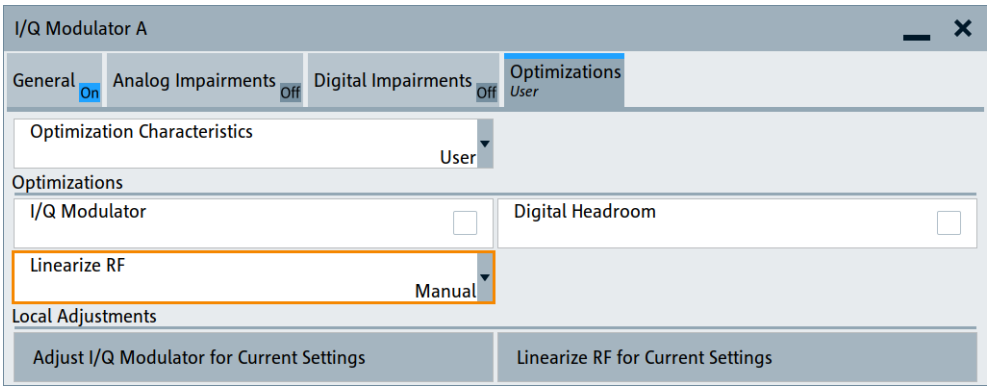
The "Version" column displays if calibration data is available or not. If it displays "Not available" contact Rohde & Schwarz. See also "Installing option R&S SMM-K575" on page 290.

To linearize the RF signal manually

Linearizing the RF signal requires R&S SMM-K541 or R&S SMM-K575.

1. Use the signal from the baseband domain as a modulation source.
   See "To enable modulation with the baseband signal" on page 292.
2. Select "I/Q Mod" > "I/Q Settings" > "Optimizations".
3. Select "Local Adjustments" > "Linearize RF for Current Settings".

   The instrument measures the AM/AM nonlinearity on the RF chain for the current frequency. During the measurement, the instrument interrupts signal generation.
4. Select "Optimizations" > "Linearize RF" > "Manual".



   The instrument uses the measured AM/AM correction data. If the option R&S SMW-K575 is also installed on your instrument, the manual mode also uses AM/PM calibration data from the factory calibration.
5. On a connected signal analyzer, monitor the signal characteristics.

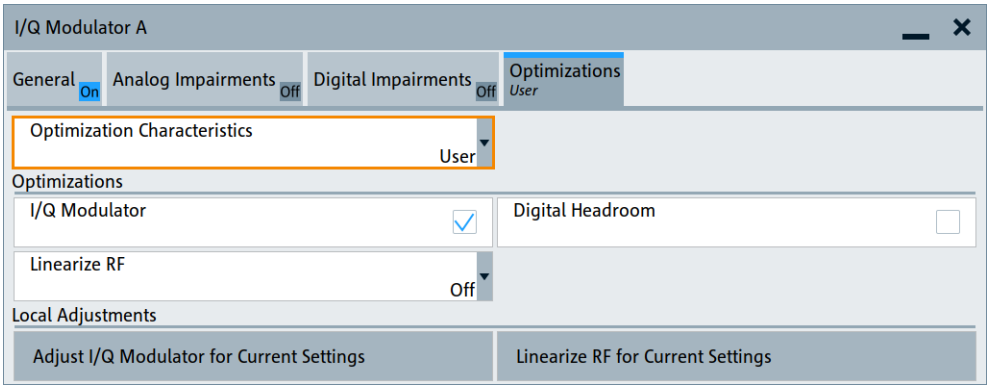
To apply other user-defined optimization characteristics

For a given baseband signal and RF frequency, perform the following:

1. Select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator".
2. Select "General" > "State" > "On".

   The I/Q modulator is enabled. Modulated is the internal baseband signal.
3. Select "I/Q Mod" > "I/Q Settings" > "Optimizations".
4. In the "Optimizations" section, select a user-defined optimization setting, for example:

   a) Select "I/Q Modulator" > "On".
   b) Select "Digital Headroom" > "Off".
   c) Select "Linearize" > "Off".



The parameter "Optimization Characteristics" > "User" indicates a user-defined setting.

5. On a connected signal analyzer, monitor the signal characteristics.

6.3.3 Improving the output signal quality

The following step-by-step instructions help you to improve the quality of the RF output signal with dedicated I/Q modulator settings:

- "To improve signal flatness" on page 296
- "To optimize for signals with high ACPR" on page 296
- "To minimize signal intermodulation" on page 297

To improve signal flatness

For a given baseband signal and RF frequency, perform the following:

1. In the block diagram, select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator" > "On".

   The I/Q modulator is enabled. Modulated is the internal baseband signal.
   This mode generates a flat signal but requires longer settling time and leads to signal interruption.

2. Select "Optimization Mode" > "High Quality".

   Note:
   Do not enable both the I/Q optimization mode "High Quality" and the RF signal level optimization mode "Uninterrupted" or "Strictly Monotone". The high-quality I/Q optimization mode leads to an RF signal interruption which blocks the RF signal level optimization.

3. On a connected signal analyzer, monitor the signal characteristics.

To optimize for signals with high ACPR

Optimize the I/Q modulator for signals with high adjacent channel power ratio (ACPR). For a given baseband signal (e.g. a 3GPP signal) and RF frequency, perform the following iterative steps:

1. In the block diagram, select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator" > "On".

The I/Q modulator is enabled. Modulated is the internal baseband signal.

2. Select "Baseband Gain" = "6 dB".
3. On a connected signal analyzer, monitor the signal characteristics.
4. Vary the value of the parameter "Baseband Gain" until the maximal signal-to-noise ratio (SNR) is achieved.

To minimize signal intermodulation

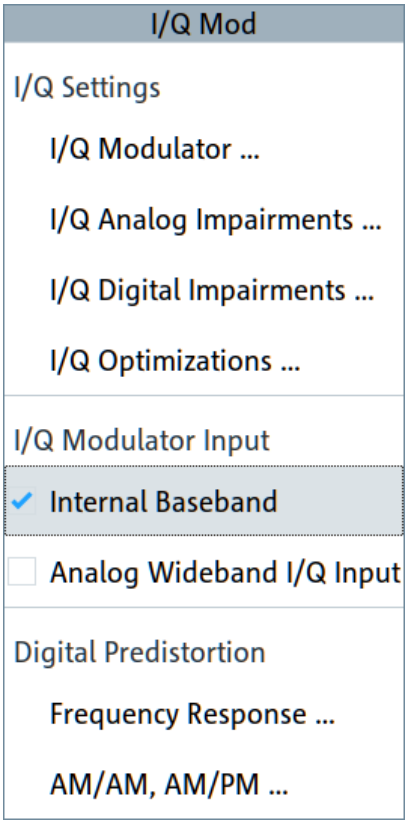
For a given baseband signal and RF frequency, perform the following iterative steps:

1. In the block diagram, select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator" > "On".
   The I/Q modulator is enabled. Modulated is the internal baseband signal.
2. If enabled, disable the "I/Q Wideband" > "Off".
3. Select "Baseband Gain" = "-2 dB".
4. On a connected signal analyzer, monitor the signal distortion characteristics.
5. Vary the value of the parameter "Baseband Gain" until the maximal suppression of the intermodulation products is achieved.

6.4 I/Q modulator settings

Access:

1. To choose the input signal of the I/Q modulator, select one of the following:
   - For the internal baseband signal, select "I/Q Mod" > "I/Q Modulator Input" > "Internal Baseband".
   - For an analog wideband input signal, select "I/Q Mod" > "I/Q Modulator Input" > "Analog Wideband I/Q Input".



See also "Source" on page 299.

2. Select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator".

   The dialog provides the I/Q modulator settings, settings for optimized wideband modulation and settings for applying analog or digital impairments.

The remote commands required to define these settings are described in Section 13.17.10, "SOURce:IQ subsystem", on page 982.

For a description on applying digital impairments and applying nonlinear effects, see the following sections:

- Section 5.2, "Impairing the signal", on page 280
- Section 6.4.2, "Optimizations settings", on page 303

See the user manual R&S SMM-K540, R&S SMM-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

See the user manual "R&S SMM-K544 User-Defined Frequency Response Correction".

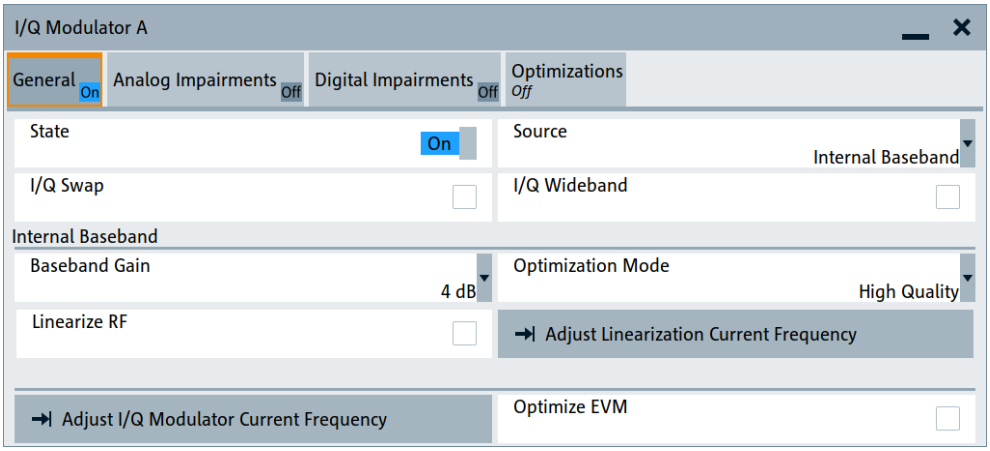
Settings:

- General settings.....299
- Optimizations settings.....303

6.4.1 General settings

Access:

► Select "I/Q Mod" > "I/Q Settings" > "I/Q Modulator".



The tab provides the general I/Q modulator settings.

Settings:

State....299
Source....299
I/Q Swap....300
I/Q Wideband....300
Crest Factor....301
Baseband Gain....301
Optimization Mode....301

State
Enables I/Q modulation.

If you use the internal baseband signal as the input signal and enable baseband signal generation, the I/Q modulator is enabled automatically. You can disable I/Q modulation, for example, if you want to route the baseband signal directly to the I/Q output connectors.

Remote command:
`[:SOURce<hw>]:IQ:STATe` on page 983

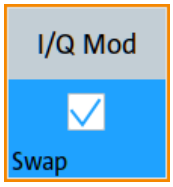
Source
Selects the input signal for the I/Q modulator.

Enabling the I/Q modulator for external source signals disables an enabled amplitude modulation of the RF output signal. See also Table 6-1.

"Internal Baseband"
Selects the internal baseband signal.

"Analog Wideband I/Q Input"
Selects an external analog signal.

Remote command:
[:SOURce<hw>]:IQ:SOURce on page 982



I/Q Swap
Selects normal or swapped I/Q control for the generated signal.

The I/Q modulator defined in the IS2000 standard differs from the definition in this implementation. The definition on which the implementation is based is used by virtually all digital communication standards, except IS95 and IS2000.

In the final step, the filtered I/Q signal is modulated to the desired RF in a different way in the I/Q modulator:

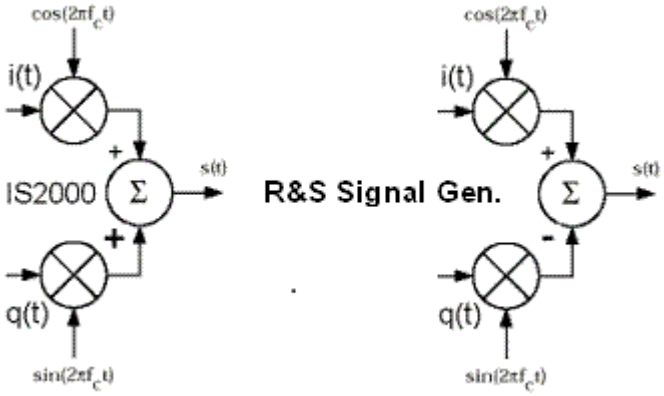


Figure 6-2: Definition of I/Q modulator in IS2000 and the R&S SMM100A

IS2000 = The RF signal s(t) is derived from the baseband I/Q signal as $s(t)=i(t)\cos(2*pi*f_c t) + q(t)\sin(2*pi*f_c t)$

R&S SMM = The RF signal s(t) is based on the definition $s(t)=i(t)\cos(2*pi*f_c t) - q(t)\sin(2*pi*f_c t)$

See also:
- Description "CDMA2000® incl. EV-DV Digital Standard for R&S SMM100A"
- Description "1xEV-DO Rev. A, Rev. B Digital Standard for R&S SMM100A"

"Off" I/Q control is normal.

"On" The modulation sidebands are inverted by swapping the I and Q signals (the Q-part of the signal is inverted).
The generated baseband signal is according to standards CDMA2000 and 1xEV-DO.

Remote command:
[:SOURce<hw>]:IQ:SWAP[:STATe] on page 985

I/Q Wideband
Activates/deactivates optimization for wideband modulation signals (higher I/Q modulation bandwidth).

The modulation frequency response of the R&S SMM100A in the useful bandwidth is improved at the expense of poorer harmonic suppression. This improvement is achieved by shifting the switching frequencies of the lowpass filters in the output section.

Remote command:
[:SOURce<hw>]:IQ:WBSTate on page 985

Crest Factor
Requires an external analog I/Q input signal, for example "Source" > "Analog Wideband I/Q Input".

Sets the crest factor of the external analog I/Q signal.

The crest factor is the difference in level between the peak envelope power (PEP) and the average power value (RMS) in dB. The R&S SMM100A uses this value for the calculation of the RF output power.

For more information, see Section 9.4.4.4, "Important signal parameters and interface characteristics", on page 487.

Note:
To set the crest factor of an external digital input signal, use the following parameter:
- "BB Input" > "Input Level" > Crest Factor.

Remote command:
`[:SOURce<hw>]:IQ:CRESt:factor` on page 984

Baseband Gain
Sets the baseband gain for a wide dynamic range.

You can amplify the baseband signal power level (positive gain) or attenuate this level (negative gain) to optimize the I/Q modulation performance. The optimization is a trade-off between signal distortion and signal-to-noise ratio (SNR).

Setting the gain has no effect for instruments with output frequencies higher than 19.5 GHz, for example R&S SMM-B1020.

How to: "To optimize for signals with high ACPR" on page 296

"-4 dB"/"-2 dB"
: Attenuates the baseband signal internally to minimize signal distortions and optimize the intermodulation characteristics of the modulated signal. But the SNR decreases, the signal noise increases.

"0 dB"
: No changes on the baseband signal, applies no optimization.

"2 dB"/"4 dB"/"6 dB"/"8 dB"
: Amplifies the baseband signal internally to maximize the SNR while minimizing the signal noise is minimized. But the signal distortions increase.
Use amplified baseband signals, for example, for 3GPP signals with high adjacent channel power ratio (ACPR).

Remote command:
For the analog I/Q signal:
`[:SOURce<hw>]:IQ:GAIN` on page 983
For digital I/Q signal:
`[:SOURce<hw>]:BB:IQGain` on page 983

Optimization Mode
Requires "Source" > "Internal Baseband".

Selects the optimization mode for I/Q modulation of the internal baseband signal. This optimization mode applies for the I/Q modulation performance and for the user-defined frequency response corrections.

How to:

- Section 6.3, "Optimizing I/Q modulation performance", on page 291
- Section "Applying user-defined frequency response corrections" in the user manual "R&S SMM-K544 User-Defined Frequency Response Correction".

For more information, refer to the specifications document.

"Fast" Fast optimization with high switching speed by compensating for I/Q skew. This mode is suitable in time sensitive environments and for narrowband signals.
Also, this mode disables I/Q modulation optimizations ("Optimization Characteristics" > "Off").

"High Quality" Optimizes I/Q modulation by compensating for I/Q skew and frequency response correction. This mode generates a flat signal over a large bandwidth but requires a longer setting time and leads to signal interruption.

Note:
Do not enable both the I/Q optimization mode "High Quality" and the RF signal level optimization mode "Uninterrupted" or "Strictly Monotone". The high-quality I/Q optimization mode leads to an RF signal interruption which blocks the RF signal level optimization.

"High Quality Table"
Improves the frequency response while maintaining setting time, there is no signal interruption.

Select this mode if your setup requires repeatable settings together with high-quality optimization or if you have wideband baseband input signals. The mode is useful in the following cases:

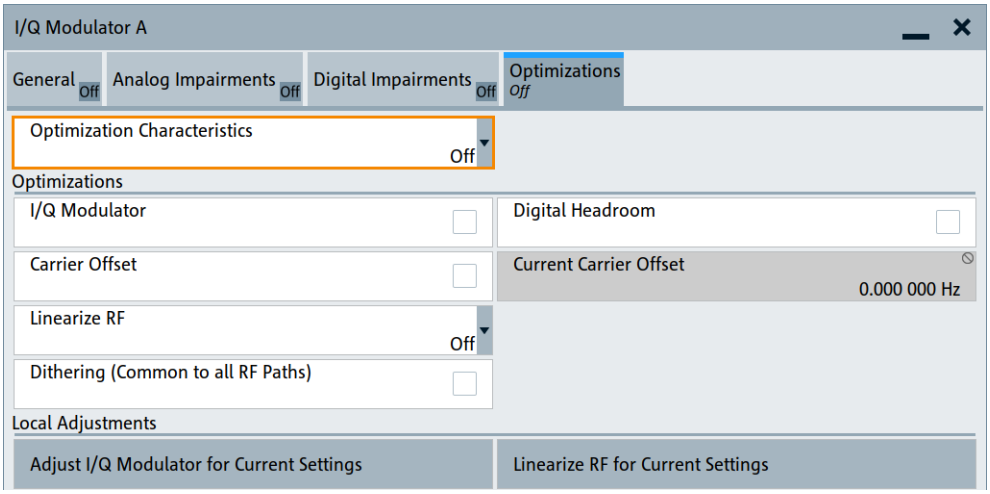
- To optimize I/Q modulation if you generate upconverted I/Q signals, for example with a connected R&S SZU.
- To optimize I/Q modulation in setups to digital predistortion setups. See the R&S SMM100A envelope tracking user manual.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE` on page 949

6.4.2 Optimizations settings

Access:

► Select "I/Q Mod" > "I/Q Settings" > "Optimizations".



The tab provides settings to configure optimized I/Q modulation methods of the internal baseband signal.

The remote commands required to define these settings are described in Section 13.17.10, "SOURce:IQ subsystem", on page 982.

Settings:

Optimization Characteristics 303
Optimizations 304
I/Q Modulator 304
Digital Headroom 304
Carrier Offset 305
Current Carrier Offset 305
Dithering (Common to all RF Paths) 305
Linearize RF 305
Local Adjustments 306
Adjust I/Q Modulator for current settings 306
Linearize RF for current settings 307

Optimization Characteristics
Selects the method for optimizing the I/Q modulation.

"Off" No dedicated I/Q modulation optimization.

"Optimize EVM"

Optimizes I/Q modulation to achieve better EVM performance. This method reduces the wideband noise and improves the nonlinear effects of amplifiers resulting in a linear gain.
The table Table 6-2 provides an overview on related parameters and their values. These values are different for an instrument that is equipped with option R&S SMM-K575 and without option R&S SMM-K575.

Table 6-2: Optimize EVM parameters and values

Parameter	With R&S SMM-K575 *)	Without R&S SMM-K575
"I/Q Modulator"	"On"	"On"
"Digital Headroom"	"On"	"On"
"Linearize RF"	"Auto"	"Off"

*) If equipped with option R&S SMM-K575 and factory calibration data, the method executes a static digital predistortion (DPD) without considering memory effects.

"User" Selects or indicates a user-defined setting of the settings in the "Optimizations" section. These settings imply a changed setting compared to the "Optimize EVM" optimizations.

Remote command:
`[:SOURce<hw>]:CORRection:OPTimize:RF:CHARacteristics` on page 963

Optimizations
Provides settings to configure the optimization parameters individually:
- "I/Q Modulator" on page 304
- "Digital Headroom" on page 304
- "Linearize RF" on page 305

I/Q Modulator
Enables automatic adjustments of the I/Q modulator after each RF frequency change or RF level change.

"Off" No adjustment of the I/Q modulator.

"On" Adjusts the I/Q modulator automatically after each RF frequency change or RF level change.

Remote command:
`[:SOURce<hw>]:CORRection:OPTimize:RF:IQModulator` on page 965

Digital Headroom
Enables an enhanced digital headroom up to full scale for a better signal-to-noise ratio. This enhancement implies an optimization for the current settings after each RF frequency change and RF level change.

"Off" No enhanced digital headroom.
Also, you need to trigger optimization for current settings manually. Select "I/Q Mod" > "Frequency Response" > "General" > "Optimize for current settings".

See the user manual "R&S SMM-K544 User-Defined Frequency Response Correction".

"On" Enhanced digital headroom with automatic optimization for current settings after each RF frequency change and RF level change.

Remote command:
`[:SOURce<hw>]:CORRection:OPTimize:RF:HEADroom` on page 965

Carrier Offset
Enables an automatic carrier offset of the I/Q signal relative to the carrier frequency of the RF signal.

If enabled, you can only route each stream to one output. Routing multiple streams to one output or one stream to multiple outputs is not allowed with an enabled carrier offset.

The carrier offset depends on the I/Q signal bandwidth or the sample rate. Use this setting to reduce local oscillator (LO) leakage.

How to: "To reduce LO leakage via an automatic carrier offset" on page 293

Remote command:
`[:SOURce<hw>]:CORRection:OPTimize:RF:COFFset` on page 964

Current Carrier Offset
If a carrier offset is enabled, the field displays the value of the current carrier offset.

This value depends on the bandwidth b_{signal} of the I/Q signal or the baseband sample rate r_{sample}, see "To reduce LO leakage via an automatic carrier offset" on page 293.

Remote command:
`[:SOURce<hw>]:CORRection:OPTimize:RF:COFFset:VALue?` on page 964

Dithering (Common to all RF Paths)
Enables dithering of the I/Q signal to improve the spectral purity of the RF output signal.

Dithering does not lead to improvements of the EVM performance or ACLR performance of the RF output signal.

Remote command:
`[:SOURce<hw>]:CORRection:OPTimize:RF:DITHering` on page 965

Linearize RF
Requires R&S SMM-K541 or R&S SMM-K575.

Selects the mode to apply a digital predistortion (DPD) to the nonlinear RF chain to linearize the RF signal.

During the calculation and RF linearization, the following applies:
- The instrument interrupts signal generation.

- If only equipped with option R&S SMM-K541, the settings for the digital predistortion AM/AM and AM/PM are disabled.

"Off" Disables the linearization of the RF chain of the instrument.

"Auto" Requires R&S SMM-K575 and factory calibration data available on the instrument. If your instrument has no calibration data, this mode is not available.
Applies an automatic AM/AM predistortion and AM/PM predistortion to the RF chain of the instrument at high output power levels.
How to: "To linearize the RF signal automatically" on page 293

"On" Requires R&S SMM-K575 and factory calibration data available on the instrument. If your instrument has no calibration data, this mode is not available.
Applies an AM/AM predistortion and AM/PM predistortion to the RF chain of the instrument over the whole RF level range.
At lower output power levels, applying the factory calibration data can lead to worse EVM and ACLR performance.
How to: "To linearize the RF signal automatically" on page 293

"Manual" Requires R&S SMM-K541.
This mode uses an AM/AM correction data from the function "Linearize RF for current settings" to linearize the RF chain of the instrument. Select "Linearize RF for current settings" before using the manual mode.
If the R&S SMM-K541 is installed on your instrument and the option R&S SMM-K575 is not installed, you cannot load user-defined digital predistortions. The AM/AM AM/PM Predistortion functionality for digital predistortion is not available.
If the option R&S SMM-K575 is also installed on your instrument, the manual mode also uses AM/PM calibration data from the factory calibration.
How to: "To linearize the RF signal manually" on page 295

If you select the auto mode or manual mode, the function "Calculate Envelope from predistorted signal" is not available.

Remote command:
`[:SOURce<hw>]:CORRection:OPTimize:RF:LINearize` on page 966

Local Adjustments
Provides settings to trigger the local adjustments of the I/Q modulator and AM/AM distortions of the RF output signal:

- "Adjust I/Q Modulator for current settings" on page 306
- "Linearize RF for current settings" on page 307

Adjust I/Q Modulator for current settings
Starts the adjustment of the I/Q modulator for the current settings of the RF frequency, RF level, baseband gain and optimizations.

Remote command:
`[:SOURce<hw>]:CORRection:OPTimize:RF:IQModulator:ADJust?`
on page 966

Linearize RF for current settings
Requires R&S SMM-K541.

Measures the AM/AM nonlinearity on the RF chain for the current frequency. During the measurement, the instrument interrupts signal generation.

Execute "Linearize RF for current settings" before setting the mode "Linearize RF" > "Manual", see "Linearize RF" on page 305.

Remote command:
`[:SOURce<hw>]:CORRection:OPTimize:RF:LINearize:ADJust?` on page 967

7 Configuring the RF signal

The vector signal generator R&S SMM100A generates RF signals with outstanding spectral purity within the frequency range from 100 kHz up to 44 GHz and with adjustable signal level over a wide range.

In addition to these real-time CW signals, you can generate RF signals from predefined lists and sweep signals that vary according to the frequency or amplitude curves.

You can also apply versatile analog modulation types with definable characteristics.

The variably adjustable output level due to the built-in attenuator, allows you to vary the RF signal level over the full level range. There are different methods to improve signal performance and to optimize the signal quality for the particular application, or to increase the accuracy and reliability of the generated RF signal.

The R&S SMM100A supports R&S NRP power sensors, e.g. to monitor the output level of the generator and to determine the level correction values for user correction lists.

Signal modes and characteristics

The R&S SMM100A generates unmodulated or analog modulated RF signals. You can output the signal in fixed mode or as a signal having periodically varying frequencies or amplitudes.

Signal modes for RF signal generation:

- Unmodulated signal
  Generates an unmodulated continuous wave (CW) of constant frequency and amplitude.

  For information on the signal frequency and level settings and example of how to configure a simple CW signal, see:
  - Section 7.5, "RF frequency settings", on page 312
  - Section 7.6, "RF level settings", on page 315
  - Section 7.7, "RF phase settings", on page 320
  - Section 3.3.1, "Generating an unmodulated carrier", on page 48
- Analog modulated signal
  Modulates the signal with an analog signal and generates amplitude, phase, frequency and pulse modulation.

Section 7.11, "Analog modulations", on page 370

- Vector modulated signal
  Generates an I/Q vector modulated signal.
  See Section 6, "Applying I/Q vector modulation", on page 289.

The R&S SMM100A allows you to provide the RF signal with constant or varying frequencies and/or amplitudes at the output:

- Constant frequency and level (CW/Fixed mode)
  The RF output signal has the set frequency and level.
- Varying frequency and/or level

– Sweep mode
An RF or LF frequency and RF level sweep signal, processed continuously, step-by-step or individually and with selectable trigger modes. You can only run one sweep at a time.
– List mode
The RF signal is based on a list of predefined frequency and level values pairs and step widths.

See Section 7.10, "Varying the RF signal in list or sweep mode", on page 334.

7.1 Required options

The equipment layout for generating the RF signal includes:

- Base unit
- Option frequency (R&S SMM-B1006/-B1006)
- Optional RF bandwidth extension options, for example, extension to 2 GHz RF bandwidth require options R&S SMM-K523, R&S SMM-K524, R&S SMM-K525 and R&S SMM-K527.

For more information, refer to the specifications document.

7.2 How to access the RF settings

Access:

1. In the block diagram, select the block "RF > RF".
2. Select the required function from the list.

   The RF block covers all functions and settings concerning the RF signal. The settings include the RF frequency and level settings. Also, they include enhanced functions for improving the signal characteristics, analog modulations, list and sweep mode settings and connector assignments and measurement functions of the RF signal.

7.3 How to activate the RF signal output

Per default, the RF output signal is deactivated. The previous state is restored when the signal is reactivated.

To activate the RF output

1. Configure the RF signal as required.
   Set, for example, the frequency and level values.
2. Activate the RF output in one of the following ways:

a) In the status bar, select the "RF On" icon to enable the RF signal output.
b) In the block diagram, select the "On" checkbox of the RF block.
c) In the RF level settings menu, select "Level > RF ON > On"
d) At the front panel, press the [RF on/off] key.

The blue color of the "RF On" icon and the RF block indicate that the RF signal output is enabled.

RF State/RF ON....310
PEP....310
RF output impedance....310

RF State/RF ON
Activates or deactivates the RF output.

Acts as the [RF on/off] key.

Remote command:
`:OUTPut<hw>[:STATe]` on page 762

PEP
Displays the PEP (Peak Envelope Power) in the status bar. This value corresponds to the level specification of a digital modulation or of a digital standard signal at the RF output.

Remote command:
`[:SOURce<hw>]:POWer:PEP?` on page 1033

RF output impedance
You can query the impedance of the RF output.

Remote command:
`:OUTPut<hw>:IMPedance?` on page 763

7.4 How to set the frequency and level

The simplest form of the RF signal is a continuous wave (CW) of constant frequency and amplitude. The RF signal is defined by its frequency, level and phase.

To access the frequency, level and phase settings

► Use one of the following:

- "Status bar" > "Frequency" / "Level"
- "Status bar" > "RF Off/On" > "RF Frequency" > "Frequency"
- "RF block" > "RF" > "RF Frequency" > "Frequency"
- "RF block" > "RF" > "RF Level" > "Level"
- "RF block" > "RF" > "RF Frequency" > "Phase"
- "Block diagram" > "RF connector label" "RF" > "RF Frequency" > "Frequency", etc.
- At the front panel, press the [Freq] or the [Level] key.

The frequency and level values are indicated in the "Status bar" so that you can see them at a glance. Values displayed in the status bar and in the "Frequency/Level" dialogs can deviate form each other.

7.4.1 References

This section shows how the R&S SMM100A includes the factors of a downstream instrument to provide an optimal RF signal for the DUT.

7.4.1.1 Displayed RF frequency and level values with downstream instruments

If you are working with a downstream instrument, like a mixer, a frequency multiplier, an amplifier or an attenuator, you can enter the parameter (offset, multiplier, amplitude) of the downstream instrument in the frequency or level settings dialog of the R&S SMM100A.

The generator includes these parameters and displays the result in the "Freq" and "Lev" fields in the status bar, as if the downstream instrument and the generator were one unit. Thus, the displayed value corresponds to the value at the RF output of the downstream instrument.

The R&S SMM100A generates the signal without the downstream parameters, but considers all additional features concerning the RF level, like digital attenuation, user correction, etc.

RF frequency and level display with a downstream instrument

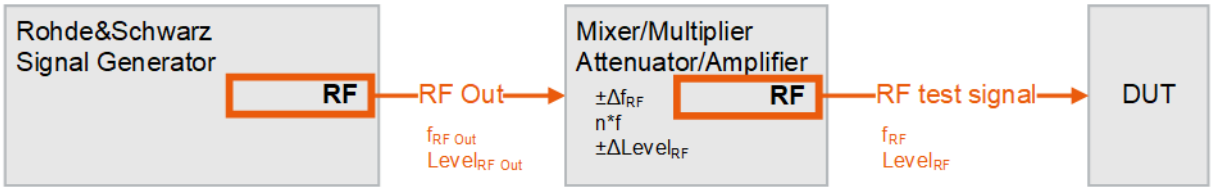


Figure 7-1: Frequency and Level display vs. frequency and level at the RF output

f_{RF}, $Level_{RF}$ = Frequency and level ("Status bar" > "Frequency" and "Level") at the output of the downstream instrument.

$f_{RF\ Out}$, $Level_{RF\ Out}$ = Frequency and level at the output connector [RF] ("RF" > "RF Frequency" > "Frequency" and "RF" > "RF Level" > "Amplitude")

n*f = Multiplication factor ("RF" > "RF Frequency" > "Multiplier")

Δf = Frequency offset ("RF" > "RF Frequency" > "Offset")

ΔLevel = Power offset ("RF" > "RF Level" > "Offset")

As shown on Figure 7-1, there are further parameters in addition to the frequency and amplitude, which affect the RF signal for the DUT, e.g. impacts of subsequent instruments. To include these impacts already in the configuration, you can set the related parameters directly in the dialogs (see RF frequency settings, or RF level settings).

Calculation of f_{RF} and $Level_{RF}$

- $f_{RF} = n*f_{RF\ Out} + \Delta f$

- $Level_{RF} = Level_{RF\ Out} + \Delta Level + Level_{DigAtt}$
  ($Level_{DigAtt}$ for active internal I/Q modulation, "RF" > "RF Level" > "Digital Attenuation")

In the "Freq" and "Lev" fields of the status bar, the R&S SMM100A shows the results of the following correlations:

1 = Status bar (display)
2,3,4 = (frequency settings dialog)

1 = Status bar (display)
2,3,4 = (level settings dialog)

The level displayed in the status bar includes "Amplitude", "Offset" and "Digital Attenuation".

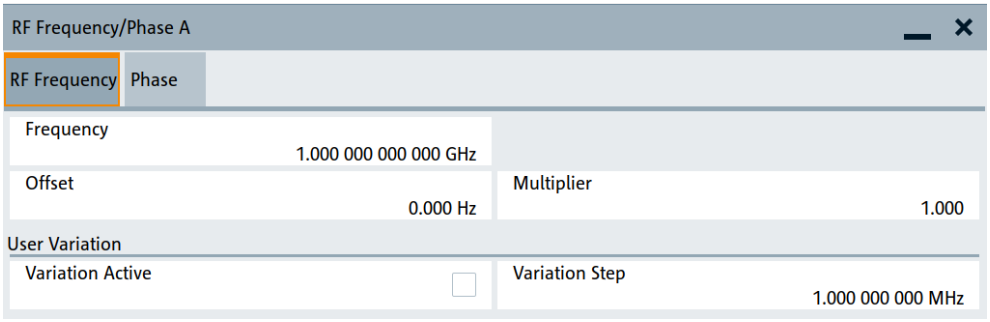
"Offset" represents a level value that impacts the RF signal outside the R&S SMM100A. In contrast, the "Digital attenuation" directly affects the level value at the RF output.

Further settings that affect the level at the RF output, like user correction, are indicated by an icon in the status bar.

7.5 RF frequency settings

Access:

► Select "RF" > "RF Frequency" > "Frequency".



In the "RF Frequency" dialog, you can configure:

- RF frequency, incl. an offset or multiplication factor of a downstream instrument
- The step size for varying the frequency with the rotary knob.

The remote commands required to define the settings are described in Section 13.17.8, "SOURce:FREQuency subsystem", on page 973.

Settings:

Frequency 313
Offset 313
Multiplier 314
Converter Mode 314
User Variation 314
└ Variation Active 315
└ Variation Step 315

Frequency
Sets the RF frequency.

This frequency is output at the RF connector.

It does not consider any parameter that affect the frequency, as e.g., a frequency offset.

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Note: Suppressed values in the status bar

For security concerns or certain operating modes, you can hide the frequency and level display in the status bar.

- ******

  The display has been disabled for security reasons.
  See:
  – Annotation Frequency
  – Annotation Amplitude

- ---

  The display is disabled when:
  – List mode is running, see Section 7.10, "Varying the RF signal in list or sweep mode", on page 334.

Remote command:
`[:SOURce<hw>]:FREQuency[:CW|FIXed]` on page 977

Offset
Sets the frequency offset.

This value represents the frequency shift of a downstream instrument, like for example a mixer.

The "Frequency" value displayed in the status bar is the resulting frequency, as it is at the output of the downstream instrument. The frequency at the R&S SMM100A RF output is not changed.

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Remote command:
[:SOURce<hw>]:FREQuency:OFFSet on page 978

Multiplier
Sets the multiplication factor for the RF frequency.

This value represents the multiplication factor of a downstream instrument, as for example a multiplier. You can also assign a negative multiplication factor, for example -1.0 to support frequency converters working in the reverse frequency position.

The "Frequency" value displayed in the status bar is the resulting frequency, as it is at the output of the downstream instrument. The frequency at the R&S SMM100A RF output is not changed.

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Remote command:
[:SOURce<hw>]:FREQuency:MULTiplier on page 978

Converter Mode
Selects the mode for calculating the output frequency of a downstream converter.

Example: Functionality of the converter mode

As the R&S SMM100A is a 2 path signal generator, it optimally supports external frequency converters. For convenient operation, this functionality calculates the resulting system frequency.

The converter mixes an I/Q modulated RF signal of the first path with an unmodulated, multiplied signal generated in the second path of the R&S SMM100A.

To configure the converter frequency:
- Set the frequency of the modulation carrier and the multiplication factor in the first path.
- Select the mixing frequency in the second path.
  According to the selected converter mode, the R&S SMM100A shows the resulting frequency in the status bar.

The modes selectable show the basis of the calculation. Due to the interaction of the two paths, active converter modes are mutually exclusive. Depending on the band to be used, select the appropriate mode:

"OFF" No converter considered.

"Multiplier * RFB + RFA" /"Multiplier * RFA + RFB"
Uses the upper sideband.

"Multiplier * RFB - RFA"/"Multiplier * RFA - RFB"
Uses the lower sideband.

Remote command:
n.a.

User Variation
Defines and activates a user-defined step width for varying the RF frequency or RF level with the rotary knob.

If disabled, the step width varies in steps of one unit at the cursor position.

Variation Active ← User Variation
Activates the set user-defined step width.

Remote command:
`[:SOURce<hw>]:FREQuency:STEP:MODE` on page 980
`[:SOURce<hw>]:POWer:STEP:MODE` on page 1037

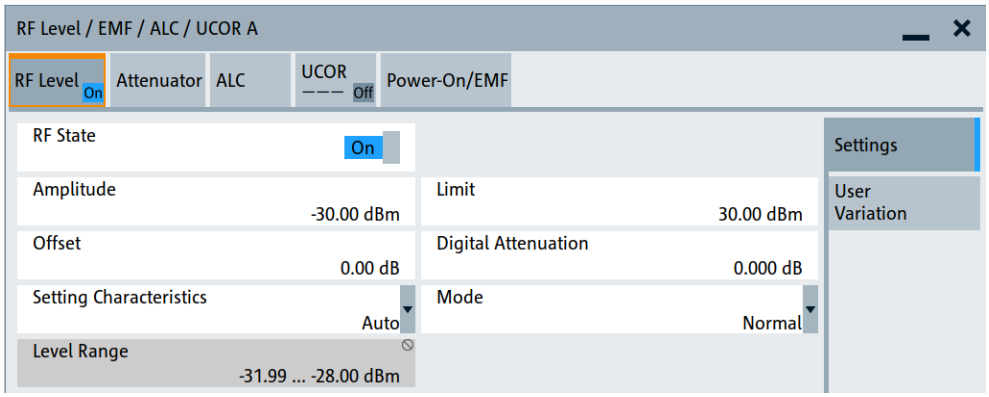
Variation Step ← User Variation
Sets the user-defined step width.

Remote command:
`[:SOURce<hw>]:FREQuency:STEP[:INCRement]` on page 981
`[:SOURce<hw>]:POWer:STEP[:INCRement]` on page 1037

7.6 RF level settings

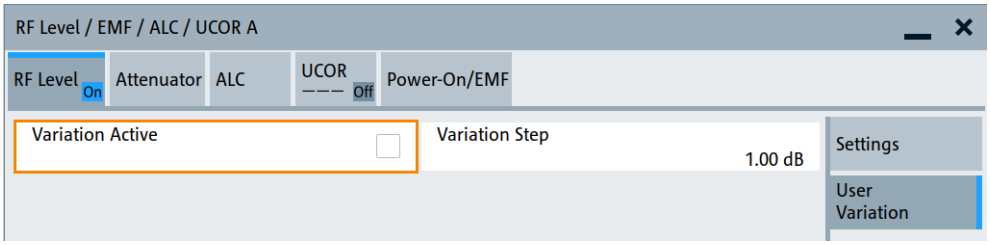
Access:

1. Select "RF" > "RF Level" > "Level".



In the "RF Level" dialog, you can configure the offset-free level, the level limit, and the step width for varying the level with the rotary knob.

2. Select "User Variation" to set the step width to be used when setting the RF level using the rotary knob.



The remote commands required to define the settings are described in Section 13.17.18, "SOURce:POWer subsystem", on page 1022.

Settings:

RF State/RF ON....316
Amplitude....316
Digital Attenuation....317
Mode....317
Setting Characteristics....317
Level Range....318
Readjust....319
Limit....319
Offset....319
User Variation....319
└ Variation Active....320
└ Variation Step....320

RF State/RF ON
Activates or deactivates the RF output.

Acts as the [RF on/off] key.

Remote command:
`:OUTPut<hw>[:STATe]` on page 762

Amplitude
Sets the level of the RF signal.

The value is offset-free and corresponds to the level at the RF connector.

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Note: Suppressed values in the status bar

For security concerns or certain operating modes, you can hide the frequency and level display in the status bar.

- ******

  The display has been disabled for security reasons.
  See:
  – Annotation Frequency
  – Annotation Amplitude

  The display is disabled when:
  – List mode is running, see Section 7.10, "Varying the RF signal in list or sweep mode", on page 334.

Remote command:
`[:SOURce<hw>]:POWer:POWer` on page 1033
Note: The SCPI command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]` sets the level of the "Level" display.
This means, the level containing offset.

Digital Attenuation
Attenuates or raises the level of the internal, digitally modulated I/Q baseband signals, and thus the level of the RF signal accordingly.

The function allows fast level changes of the internal I/Q signals. You can determine an attenuation value between -3 dB and +80 dB. The instrument calculates the digital attenuation to the $Level_{PEP}$ and the $Level_{rms}$ as follows:

$Level_{PEP(RF\ output)}$ = $Level_{PEP}$ - Digital Attenuation

$Level_{rms(RF\ output)}$ = $Level_{rms}$ - Digital Attenuation

The level range changes accordingly.

Note: The digital attenuation has no effect on the RF output level when you work in CW mode or with externally applied I/Q signals, i.e. with unmodulated signals.
If the digital attenuation effects the RF level, the R&S SMM100A indicates the resulting level in the "Status bar". It is also denoted by an icon next to the level indicator.

Note also that several other parameters affect the displayed RF level value.

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Remote command:
`[:SOURce<hw>]:POWer:ATTenuation:DIGital` on page 1030

Mode
Allows you to optimize the RF output signal for applications, where improved harmonic distortion or improved wideband noise is required.

"Normal" Generates an RF output signal with high signal to noise ratio as well as low distortion.

"Low Noise" Optimizes the signal to noise ratio.

"Low Distortion"
Reduces distortion (harmonics) of the RF signal to a minimum.

For more information, refer to the specifications document.

Remote command:
`[:SOURce<hw>]:POWer:LMODe` on page 1031

Setting Characteristics
Selects additional quality characteristics to optimize the behavior of the RF signal level for the specific application.

"Auto" Sets the RF output level automatically according to the selected mode.
In this mode, the instrument provides the highest dynamic range and fastest setting times.
The RF signal is shortly blanked when the step attenuator is switching.

For more information, refer to the specifications document.

"Uninterrupted"
Suppresses blanking at level transitions. Frequency transitions can lead to an RF level blanking due to hardware-specific switching points.
This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

Note:
Do not enable both the I/Q optimization mode "High Quality" and the RF signal level optimization mode "Uninterrupted" or "Strictly Monotone". The high-quality I/Q optimization mode leads to an RF signal interruption which blocks the RF signal level optimization.

"Strictly Monotone"
Executes signal level changes monotonically increasing or decreasing.
The setting makes sure that increasing the level value exclusively results in an increased output level, and vice versa.
All electronic switches, which can affect the monotonicity are fixed.
The operation mode is useful for applications using level searching algorithms which rely on a strictly monotonous behavior.

"Constant-VSWR"
Suppresses output impedance variations at the RF output connector, due to changed level settings.

"Continuous-Phase"
Suppresses phase discontinuities.
This mode reduces the dynamic range of the instrument and the step attenuator is fixed (equates to "Strictly Monotone").

"Constant-Phase"
This mode keeps the phase constant by coupling the digital attenuation directly to the level setting.

Note: The coupling is only active when the I/Q modulator is in operation.

Pressing Readjust adds the value of the digital attenuation to the level setting, and sets the Digital Attenuation = 0. In total, the level value remains constant.

"User"
Selects this entry automatically when you change one of the following parameters from the default setting:
- "Attenuator" > Mode
- "ALC" > State, Detector Sensitivity or Driver Amplifier

Note: If you select another setting characteristic, the R&S SMM100A presets the modified attenuator and ALC parameters.

Remote command:
`[:SOURce<hw>]:POWer:LBEHaviour` on page 1031

Level Range
Shows the interruption-free range of the level that you can use in the selected mode.

Remote command:
:OUTPut<hw>:AFIXed:RANGe:LOWer? on page 763
:OUTPut<hw>:AFIXed:RANGe:UPPer? on page 763

Readjust
Recalculates and adjusts the internal switch positions of the RF chain according to the current level.

The R&S SMM100A provides the "Readjust" function when you change one of the following parameters from the default setting:

- "RF Level" > Setting Characteristics
- "Attenuator" > Mode > FixedSetting Characteristics

In ALC mode "Sample & Hold" or "Sample & On" mode, the function also triggers a new sample process. During the recalculation, the output level is blanked briefly.

Remote command:
[:SOURce<hw>]:POWer:ALC:SONCe on page 1028

Limit
Sets an upper limit for the output power.

Note: The parameter "RF level" > **"Limit"** and "NRP power control" > **"RF Amplitude Limit"** are identical.

You can use this value to protect your DUT from damage due to high input power. If you enter an RF level above this value, the instrument limits the output power to this specified value, and generates the warning message:

"Pep value greater than the defined limit." However, the level indication in the status bar is not affected.

The setting is not affected by an instrument preset ([Preset] key or *RST) and the "Save/Recall" function. It is reset only by factory preset.

Remote command:
[:SOURce<hw>]:POWer:LIMit[:AMPLitude] on page 1031

Offset
Sets a level offset.

This value represents the level shift of a downstream instrument, like, for example, an attenuator or an amplifier.

The "Level" value displayed in the status bar is the resulting level, as it is at the output of the downstream instrument. The level at the R&S SMM100A RF output is not changed.

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Remote command:
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet on page 1038

User Variation
Defines and activates a user-defined step width for varying the RF frequency or RF level with the rotary knob.

If disabled, the step width varies in steps of one unit at the cursor position.

Variation Active ← User Variation
Activates the set user-defined step width.

Remote command:
[:SOURce<hw>]:FREQuency:STEP:MODE on page 980
[:SOURce<hw>]:POWer:STEP:MODE on page 1037

Variation Step ← User Variation
Sets the user-defined step width.

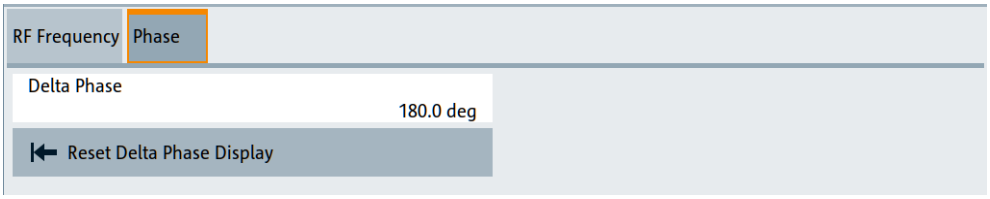
Remote command:
[:SOURce<hw>]:FREQuency:STEP[:INCRement] on page 981
[:SOURce<hw>]:POWer:STEP[:INCRement] on page 1037

7.7 RF phase settings

The phase in sinusoidal signals defines the initial angle at its origin.

Access:

► Select "RF" > "RF Frequency" > "Phase".



In the "RF Phase" tab, you can determine the delta phase value and reset the phase to this reference.

The remote commands required to define the settings are described in Section 13.17.17, "SOURce:PHASe subsystem", on page 1022.

Settings:

Delta Phase....320
Reset Delta Phase Display....320

Delta Phase
Sets the phase of the RF signal.

The current phase of the signal is used as the reference.

Remote command:
[:SOURce<hw>]:PHASe on page 1022

Reset Delta Phase Display
Adopts the selected "Delta Phase" value as the current value, and resets delta phase to 0 degrees.

Remote command:
[:SOURce<hw>]:PHASe:REFerence on page 1022

7.8 Reference oscillator

The R&S SMM100A is equipped with an internal reference oscillator that generates a reference frequency of 10 MHz. It is used as internal reference source for the synthesizer.

Alternatively, you can apply an external reference signal. If equipped with the required options, the R&S SMM100A can process external reference frequency in the range 1 MHz to 100 MHz and the 1 GHz reference frequency.

Regardless of the used reference source (internal or external), the R&S SMM100A always provides the configured reference frequency at the output. You can use it, for example to synchronize several interconnected instruments, see Section 7.8.5, "Using the reference frequency for instruments synchronization", on page 326, for an overview of typical test situations.

The reference oscillator settings are not affected by an instrument preset ([Preset] key or `*RST`) and the "Save/Recall" function. They are reset only by "Set To Default" in the corrresponding refererence frequency dialog or by a factory preset.

7.8.1 Required options

R&S SMM100A base unit equipped with the following options:

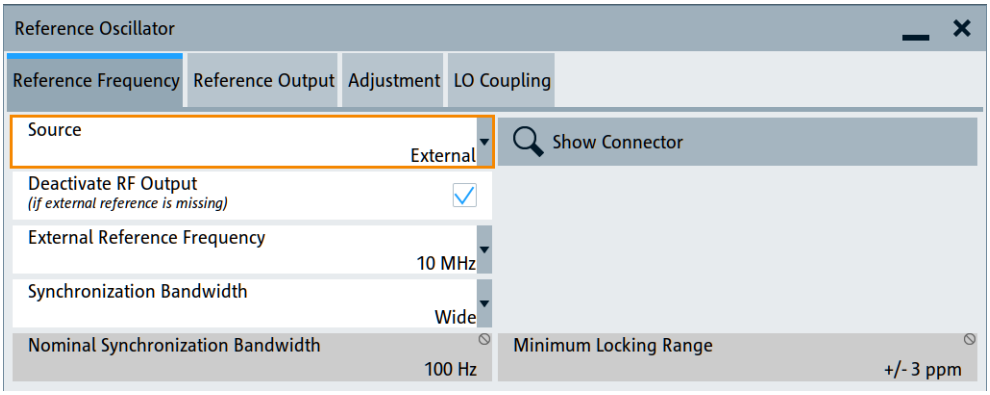
- 100 MHz, 1 GHz ultra low noise reference input and output (R&S SMM-K703)
- 1 MHz to 100 MHz flexible reference input (R&S SMM-K704)

For more information, refer to the specifications document.

7.8.2 Reference frequency settings

Access:

1. Select "RF" > "RF Frequency" > "Reference Frequency".



In the "Reference Frequency" tab, you can select the reference frequency signal source and the frequency and synchronization bandwidth mode of an external reference signal.

2. Observe the information in the status bar of the block diagram.

   The status bar indicates the current oscillator configuration.

   The remote commands required to define these settings are described in Section 13.17.19, "SOURce:ROSCillator subsystem", on page 1040.

Settings:

Source....322
Show/Show Connector....322
Deactivate RF Output (if external reference is missing)....323
External Reference Frequency....323
Variable Reference Frequency....323
Synchronization Bandwidth....323
Nominal Synchronization Bandwidth....324
Minimum Locking Range....324

Source
Selects the reference frequency source.

"Internal" Uses the internal reference oscillator, either with calibrated or a user-defined Adjustment Value.

Note: The internal reference frequency automatically uses Synchronization Bandwidth > Narrow. Thus, if you preset this parameter, or set the reference source from "External" to "Internal" manually, the R&S SMM100A sets the bandwidth to "Narrow".

"External" Uses an external reference signal.

Note: If the external reference is missing, the R&S SMM100A issues a warning message and indicates the icon (external reference missing).

To set the frequency of the external reference, see "External Reference Frequency".

Remote command:
`[:SOURce]:ROSCillator:SOURce` on page 1042

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

Deactivate RF Output (if external reference is missing)
Turns off the RF output when the external reference signal is selected, but no signal is supplied.

This function prevents that no improper RF signal due to the missing external reference signal is used for measurements. A message indicates that the RF output is deactivated.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:RFOFf[:STATe]` on page 1042

External Reference Frequency
Selects the frequency of the external reference input signal.

"10 MHz" 10 MHz external reference frequency

"100 MHz"/"1 GHz"
Option: R&S SMM-K703
Selects the external reference frequency.

"Variable" Requires R&S SMM-K704.
The external reference signal has an arbitrary frequency, within the permissible range from 1 MHz to 100 MHz.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:FREQuency` on page 1043

Variable Reference Frequency
Requires R&S SMM-K704 and "External Reference Frequency" > "Variable".

Sets a variable value for the external reference frequency.

For more information, refer to the specifications document.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:FREQuency:VARiable` on page 1043

Synchronization Bandwidth
Selects the synchronization bandwidth for an external reference signal, set with "Source > External".

The resulting bandwidth is indicated by the parameter Nominal Synchronization Bandwidth.

"Narrow" The internal reference oscillator is synchronized to the external signal with narrow bandwidth.
This setting is recommended if the phase noise of the external signal is worse than the phase noise of the internal OCXO.

"Wide" Synchronizes the internal oscillator to the external signal with the maximum possible bandwidth.
This mode is the recommended standard mode and for precise reference sources of high spectral purity.

Note: If the frequency of the external reference signal is outside the locking range of the internal reference oscillator, spurs due to the difference of the internal and external reference frequency are generated in the reference PLL.
The R&S SMM100A issues an error message.

For more information, refer to the specifications document.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:SBANdwidth` on page 1043

Nominal Synchronization Bandwidth
Indicates the nominal synchronization bandwidth for the selected external reference frequency and the synchronization bandwidth.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:NSBandwidth?` on page 1044

Minimum Locking Range
Indicates the minimum locking range for the selected external reference frequency and the synchronization bandwidth.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:MLRange?` on page 1044

7.8.3 Reference output settings

Access:

1. Select "RF" > "RF Frequency" > "Reference Frequency".
2. Select "Reference Output".

In the "Reference Output" tab, you can set the reference frequency value at the output connectors.
As a result of parameter dependencies, "Preset This Parameter" sometimes does not affect output dialogs.
The remote commands required to define these settings are described in Section 13.17.19, "SOURce:ROSCillator subsystem", on page 1040.

Settings:

Reference Output/1 GHz Reference Output 325
Show/Show Connector 325

Reference Output/1 GHz Reference Output
Selects frequency reference output signal for downstream instruments.

"Off" Deactivates the reference signal output.

"10 MHz" Derives a signal with 10 MHz frequency from the internal reference oscillator and provides this signal at the output.

"100 MHz" Option: R&S SMM-K703
Provides the 100 MHz reference frequency signal at the output.

"1 GHz" Option: R&S SMM-K703
Provides the 1 GHz reference frequency signal at the output.

"Input Signal (loop through)"
Option: R&S SMM-K703/-K704
Passes the external reference frequency to the output directly.

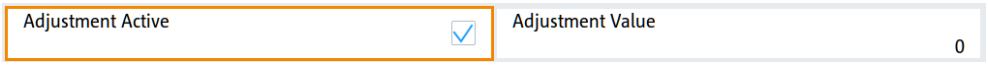
Remote command:
`[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE` on page 1044
`[:SOURce]:ROSCillator:OUTPut:ALTernate:FREQuency:MODE` on page 1045

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

7.8.4 Adjustment settings

Access:

1. Select "RF" > "RF Frequency" > "Reference Frequency".
2. Select "Adjustment".



Settings:

Adjustment Active 325
Adjustment Value 326

Adjustment Active
Selects the adjustment mode.

"Off" Uses the calibrated internal reference frequency.

"On" Allows you to apply a deviation to the internal reference frequency, according to your requirements.
Enter the value in the Adjustment Value field.

Remote command:
`[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe]` on page 1046

Adjustment Value
Sets a user-defined adjustment value for the internal reference frequency. This value takes effect when it is activated with Adjustment Active.

- "0" represents the calibrated state.
- The setting range depends on the reference oscillator type and its factory calibration value.

Note:
The setting is not affected by an instrument preset ([Preset] key or `*RST`) and the "Save/Recall" function. It is reset only by factory preset.

Remote command:
`[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue` on page 1045

7.8.5 Using the reference frequency for instruments synchronization

Test setups with two or more instruments often require that the instruments use a common reference frequency. Depending on the availability of external reference frequency source and its quality, the instruments are connected and configured in different ways.

This section gives an overview of the possible test setups and the related settings. The following situations are considered:

- External reference source is not available or the **built-in reference oscillator** is of better quality than the external source
  (see "Distributing the internal 10 MHz reference signal to further instruments" on page 326)
- **Clean external reference source** with quality exceeding the quality of the built-in reference oscillator
  (see "Using external reference source" on page 327)
- **Interfered or noisy external reference signal**
  (see "Deriving 10 MHz from the external reference frequency" on page 328)
- **1 GHz reference coupling** for phase coherence of the RF signals with enhanced long-term phase stability
  (see "Sharing the 1 GHz reference frequency to obtain phase-coherent signals" on page 327)

Connectors overview

Use the "Show Connector" function to indicate the connector on the front/real panel:

- "Ref In/Ref Out" on page 44
- 1GHz "Ref In/Ref Out" on page 44
- "EFC" on page 44

Distributing the internal 10 MHz reference signal to further instruments

The internal reference oscillator provides the reference frequency:

- Internal f_{ref} = 10 MHz (10 MHz at connector Ref Out)
- Source = "Internal"
- Reference Output/1 GHz Reference Output = "10 MHz"

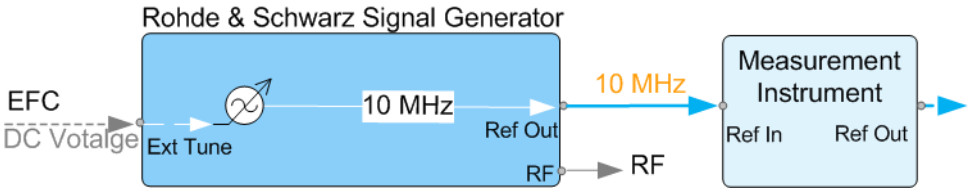


Figure 7-2: Synchronizing instruments using the internal 10 MHz reference signal of the R&S SMM100A

EFC = External frequency control
EFC,Ref In,Ref Out = Connectors

In phase noise measurement systems, for example, you can also use the EFC (external frequency control) function and shift the frequency. EFC is a function that transforms an external tuning voltage into frequency shift, where the value range of the resulting frequency is a technical characteristic. Further parameters are sensitivity, input voltage range, impedance and maximum bandwidth for external tuning signal.

Consider the following interdependency:

- EFC in combination with an external PLL
  If the EFC is applied in combination with an external PLL (phase locked loop), the PLL bandwidth must be smaller than the bandwidth of the external tuning signal.
- FM-DC mode
  If the measurement requires higher PLL bandwidth, we recommend that you use the external FM modulation (DC coupling) in low noise mode.
  The FM-DC mode yields a fixed tuning sensitivity that is independent of the RF output frequency and corresponds to the selected FM deviation.

For more information, refer to the specifications document.

Sharing the 1 GHz reference frequency to obtain phase-coherent signals

Compared to 10 MHz, a 1 GHz reference signal significantly improves the achievable phase stability between two signal sources. Because the synchronization frequency increases by a factor of 100, the relative phase fluctuations between the sources can be reduced.

1 GHz at connector Ref In 1GHz and 1 GHz at Ref Out 1GHz

- External f_{Ref} = 1 GHz
- Source = "External"
- External Reference Frequency = "1 GHz"
- 1GHz Reference Output = "1 GHz"

Using external reference source

If you have a clean external reference signal with 10 MHz or 100 MHz frequency, for example, you can **directly pass it to the output**. The signal quality remains the same.

10 MHz, 100 MHz at connector Ref Out and Ref In

- External f_{Ref} = 10 MHz or 100 MHz
  (*earlier RF hardware versions*: 5 MHz, 10 MHz, 13 MHz)

- Source = "External"
- Reference Output = "10 MHz, 100 MHz" or "Input Signal (loop through)" (*earlier RF hardware versions*: 5 MHz, 10 MHz, 13 MHz)
- Set the synchronization bandwidth according to the requirements of the application.

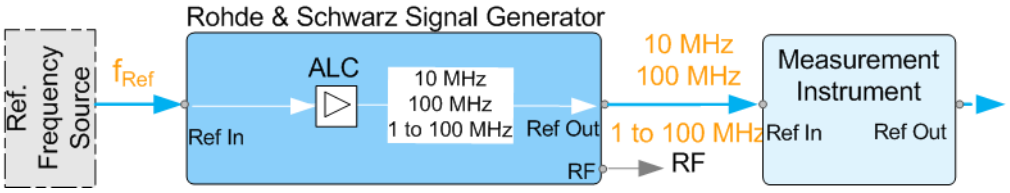


Figure 7-3: Synchronizing instruments with a 10 MHz external reference signal

Ref. Frequency Source = e.g., Rohde & Schwarz signal analyzer
f_{Ref} = 10 MHz, 100 MHz, 1 MHz to 100 MHz external reference frequency
Ref In, Ref Out = Connectors

You can forward reference frequency between 1 MHz and 100 MHz directly to the output in the same way.

For more information, refer to the specifications document.

- External f_{Ref} = 1 MHz to 100 MHz
  (**1 MHz to 100 MHz at connector Ref In and Ref Out**)
- Source = "External"
- Variable Reference Frequency = "Variable"
- External Reference Frequency = current external frequency
- Reference Output = "Input Signal (loop through)" or specify the reference frequency the synchronized instrument supports
- Set the synchronization bandwidth according to the requirements of the application.

Deriving 10 MHz from the external reference frequency

10 MHz reference frequency can be derived from the following external reference signals:

- 10 MHz from internal oscillator locked to external input
- 100 MHz and 1 GHz external reference signals
- External reference signal between 1 MHz and 100 MHz
- If the external reference signal is interfered (noisy)

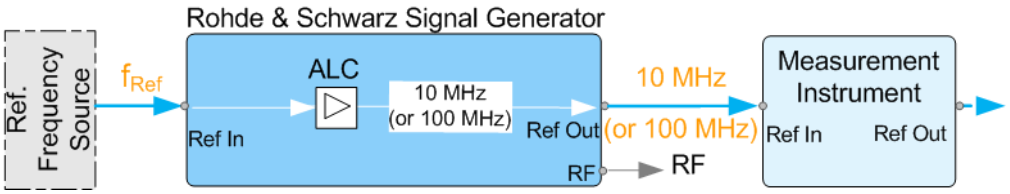


Figure 7-4: Synchronizing instruments with 10 MHz (derived from an external reference frequency)

Ref. Frequency Source = e.g., Rohde & Schwarz signal analyzer
f_{Ref} = 10 MHz, 100 MHz, 1 MHz to 100 MHz, 1 GHz** external reference frequency
** = 1 GHz uses Ref In 1 GHz connector
Ref In, Ref Out = Connectors

1 GHz, 1 MHz to 100 MHz at connector Ref In 1 GHz/Ref In and 10 MHz at Ref Out

- E.g., external Ref. f_{ref} = 100 MHz
- Source = "External"
- External Reference Frequency = "100 MHz"
- Reference Output/1 GHz Reference Output = "10 MHz"
- Synchronization Bandwidth = "Narrow"

7.9 Local oscillator coupling

The local oscillator (LO) coupling function allows a distribution of the local oscillator signal in a way that multiple RF signals can be derived from the same LO signal. Derivation from the same LO signal is mandatory for minimizing the phase fluctuations between these RF signals.

The R&S SMM100A uses either the internal oscillator frequency for the LO signal that is the output signal of the internal synthesizer or an external frequency source.

Connectors

- The internal LO signal is output at the LO Out connector.
- An external signal is fed in at the LO In connector.

The instrument cannot verify the frequency of the oscillator signal that is fed in. We recommend that you fed in signal with the same frequency as shown in the settings dialog, see LO OUT Frequency.

See also "To locate the LO In/Out connectors" on page 332.

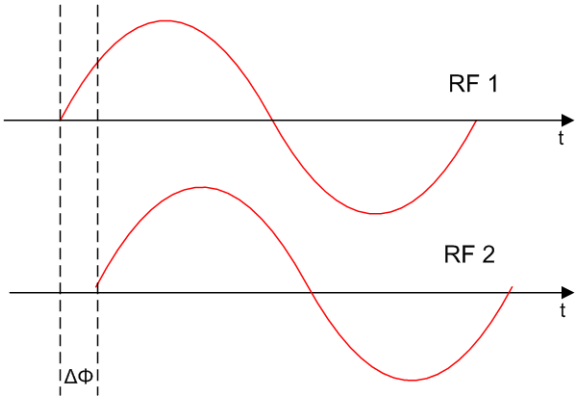
7.9.1 Required options

The equipment layout for using the LO coupling function includes:

- Base unit
- Option phase coherence (R&S SMM-B90)

7.9.2 Phase coherence

Phase coherence of RF signals designates a defined, constant delta phase between two or more RF carrier signals with the same frequency or a multiple of the frequency.



If two signal generators are coupled via their 10 MHz reference, they are generating the same frequency but only from the long term perspective. Having a closer look into the instantaneous differential phase (“delta phase”) of these two RF signals, the following are possible causes for instabilities:

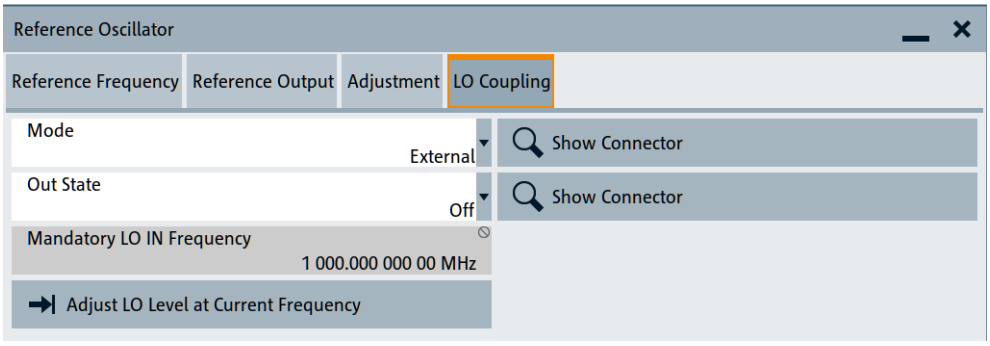
- Phase noise of the two synthesizers
- *Weak* coupling at 10 MHz and a long synthesis chain up to the RF domain
- Temperature differences which cause a change of the effective electrical length of some synthesizer components

Most critical for a stable delta phase is the thermal RF phase fluctuation between multiple RF synthesizers. These fluctuations can be minimized by using a common synthesizer, that means a common local oscillator (LO) signal for all RF carrier. The LO signal is internally used for upconverting the baseband signal to the RF. Only if the LO signal is the same for all carriers, you can achieve a stable phase relationship between the RF signals.

7.9.3 LO coupling settings

Access:

► Select "RF" > "LO Coupling ...".



The tab provides settings to configure the coupling of the local oscillator signal in the RF signal paths.

LO coupling prerequisites

Using the LO coupling function requires an enabled I/Q modulator ("I/Q Mod" > "On").

The remote commands required to define these settings are described in Section 13.17.8, "SOURce:FREQuency subsystem", on page 973.

Mode

Selects the coupling mode of the LO signals.

See a typical test setup in Section 7.9.4, "Configuring cascaded instruments", on page 332.

Note: Working with an **external** oscillator signal disables all setting parameters of the "RF Frequency / Phase / Ext. Reference" dialog.
In **external** mode with active Out State, the LO coupling mode is defined within an RF frequency range of 80 MHz to 6 GHz. If you the set the RF frequency below 80 MHz, the R&S SMM100A adjusts the frequency to the minimum value and displays a corresponding message.

"Internal" Uses the internal signal.

"External" Uses an externally supplied signal.

Remote command:
`[:SOURce<hw>]:FREQuency:LOSCillator:MODE` on page 975.

Out State

Activates or deactivates the LO output.

"On" Switches the LO output signal on.
For coupling two instruments, the internal local oscillator signal is also available at the LO Out connector.

"Off" Switches the LO output signal off.

Remote command:
`[:SOURce<hw>]:FREQuency:LOSCillator:OUTPut:STATe` on page 976

Mandatory LO IN Frequency

Displays the frequency that must be applied as external LO frequency.

Remote command:
`[:SOURce<hw>]:FREQuency:LOSCillator:INPut:FREQuency?` on page 975

LO OUT Frequency

Displays the current LO frequency at the LO Out connector.

Remote command:
`[:SOURce<hw>]:FREQuency:LOSCillator:OUTPut:FREQuency?` on page 975

Show/Show Connector

Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

Adjust LO Level at Current Frequency

Adjusts the level of the oscillator signal to optimum, if an external LO signal is applied.

The function is enabled in the following cases:

- An external "LO Coupling Mode" is selected.
- "Out State" is on.

Note: If your test setup consists of several cascaded Rohde & Schwarz instruments, always use an external oscillator signal and start the LO level adjustment with the first instrument. Continue in the order up to the last.

Remote command:
`:CALibration<hw>:LOSCillator:COUPling:LOCal?` on page 737

7.9.4 Configuring cascaded instruments

This section describes how you can find out the location of the LO signal connectors (LO In/Out). You can also find instructions for configuring the LO signals of several disconnected signal generators.

To locate the LO In/Out connectors

The LO In and LO Out connectors are located on the rear panel. To find out the exact position, proceed as follows:

1. In the block diagram, select the "T/E/P/L/V" status indication field above the "RF" block.
2. Select "LO In" > "Show".

   The connector is on the rear panel.

   See also Section 11.2.4, "RF connectors settings", on page 568.

To configure LO coupling with cascaded instruments

Use the LO coupling function, for example, to generate beamforming signals. The test setups in the following examples represent possible applications and provide information about the coupling modes set in the signal generators. For the configuration via remote control, see the examples in Section 13.17.8, "SOURce:FREQuency subsystem", on page 973.

The first test setup example represents all variants of the coupling modes, and describes step by step how to configure each of the Rohde & Schwarz signal generators. The following examples show further conceivable test setups. To configure these test setups, proceed similarly as shown in the first example.

Example: Cascading three Rohde & Schwarz signal generators

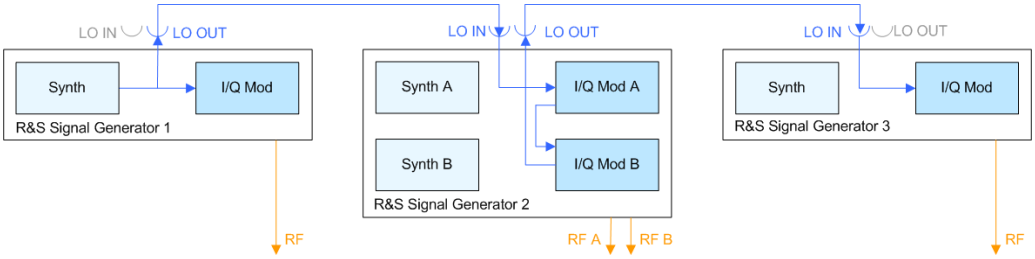


Figure 7-5: Set up of LO coupling with three Rohde & Schwarz Signal Generators

Generator 1 = "Internal"; "LO Out" > "On"
Generator 2 = "A External & A->B Coupled"; "LO Out" > "On"
Generator 3 = "External"; "LO Out" > "Off"

A frequency of 5 GHz is assumed.

- Signal Generator 1 is a one-path instrument, for example R&S SMM100A and uses its internal oscillator signal.
- Signal Generator 2 is a two-paths instrument, for example an R&S SMW. It receives the LO signal from the first instrument and assigns it to both paths.
- Signal Generator 3 is a one-path instrument, for example the R&S SMM100A or the R&S SGT100A. It receives the LO signal from the second instrument.

To configure the application, proceed as follows:

1. Connect the first signal generator Ref Out with LO In of the second instrument, and similarly the LO Out of the second signal generator with LO In of the third.
2. Configure **Signal Generator 1.**
   Set the frequency "Freq" = "5 GHz".
   a) Select "RF" > "LO Coupling" > "Mode" > "Internal".
   b) Set "Out State" > "On".
3. Configure **Signal Generator 2.**
   a) Set the frequency "Freq" = "5 GHz".
   b) Select "RF" > "LO Coupling" to check if both paths are able to deal with the desired RF frequency.
      - If both paths can handle the RF frequency, select "Mode" > "A External & A->B Coupled"
      - If path A is not sufficiently equipped, select "Mode" > "A RF Off & B External"
      - If path B is not able to handle the frequency, select "Mode" > "A External & B RF Off"
   c) Set "Out State" > "On".

d) If the attenuation between the interconnection LO Out and LO In is more than 1 dB at the oscillator frequency, we recommend that you execute "Adjust LO Level Current Frequency".
Note: Complete the adjustment procedure before you perform the adjustment on a subsequent instrument.
The signal generator automatically adjusts the internal LO signal level at the I/Q modulator and LO Out connector.

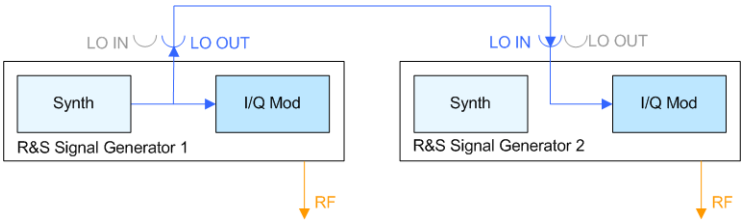
4. Configure **Signal Generator 3.**
   a) the frequency "Freq" = "5 GHz".
   b) Select "RF" > "LO Coupling" > "Mode" > "External".
   c) Set "Out State" > "Off".
   d) If the attenuation between the interconnection LO Out and LO In is greater than 1 dB at the oscillator frequency, we recommend that you perform level adjustment:
      - Check if the "Adjust LO Level Current Frequency" procedure of the previous instrument is completed.
      - Execute "Adjust LO Level Current Frequency".

      The signal generator automatically adjusts the internal LO signal level at the I/Q modulator and LO Out connector.

   All instruments generate the RF signals in phase, as they use the same oscillator signal looped through all instruments.

Example: Generating a beamformed signal (single path instruments)

This example shows a test setup with two single-path Rohde & Schwarz generators.



Generator 1 = "Internal"; "LO Out" > "On"
Generator 2 = "External"; "LO Out" > "Off"

The *Signal Generator 1* uses its internal oscillator signal. *Signal Generator 2* receives the LO signal from the first instrument. The frequency is assumed to be 2 GHz.

7.10 Varying the RF signal in list or sweep mode

The operating modes "List" and "Sweep" allow you to generate an RF signal having periodically varying frequencies or amplitudes.

A signal generated with varying parameters scans a certain range of varying values of a parameter, with defined start and end points, and can be repeated cyclically.

The R&S SMM100A supports two basic methods:

- **Sweep** mode
  The instrument generates an RF signal which varies its frequency or level values in discrete steps between the start and end values. The values change according to a specific shape like sawtooth or triangle. The spacing is linear or logarithmmic.

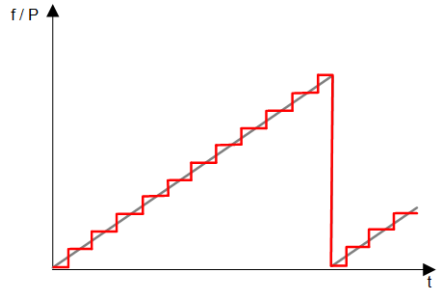


Figure 7-6: Schematic representation of a signal generated in sweep mode

  The main application field of the "Sweep" mode is to determine the frequency response a DUT.

- **List** mode
  The instrument generates a varying output signal, based on a previously saved list with frequency, amplitude and step width values. While in sweep mode the frequency **or** the level values change, in list mode you can vary **both parameters simultaneously**. The frequency and level values do not need to have ascending or descending order, they can vary arbitrarily.
  You can use a global dwell time, which means that the time interval is constant for all steps of the list, or different dwell times for each value pair.
  Figure 7-7 represents the frequency and power value pairs, in this case with the dwell time set the same for all steps (global dwell time).

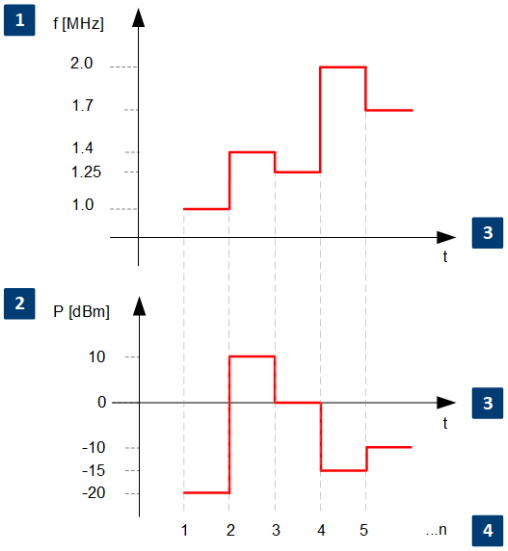


Figure 7-7: Schematic representation of a signal generated in list mode (global dwell time)

1 = RF frequency
2 = RF Level
3 = Dwell time (global)
4 = List index

The list mode is especially useful in high-speed measurements with fast changing frequency and level settings.

Note that the shown diagrams represent the behaviour in theory. In real signal generation, the instruments usually have a blank time when the frequency or level changes.

Interactions and characteristics of list and sweep mode

- Activating the list mode automatically deactivates all RF and LF sweeps and vice versa.
- In list processing mode, the frequency and level display in the status bar is disabled.

- The sweep modes only work with a *global* dwell time, that means the time intervals are constant during signal generation.
- If you want to hold a running sweep at a specific frequency or level value, enter the value in the status bar. The sweep stops immediately.
- We recommend that you switch off the display update for optimum sweep performance, especially with short dwell times
  See Section 11.1.3, "Display update settings", on page 560.

7.10.1 Signal generation and triggering in the sweep and list modes

In both operating modes "List" and "Sweep", triggering and signal generation follow the same principle. The instrument generates the signal continuously (that means triggered automatically) or in individual steps (controlled manually by an internal or external trigger signal).

The instrument expects the trigger signal at the Inst Trig connector.

If the dwell time in sweep or list mode is too short or external trigger signals come too fast, the signal generation delays. As the delay increases, the R&S SMM100A signals an overrun, or even stops sweep or list mode signal generation, if the delay gets too long.

The instrument diplays corresponding error messages.

The figures in this section give an overview on the signal generation in the sweep and list modes and the appropriate triggering. The figures show the signal state after activating the mode and the generation of the signal when a trigger event occurs. For each mode, the relevant parameters and settings are briefly explained.

Each "Sweep" and "List" mode dialog provides also a "Reset" function that sets the signal to the initial value or the beginning of the list. Depending on the selected trigger mode, the signal generation proceeds accordingly.

The naming of the selection parameters in manual control (GUI) sometimes deviates from the naming in the remote-control commands. In addition, the value names of the selection parameters used in the signal generator partly differ from the SCPI syntax. The instrument accepts all value names.

The correlation between the manual control and the corresponding remote control commands, including the SCPI conform syntax are explained for each mode (see the cross-reference tables).

See also the following programming examples on the sweep and list modes in remote control:

- Example "Setting up an RF frequency or power sweep" on page 1047
- Example "Setting up an LF sweep" on page 992
- Example "Create an RF list and activate the list mode" on page 1004

Auto mode (Sweep/List)

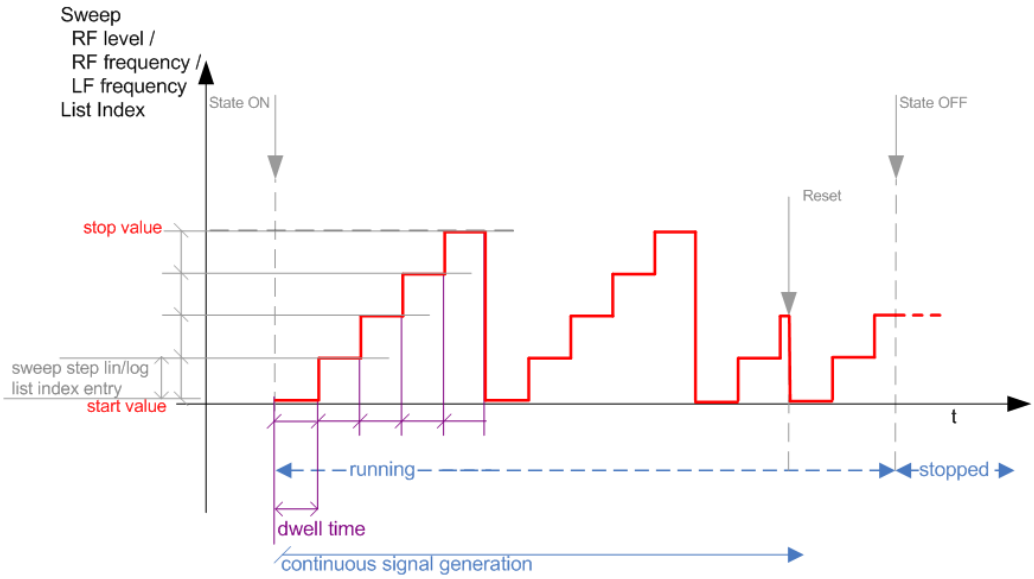


Figure 7-8: Auto mode (Sweep/List)

- The instrument generates the signal continuously.
- Trigger mode "Auto" is prerequisite (default). It causes the continuous generation of the sweep signal.
- Starts signal generation immediately with "State = On".
- Switches automatically to the next step when the Dwell time has elapsed.
- Stops signal generation with "State = Off".

Table 7-1: Cross-reference between manual and remote control in Auto mode (Sweep/List)

Manual control mode: "Auto"	Remote commands Rohde & Schwarz proprietary and [SCPI conform] value name
RF frequency sweep	:TRIGger<hw>:FSWeep:SOURce AUTO [IMMediate] :SOURce<hw>:SWEep:FREQuency:MODE AUTO
RF level sweep	:TRIGger<hw>:PSWeep:SOURce AUTO [IMMediate] :SOURce<hw>:SWEep:POWer:MODE AUTO
LF frequency sweep	:TRIGger<hw>:LFFSweep:SOURce AUTO [IMMediate] :SOURce<hw>:LFOutput<ch>:SWEep:FREQuency:MODE AUTO
List	:SOURce<hw>:LIST:MODE AUTO :SOURce<hw>:LIST:TRIGger:SOURce AUTO

Single / Extern Single mode (Sweep/List)

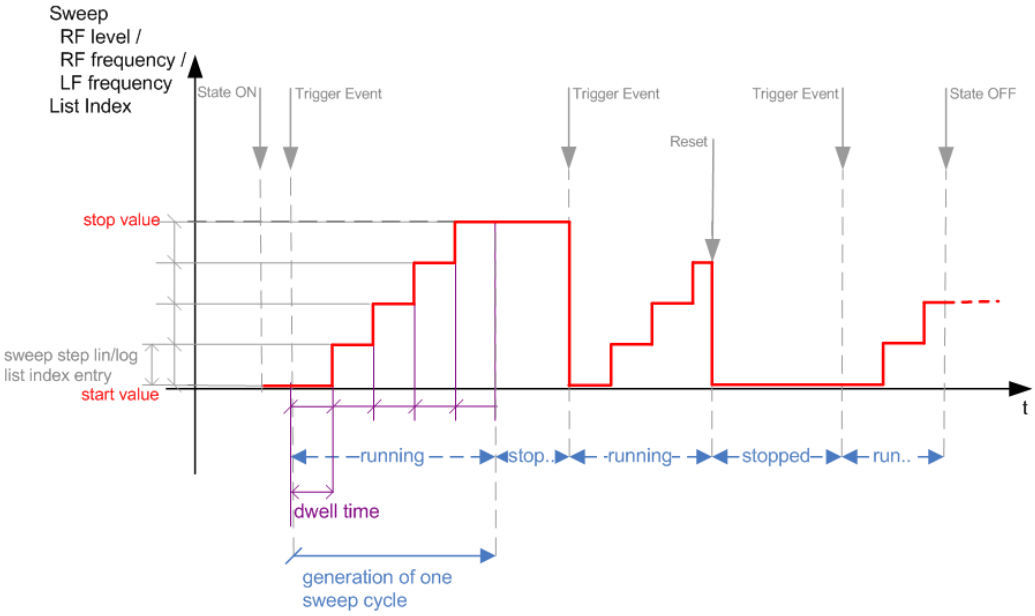


Figure 7-9: Single / Extern Single mode (sweep / list)

In single mode, you can specify, that the signal returns to the start value when a sweep cycle has been completed.

See "The Retrace function" on page 343 for details.

- The instrument generates a single sweep cycle.
- Trigger mode "Manual". A trigger event initiates one sweep from the start value to the end value.
- "State = On" sets the signal to the start value: the sweep start frequency, the sweep start power or the frequency-power value pair of the selected index in the list.
- Starts signal generation with a trigger event.

- Switches automatically to the next step when the Dwell time has elapsed.
- Stops signal generation at the set end value and waits for the subsequent trigger event.
- Trigger sources:
  – The "Execute Single Sweep" function.
  – The corresponding remote control command.
  – An externally applied trigger signal.
- "State = Off" stops the signal generation in sweep or list mode.

Table 7-2: Cross-reference between manual and remote control in Single / Extern Single modes (Sweep/List)

Manual control mode: "Single / Extern Single"	**Remote commands Rohde & Schwarz proprietary and [SCPI conform] value name**
RF frequency sweep	`:TRIGger<hw>:FSWeep:SOURce SINGle [BUS]` "Single" **or** `:TRIGger<hw>:FSWeep:SOURce EXTernal [EXTernal]` "Extern Single" `:SOURce<hw>:SWEep:FREQuency:MODE AUTO`
RF level sweep	`:TRIGger<hw>:PSWeep:SOURce SINGle [BUS]` for "Single" **or** `:TRIGger<hw>:PSWeep:SOURce EXTernal [EXTernal]` for "Extern Single" `:SOURce<hw>:SWEep:POWer:MODE AUTO`
LF frequency sweep	`:TRIGger<hw>:LFFSweep:SOURce SINGle [BUS]` "Single" **or** `:TRIGger<hw>:LFFSweep:SOURce EXTernal [EXTernal]` "Extern Single" `:SOURce<hw>:LFOutput<ch>:SWEep:FREQuency:MODE AUTO`
List	`:SOURce<hw>:LIST:TRIGger:SOURce SINGle` "Single" **or** `:SOURce<hw>:LIST:TRIGger:SOURce EXTernal` "Extern Single" `:SOURce<hw>:LIST:MODE AUTO`

Step / Extern Step mode (Sweep/List)

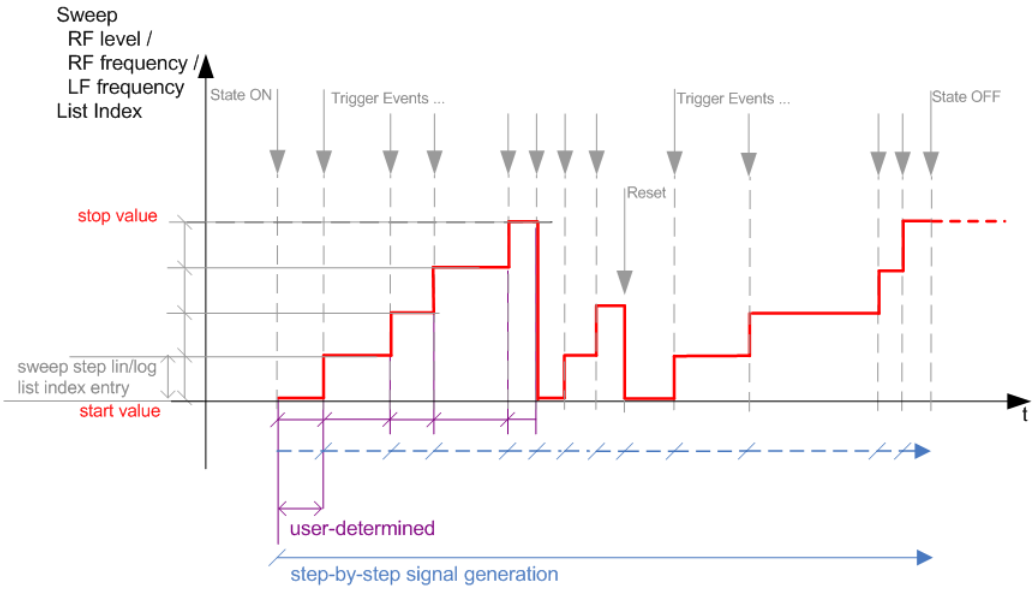


Figure 7-10: Step / Extern Step mode (sweep / list)

- The instrument generates the signal step-by-step.
- Starts signal generation with "State = On".
- Switches to the next step with a manual action.
  If the end value is reached, signal generation starts again from the beginning.
- Stops signal generation with "State = Off".
- Trigger sources:
  - The rotary knob at the front panel.
  - The [Arrow] keys at the front panel.
  - The corresponding remote control commands.
  - An externally applied trigger signal.

To step through the sweep frequencies or levels:

- In manual mode:
  - Set the Current Frequency or Current Level values
  - Use the [Up] and [Down] keys or the rotary knob
- In remote control mode:
  - Use the commands `[:SOURce<hw>]:FREQuency:MANual` or `[:SOURce<hw>]:POWer:MANual` with the `UP` or `DOWN` parameter

Steps that would exceed the sweep range are ignored.

Table 7-3: Cross-reference between manual and remote control in Step / Extern Step modes (Sweep/ List)

Manual control mode: **"Step / Extern Step"**	**Remote commands** **Rohde & Schwarz proprietary and [SCPI conform] value name**
RF frequency sweep	`:TRIGger<hw>:FSWeep:SOURce SINGle [BUS]` "Step" **or** `:TRIGger<hw>:FSWeep:SOURce EXTernal [EXTernal]` for "Extern Step" `:SOURce<hw>:SWEep:FREQuency:MODE STEP`
RF level sweep	`:TRIGger<hw>:PSWeep:SOURce SINGle [BUS]` "Step" **or** `:TRIGger<hw>:PSWeep:SOURce EXTernal [EXTenal]` "Extern Step" `:SOURce<hw>:SWEep:POWer:MODE STEP`
LF frequency sweep	`:TRIGger<hw>:LFFSweep:SOURce SINGle [BUS]` "Step" **or** `:TRIGger<hw>:LFFSweep:SOURce EXTernal [EXTenal]` "Extern Step" `:SOURce<hw>:LFOutput<ch>:SWEep:FREQuency:MODE STEP`
List	`:SOURce<hw>:LIST:TRIGger:SOURce SINGle` "Step" **or** `:SOURce<hw>:LIST:TRIGger:SOURce EXTernal` "Extern Step" `:SOURce<hw>:LIST:MODE STEP`

Extern Start/Stop mode (sweep)

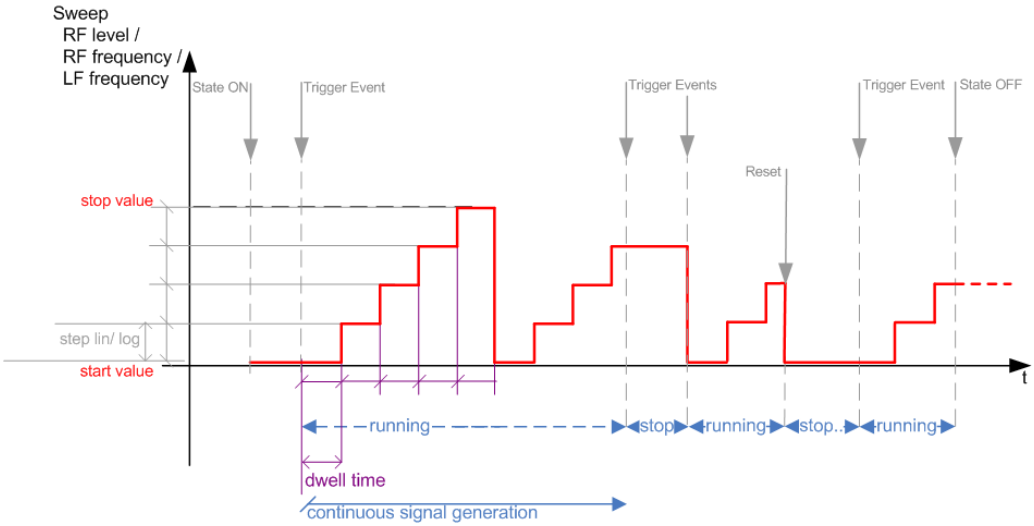


Figure 7-11: Extern Start/Stop mode (sweep)

- The instrument generates the signal continuously.
- Trigger mode "Auto" and "Sweep > State = On" are prerequisite.
- State "On" sets the signal to the start value, that is one of the following:
  - Sweep start frequency
  - Sweep start power
  - Frequency-power value pair of the selected index in the list
- Starts signal generation with a trigger event.

- Switches automatically to the next sweep step when the Dwell time has elapsed. If the end value is reached, signal generation continues with the next sweep cycle.
- Stops signal generation with the next external trigger event.
- Starts the signal generation again with the next trigger event, beginning at the start value.
- "State = Off" stops the signal generation in sweep or list mode.
- Trigger source: An externally applied trigger signal.

Table 7-4: Cross-reference between manual and remote control in Extern Start/Stop modes (sweep)

Manual control mode: "Extern Start/Stop"	Remote commands Rohde & Schwarz proprietary and [SCPI conform] value name
RF frequency sweep	:TRIGger<hw>:FSWeep:SOURce EAUTo [-] :SOURce<hw>:SWEep:FREQuency:MODE AUTO
RF level sweep	:TRIGger<hw>:PSWeep:SOURce EAUTo [-] :SOURce<hw>:SWEep:POWer:MODE AUTO
LF frequency sweep	:TRIGger<hw>:LFFSweep:SOURce EAUTo [-] :SOURce<hw>:LFOutput<ch>:SWEep:FREQuency:MODE AUTO

Manual mode (Sweep/List)

The **manual** mode only applies to remote control. It is not visible in the graphical user interface of the instrument and is described here for completeness.

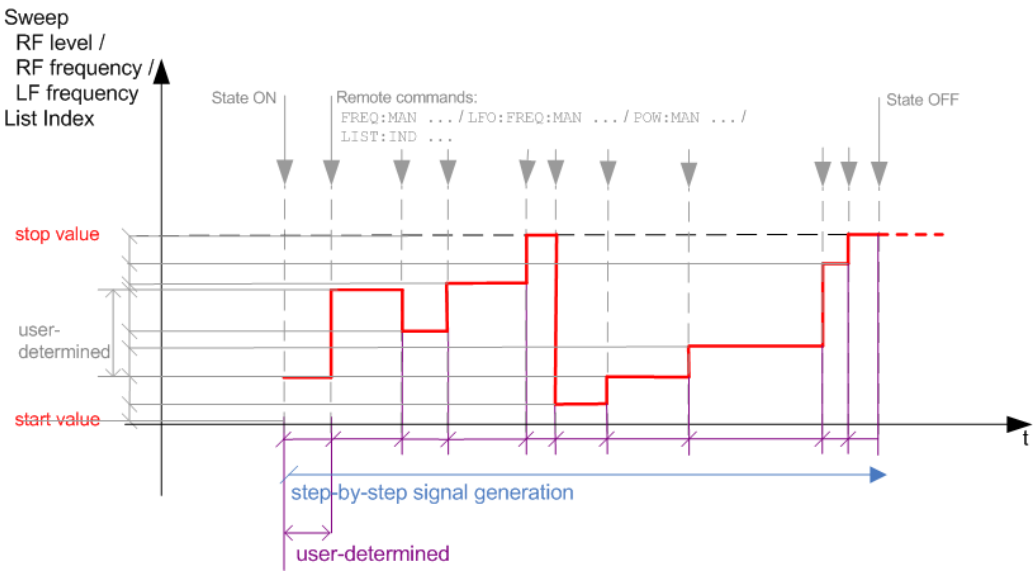


Figure 7-12: Manual mode in remote control (sweep / list)

- The instrument generates the signal in steps.
- Starts signal generation with "State = On".
- Switches to the next step with a user defined setting via remote control.

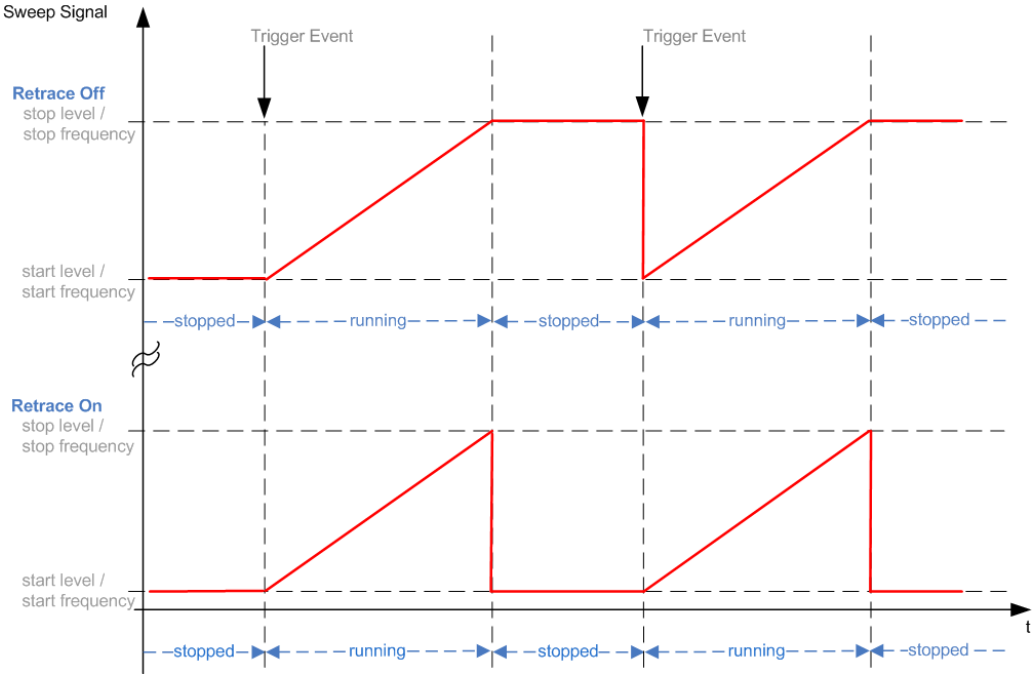
You can arbitrarily select a value within the range of the start and stop values by setting the frequency, power or index using the corresponding remote control command. There is no ascending or descending order.

- Stops signal generation with "State = Off".

Table 7-5: Remote control commands in manual mode (Sweep/List)

Remote control mode: Manual	Remote commands Rohde & Schwarz proprietary and [SCPI conform] value name
RF frequency sweep	`:SOURce<hw>:FREQuency:MANUal <Manual>`
RF level sweep	`:SOURce<hw>:POWer:MANual <Manual>`
LF frequency sweep	`:SOURce<hw>:LFOUTput:FREQuency:MANual <Manual>`
List	`:SOURce<hw>:LIST:INDex <Index>`

The Retrace function



Retrace is a function especially designed for "Single" sweep modes, when the sweep signal follows a sawtooth shape. Working in this mode, the instrument performs a single sweep cycle when a trigger event occurs. The signal generation stops at the set end point (stop frequency or stop level), and waits for the next trigger event.

In this state, the upper value of the signal remains at the output until the next cycle starts. In particular, if you generate a level sweep signal, the high amplitude of the signal is output for a certain time. To protect the DUT from overload, the retrace function immediately resets the signal value to the start value at the end of a sweep cycle. It returns to the start level or start frequency until the next trigger is applied.

You can use the "Retrace" function if "Sweep > Mode = Single/External Single" and "Shape = Sawtooth", see:

- "Shape" on page 354
- "Mode" on page 353

7.10.2 About sweep mode

In sweep mode, the signal generator scans the sweep range gradually from one point to another, using a defined step size and following a triangle or sawtooth shape. This mode also enables you to change direction, that means, it is possible to step backwards.

See Section 7.10.2.2, "Sweep signal shapes", on page 346.

Configuration and operation of sweep mode signals

- The R&S SMM100A generates a sweep signal by varying either the *RF frequency*, the *RF level* or the *LF frequency*.
- In all sweep modes, you can perform a complete sweep cycle once, repeat the cycle continuously or step through it gradually.
- The instrument generates the sweep signal according to the sweep settings.
- The "Reset Sweep" function, provided in the sweep settings dialogs enables you to reset the sweep to its initial value and restart it.

Impact of changing the sweep mode during performance

If you change the sweep mode during the execution, the signal generator stops the sweep and starts with the next trigger event at the initial value.

7.10.2.1 Correlating parameters in sweep mode

A sweep signal is a periodic signal that changes its frequency or level, or both, from a starting value to an ending value in a defined time.

The R&S SMM100A provides various possibilities to configure a sweep signal. For example, you can determine the sweep range by the start and end values, or based on the start value and span. In any case, related parameters are adjusted accordingly.

The formulas below show how the sweep parameters correlate and the corresponding calculation basis, by the frequency and offset settings. Apart from "Center Frequency", "Span" and "Step_lin", the values apply accordingly to the level settings.

Table 7-6: Variables that are used in the following formulas

Variable	Description
Sweep range	Defined frequency or level value range
f_{CENTer}	Defined center frequency
f_{SPAN}	Defined extend of the sweep range

Variable	Description
f_{OFFSet}	Frequency offset
f_{STARt}	Start frequency of the sweep range
f_{STOP}	End frequency of the sweep range
f_1	Current sweep frequency
f_2	Next, subsequent sweep frequency
step_lin	Step size in linear scaling
step_log	Step size in logarithmic scaling
POINts	Number of steps within the sweep range

Sweep range

The sweep range is defined by a start and an end value. How the remaining parameters correlate is shown below.

Offset = 0

Sweep Range = f_{STARt} to f_{STOP}

$f_{CENTer} = (f_{STARt} + f_{STOP})/2$

$f_{SPAN} = (f_{STOP} - f_{STARt})$

Where:

$f_{STARt} = f_{CENTer} - (f_{SPAN}/2)$

$f_{STOP} = f_{CENTer} + (f_{SPAN}/2)$

Offset≠0

A defined offset also affects the sweep range and the center frequency. Therefore, the set frequencies are only absolute values, if the Offset = 0. Offset ≠ 0 shifts the frequencies with the offset value:

Sweep Range = $f_{STARt} + f_{OFFSet}$ to $f_{STOP} + f_{OFFSet}$

$f_{CENTer} = f_{CENTer} + f_{OFFSet}$

$f_{SPAN} = f_{SPAN} + f_{OFFSet}$

The value range of the instrument is calculated as follows:

$RF_{min} + f_{OFFSet}$ to $RF_{max} + f_{OFFSet}$

It is possible to set $f_{STARt} > f_{STOP}$ and $f_{STARt} < f_{STOP}$, so that even a negative value is permitted for the "Span".

If you change the start and/or stop frequency, the span and center frequency change accordingly, and vice versa.

Sweep steps

In the following, you see how the sweep steps are calculated depending on the defined spacing mode. The formulas show a frequency sweep, but apply to the level settings in the same way.

The step size is added to the current value, to get the subsequent sweep step.

With **linear** scaling, the next frequency is calculated according to:

$f_2 = f_1 + step_lin$

In the **logarithmic** scaling, the step size is determined in per cent, as a constant fraction of the current frequency.

Successive frequencies are calculated as follows:

- For $f_{STARt} < f_{STOP}$
  $f_2 = f_1*(1 + step_log/100)$
  If $f_2 > f_{STOP}$, then $f_2 = f_{STOP}$
- For $f_{STARt} > f_{STOP}$
  $f_2 = f_1/(1 + step_log/100)$
  If $f_2 < f_{STOP}$, then $f_2 = f_{STOP}$

With "Shape = Triangle", the frequency values on the slope from f_{STOP} to f_{STARt} are the same as on the slope from f_{STARt} to f_{STOP}.

If you specify the number of steps within the sweep range, the step size is adjusted according to the following correlation:

- For **linear** sweeps and $f_{STARt} < f_{STOP}$
  $POINts_{frequency} = ((f_{STARt} - f_{STOP})/step_lin) +1 = (f_{SPAN}/step_lin) + 1$
- For **logarithmic** sweeps and $f_{STARt} < f_{STOP}$
  $POINts_{frequency} = ((\log f_{STOP} - \log f_{STARt})/\log step_log) +1$

If step_log changes, the value of POINts is adjusted. The f_{STARt} and f_{STOP} values are retained.

7.10.2.2 Sweep signal shapes

The R&S SMM100A supports the following sweep shapes:

- Sawtooth
  The sweep sequence resembles a sawtooth. One sweep runs from start to stop frequency, or level value respectively. Each subsequent sweep starts again at the start value.

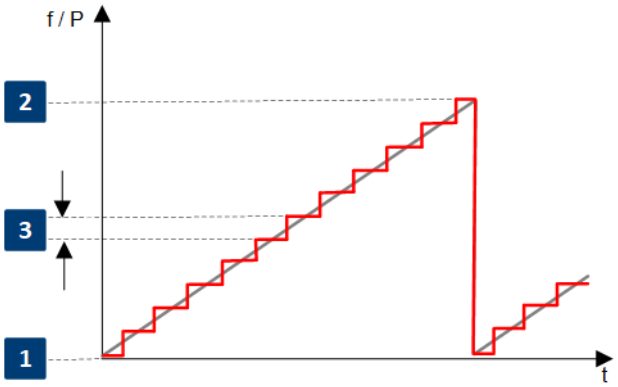


Figure 7-13: Sweep signal sawtooth shape

1 = Start value
2 = Stop value
3 = Step size

- Triangle
  The sweep sequence resembles a triangle. One sweep runs from start to stop value frequency and back. Each subsequent sweep starts at the start value.

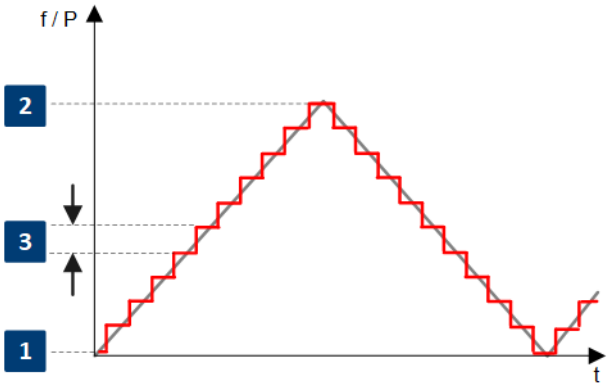


Figure 7-14: Sweep signal triangle shape

1 = Start value
2 = Stop value
3 = Step size

The current frequency or level of an RF frequency, level or LF frequency sweep is determined by the shape (e.g. sawtooth or triangle) and the spacing (linear or logarithmic), and the step size.

7.10.3 About list mode

The list mode is used to generate the RF signal based on a set of predefined frequency and amplitude value pairs, with individual step times. You can define the values arbitrarily, in any order and varying step sizes, within the entire configurable value range of the instrument.

Configuration and operation of list mode signals

The parameters configuring the RF signal are defined in a list (table) and stored in a file.

Creating and handling lists

List files can be created in the following ways:

- **Internally**
  Use the build-in table editor with columns for the frequency-level values pairs and the dwell time.
  Define the values manually (row by row) or automatically, based on value range and step size.
  See Section 7.10.7, "List data editor", on page 366.
  Lists are saved as files with user-definable filename and the predefined file extension `*.lsw`. To load a saved file, use the "File Manager".
  See Section 10.9, "Using the file manager", on page 540.
- Lists can be exported, too. For example, to exchange configuration between instruments or to modify the file content with an external program and reload them again.
- **Externally**
  Create a list file as a CSV file with Microsoft Excel, with a Notepad or a similar tool and save it with the predefined extension. Transfer the file to and load it into the instrument.

Dwell time mode

You can choose whether you want to use different dwell times or a fixed value for all steps in the list mode:

- "From List"
  This mode uses the values from the data table.
  See Section 7.10.7, "List data editor", on page 366.
- "Global"
  This mode processes the list with a fixed time interval you can set with Global Dwell Time.

List processing mode

The R&S SMM100A generates signals from list files in two modes, "Live" and "Learned (Frozen RF Settings)". These modes differ in terms of signal quality, signal processing and switching time.

For details, see:

- "Learn List Mode Data list processing mode" on page 350
- "Live list processing mode" on page 350

Interactions and characteristics

- For a mechanical step attenuator the fixed mode is effective. The step attenuator is fixed to a value which allows to set the maximum level of the data list.

7.10.4 Significant parameters and functions

This section provides some basic parameters, settings and functions that affect the operating modes CW, list and sweep, that means at all frequency and level transitions of the RF signal.

Dwell time

Dwell time is the length of time that elapses from the beginning until the end of a step in list or sweep mode.

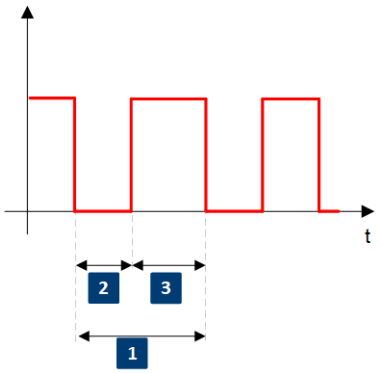


Figure 7-15: Dwell Time vs. settling time

1 = "Dwell Time" (as set with the parameter)
2 = Settling time
3 = Dwell time (effective)

However, the time the instrument requires for the signal to settle reduces the set dwell time:

$t_{dwell(effective)} = t_{dwell} - t_{setlting}$

If the dwell time in sweep or list mode is too short or external trigger signals come too fast, the signal generation delays. As the delay increases, the R&S SMM100A signals an overrun, or even stops sweep or list mode signal generation, if the delay gets too long.

The instrument diplays corresponding error messages.

Hardware adjustments

The first time a list (new or modified) is processed, the instrument automatically calculates the necessary hardware settings. It can be performed during list processing, but delays the first cycle, especially with short dwell times.

With long dwell times, you can perform this calculation while the list is being processed; the entered dwell times are observed. With short dwell times, calculation of the hardware settings increases the dwell time for the initial processing cycle; the entered value is only observed from the second processing cycle onwards. In this case, a message indicates that there is a deviation between the current and set dwell times. After

the first cycle, you do not need to perform additional calculations. The current dwell times do not deviate from the set dwell times.

Blanking

The instrument applies *blanking*, which temporarily turns off the RF signal when the frequency or level changes, until the signal has settled to a stable state.

Temporary blanking applies to all operating modes.

Learn List Mode Data list processing mode

Before signal generation starts, the instrument reads the values of the data list in sequence and determines the corresponding hardware settings for each value pair. Along with the current RF state and the modulation settings, the function stores the list data in the temporary memory.

Once the entire table is processed, the R&S SMM100A starts signal generation by replaying the stored values from the list. Thus, it achieves fast switching of the RF signal with high accuracy.

This mode provides optimized switching times, and is particularly useful if dwell times of less than 2 ms are required.

However, consider that R&S SMM100A generates the signal from the saved data, thus reflecting the state of the instrument at the time of recording. Modifications of settings during list processing are ignored. If you turn off the instrument, the list file remains saved on the internal memory, but not the learned data in the temporary memory.

When to use the "Learn List Mode Data" function

The instrument performs the learning process in the following situations:

- RF state is on (prerequisite)
- You deliberately activate this function, provided a list is loaded and RF is on.
- You switch list mode on in "Learned" run mode and no data is available in the memory
- You change the list data file

Perform the list mode learning in the following situations:

- Always when:
  - You change any value in the list.
  - Any hardware setting changes.
    Especially if you have fluctuating environmental conditions, the hardware settings need to be adjusted.
- We recommend that you learn the list before activating the list mode, even if the list has been learned previously.

Live list processing mode

The R&S SMM100A generates the signal directly from the value pairs in the database, and adjusts the hardware settings accordingly. The current instrument state and thus

any change during the signal generation directly affects the RF signal. The temporary memory is not used.

You can conveniently modify parameters like modulation settings during run-time. Learning list mode data is not required. Impacts like temperature drift are also considered immediately.

This mode is optimized for **maximum signal quality**, and is useful if dwell times higher than 2 ms are sufficient.

7.10.5 Sweep mode settings

This section lists the settings of **all** available sweep modes.

Access:

1. Select "RF" > "Sweep / List" > "RF Frequency Sweep"
2. Select "RF" > "Sweep / List" > "RF Level Sweep"
3. Select "RF" > "Sweep / List" > "LF Frequency Sweep"

   The sweep modes use the similar parameters to be configured. Thus, the description comprises the settings of all sweep dialogs. If parameters relate to only particular modes, they are pointed out.

The remote commands required to define these settings are described in:

- Section 13.17.8, "SOURce:FREQuency subsystem", on page 973
- Section 13.17.18, "SOURce:POWer subsystem", on page 1022
- Section 13.17.20, "SOURce:SWEep subsystem", on page 1046
- Section 13.17.12, "SOURce:LFOutput subsystem", on page 991

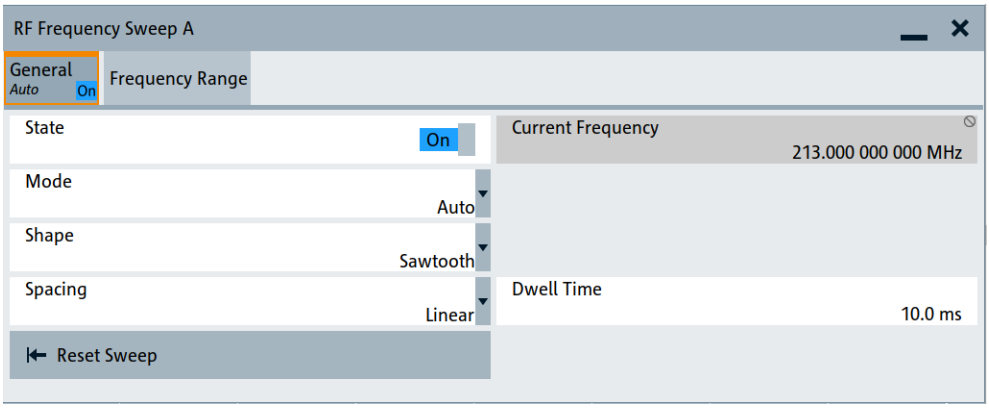
Settings:

- General sweep settings....351
- Frequency range settings....356
- Level range settings....357

7.10.5.1 General sweep settings

Access:

► Select, for example, "RF" > "Sweep / List" > "RF Frequency Sweep".



Settings:

State (RF frequency sweep)..... 352
State (RF level sweep)..... 352
State (LF frequency sweep)..... 352
Current Frequency..... 353
Current Level..... 353
Mode..... 353
Retrace..... 354
Shape..... 354
Spacing..... 354
Dwell Time..... 354
Trigger Slope..... 355
Execute Single Sweep..... 355
Show/Show Connector..... 355
Reset Sweep..... 355

State (RF frequency sweep)
Activates RF frequency sweep signal generation.

Note: Active RF frequency, RF level or RF combined sweep modes deactivate the LF sweep or List mode and vice versa.

Remote command:
`[:SOURce<hw>]:FREQuency:MODE` on page 976

State (RF level sweep)
Activates RF level sweep signal generation.

Note: Active RF frequency, RF level or RF combined sweep modes deactivate the LF sweep or List mode and vice versa.

Remote command:
`[:SOURce<hw>]:POWer:MODE` on page 1032

State (LF frequency sweep)
Status of the LF frequency sweep signal.

You find this parameter in two dialogs:

- "LF Frequency Sweep" turns on/off the signal generation.

See Sweep mode settings for access.

- "Analog Modulation Sources" displays the current state (read-only). If it is turned on, this dialog provides the varying sweep frequency, see Current Frequency.

Note: Active RF frequency, RF level or RF combined sweep modes deactivate the LF sweep or List mode and vice versa.

Remote command:
[:SOURce<hw>]:LFOutput:FREQuency:MODE on page 995

Current Frequency
Displays the current frequency sweep value for all sweep Modes, except of Mode > Step. In this mode, you can enter the next frequency setting manually.

Remote command:
[:SOURce<hw>]:FREQuency:MANual on page 978
[:SOURce<hw>]:LFOutput:FREQuency:MANual on page 995

Current Level
Displays the current level sweep value for all sweep Modes, except of Mode > Step. In this mode, you can enter the next level setting manually.

Remote command:
[:SOURce<hw>]:POWer:MANual on page 1032

Mode
Selects the sweep mode.

See Section 7.10.1, "Signal generation and triggering in the sweep and list modes", on page 336.

"Auto" Generates a continuously repeating sweep signal directly after activating the sweep mode.
The sweep steps are performed automatically, controlled by the dwell time.

"Single / Extern Single"
Generates a single sweep cycle after a trigger event.
The sweep steps within the cycle are performed automatically, controlled by the dwell time. If one cycle is completed, the instrument waits for the next trigger event.

"Step / Extern Step"
Generates the sweep signal step-by-step, manually triggered.

"Extern Start/Stop"
Generates a continuously repeating sweep signal that is started, stopped, and restarted by subsequent external trigger events.
The sweep steps are performed automatically, controlled by the dwell time.

Remote command:
RF frequency sweep:
[:SOURce<hw>]:SWEep[:FREQuency]:MODE on page 1051
:TRIGger<hw>:FSWeep:SOURce on page 1096
RF level sweep:

[:SOURce<hw>]:SWEep:POWer:MODE on page 1049
:TRIGger<hw>:PSWeep:SOURce on page 1096
LF frequency sweep:
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:MODE on page 1001
:TRIGger<hw>:LFFSweep:SOURce on page 1096

Retrace
For "Shape = Sawtooth" and "Mode = Single/External Single", enables changing the signal to the start value while it is waiting for the next trigger event. It returns to the start level or start frequency until the next trigger is applied.

Remote command:
RF frequency sweep:
[:SOURce<hw>]:SWEep[:FREQuency]:RETRace on page 1053
RF level sweep:
[:SOURce<hw>]:SWEep:POWer:RETRace on page 1053
LF frequency sweep:
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:RETRace on page 1002

Shape
Selects the waveform shape of the sweep signal.

"Sawtooth" The sweep runs from start to stop frequency. The subsequent sweep starts at the start value, i.e. the shape of the sweep sequence resembles a sawtooth.

"Triangle" The sweep runs from start to stop value and back, i.e. the shape of the sweep resembles a triangle. Each subsequent sweep starts at the start frequency.

Remote command:
RF frequency sweep:
[:SOURce<hw>]:SWEep[:FREQuency]:SHAPe on page 1052
RF level sweep:
[:SOURce<hw>]:SWEep:POWer:SHAPe on page 1052
LF frequency sweep:
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:SHAPe on page 1002

Spacing
In "RF and LF Frequency Sweep" mode, "Spacing" selects the mode for calculating the frequency interval, which increases or decreases the current frequency at each step.

To determine the step size, select the parameter Step Linear/Step Logarithmic.

"Linear" Takes the frequency value entered as absolute value in Hz.

"Logarithmic" Takes the value entered as a logarithmic value, i.e. as a constant fraction of the current frequency in %.

Remote command:
RF frequency sweep:
[:SOURce<hw>]:SWEep[:FREQuency]:SPACing on page 1052

Dwell Time
Defines the duration of the individual sweep steps.

Note: In case of considerable overrun conditions, the R&S SMM100A turns off the sweep mode.

See also Section 7.10.4, "Significant parameters and functions", on page 349.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:SWEep[:FREQuency]:DWELl` on page 1050
RF level sweep:
`[:SOURce<hw>]:SWEep:POWer:DWELl` on page 1049
LF frequency sweep:
`[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:DWELl` on page 1000

Trigger Slope
For "Mode = Extern Step/Single", selects the polarity of the active slope of an applied instrument trigger.

Trigger signal is expected at the Inst Trig connector.

"Positive" The rising edge of the trigger signal triggers the instrument.

"Negative" The falling edge of the trigger signal triggers the instrument.

Remote command:
`[:SOURce<hw>]:INPut:TRIGger:SLOPe` on page 982

Execute Single Sweep
In "Mode = Single", starts a sweep manually.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:SWEep[:FREQuency]:EXECute` on page 1052
`:TRIGger<hw>:FSWeep[:IMMediate]` on page 1097
RF level sweep:
`[:SOURce<hw>]:SWEep:POWer:EXECute` on page 1052
`:TRIGger<hw>:PSWeep[:IMMediate]` on page 1097
LF frequency sweep:
`[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:EXECute` on page 1001
`:TRIGger<hw>:LFFSweep:IMMediate` on page 1097
General:
`:TRIGger<hw>[:SWEep][:IMMediate]` on page 1097

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

Reset Sweep
Resets a sweep.

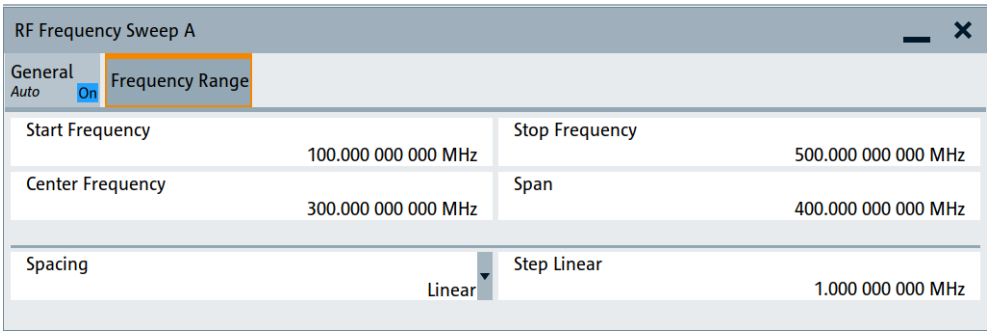
With the next trigger event, the sweep starts at the initial value.

Remote command:
`[:SOURce<hw>]:SWEep:RESet[:ALL]` on page 1054

7.10.5.2 Frequency range settings

Access:

1. Select for example "RF" > "Sweep / List" > "RF Frequency Sweep"
2. Select "Frequency Range".



Settings:

Start Frequency/Stop Frequency 356
Center Frequency 356
Span 356
Spacing 357
Step Linear/Step Logarithmic 357

Start Frequency/Stop Frequency
Defines the frequency sweep range by setting the start and end values.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:FREQuency:STARt` on page 980
`[:SOURce<hw>]:FREQuency:STOP` on page 980
LF frequency sweep:
`[:SOURce<hw>]:LFOutput:FREQuency:STARt` on page 996
`[:SOURce<hw>]:LFOutput:FREQuency:STOP` on page 996

Center Frequency
Requires sweep mode "RF Frequency Sweep" mode. Sets the RF center frequency.

Remote command:
`[:SOURce<hw>]:FREQuency:CENTer` on page 979

Span
Requires sweep mode "RF Frequency Sweep". Sets the span of the frequency sweep range.

Remote command:
`[:SOURce<hw>]:FREQuency:SPAN` on page 979

Spacing
In "RF and LF Frequency Sweep" mode, "Spacing" selects the mode for calculating the frequency interval, which increases or decreases the current frequency at each step.

To determine the step size, select the parameter Step Linear/Step Logarithmic.

"Linear" Takes the frequency value entered as absolute value in Hz.

"Logarithmic" Takes the value entered as a logarithmic value, i.e. as a constant fraction of the current frequency in %.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:SWEep[:FREQuency]:SPACing` on page 1052

Step Linear/Step Logarithmic
Requires sweep mode "RF Frequency Sweep" or "LF Frequency Sweep".

Sets the step width for individual frequency sweep steps. The value is added at each sweep step to the current frequency.

Depending on the current spacing (sweep interval), you can enter either an absolute or logarithmic step width.

"Step Linear" The step width is a constant value in Hz.

Remote command:
`[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear]` on page 1053
`[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP[:LINear]` on page 1003

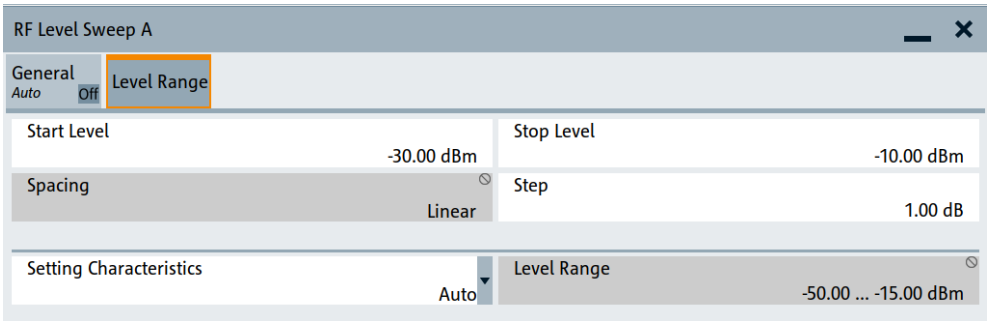
"Step Logarithmic"
The step width is determined logarithmically in percent as a constant fraction of the current frequency.

Remote command:
`[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic` on page 1053
`[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP:LOGarithmic` on page 1003

7.10.5.3 Level range settings

Access:

1. Select "RF" > "Sweep / List" > "RF Level Sweep"
2. Select "Level Range".



Settings:

Start Level/Stop Level....358
Spacing....358
Step....358
Setting Characteristics....358
Level Range....360

Start Level/Stop Level
Defines the RF level sweep range by setting the start and end values.

Remote command:
RF level sweep:
`[:SOURce<hw>]:POWer:STARt` on page 1034
`[:SOURce<hw>]:POWer:STOP` on page 1034

Spacing
Indicates that the instrument distributes the level steps linearly (straight proportional), i.e. the level steps have the same size.

To determine the step size, use the parameter Step.

Remote command:
n.a.

Step
Sets the step width for the RF level sweep in dB.

The "RF level sweep" mode increases or decreases the level value linearly by the set value.

Remote command:
`[:SOURce<hw>]:SWEep:POWer:STEP[:LOGarithmic]` on page 1050

Setting Characteristics
Selects additional quality characteristics to optimize the behavior of the RF signal level for the specific application.

"Auto" Sets the RF output level automatically according to the selected mode.
In this mode, the instrument provides the highest dynamic range and fastest setting times.
The RF signal is shortly blanked when the step attenuator is switching.

For more information, refer to the specifications document.

"Uninterrupted"
Suppresses blanking at level transitions. Frequency transitions can lead to an RF level blanking due to hardware-specific switching points.
This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

Note:
Do not enable both the I/Q optimization mode "High Quality" and the RF signal level optimization mode "Uninterrupted" or "Strictly Monotone". The high-quality I/Q optimization mode leads to an RF signal interruption which blocks the RF signal level optimization.

"Strictly Monotone"
Executes signal level changes monotonically increasing or decreasing.
The setting makes sure that increasing the level value exclusively results in an increased output level, and vice versa.
All electronic switches, which can affect the monotonicity are fixed.
The operation mode is useful for applications using level searching algorithms which rely on a strictly monotonous behavior.

"Constant-VSWR"
Suppresses output impedance variations at the RF output connector, due to changed level settings.

"Continuous-Phase"
Suppresses phase discontinuities.
This mode reduces the dynamic range of the instrument and the step attenuator is fixed (equates to "Strictly Monotone").

"Constant-Phase"
This mode keeps the phase constant by coupling the digital attenuation directly to the level setting.

Note: The coupling is only active when the I/Q modulator is in operation.

Pressing Readjust adds the value of the digital attenuation to the level setting, and sets the Digital Attenuation = 0. In total, the level value remains constant.

"User" Selects this entry automatically when you change one of the following parameters from the default setting:
- "Attenuator" > Mode
- "ALC" > State, Detector Sensitivity or Driver Amplifier

Note: If you select another setting characteristic, the R&S SMM100A presets the modified attenuator and ALC parameters.

Remote command:
[:SOURce<hw>]:POWer:LBEHaviour on page 1031

Level Range
Shows the interruption-free range of the level that you can use in the currently selected mode.

Remote command:
[:SOURce<hw>]:POWer:RANGe:LOWer? on page 1039
[:SOURce<hw>]:POWer:RANGe:UPPer? on page 1039

7.10.6 List mode settings

The "List Mode" dialog contains all the functions and settings for creating and handling lists with RF frequency/level pairs for generating the RF signal based on these values.

Access:

► Select "RF" > "Sweep / List" > "List mode".

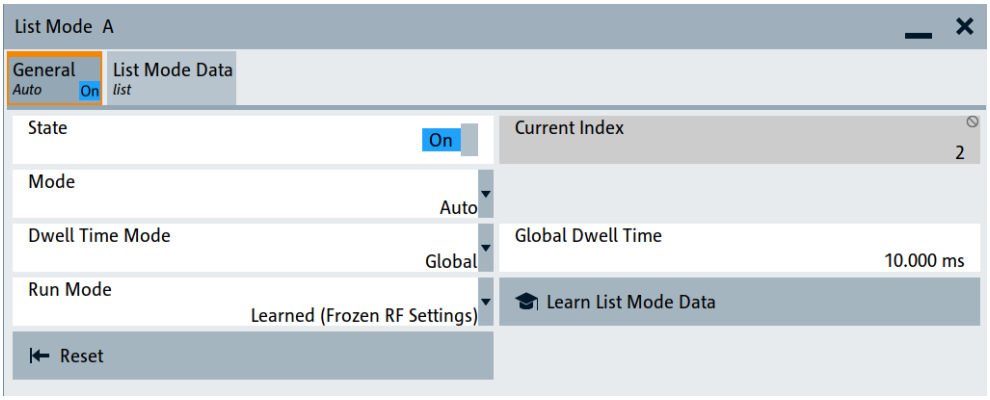
The dialog contains parameters for configuring the list mode processing, entering list mode data and transferring data files from or to the instrument.
The remote commands required to define these settings are described in Section 13.17.13, "SOURce:LIST subsystem", on page 1004.

- General settings....360
- List mode data settings....363
- Import/export settings....364

7.10.6.1 General settings

Access:

► Select "RF" > "Sweep / List" > "List Mode" > "General".



In the "General" tab, you can configure the trigger and dwell time modes for list processing and activate signal generation.

Settings:

State....361
Current Index....361
Mode....361
Dwell Time Mode....362
Global Dwell Time....362
Run Mode....362
Learn List Mode Data....362
Trigger Slope....362
Show/Show Connector....363
Reset....363
Execute Single....363

State
Activates the list mode and processes the currently selected list.

Note: Active RF frequency, RF level or RF combined sweep modes deactivate the LF sweep or List mode and vice versa.

Remote command:
`[:SOURce<hw>]:FREQuency:MODE` on page 976

Current Index
Sets the list index for list processing in "Step" mode. In the other modes, the index indicates the current step.

Remote command:
`[:SOURce<hw>]:LIST:INDex` on page 1009

Mode
Selects the mode for list processing.

See Section 7.10.1, "Signal generation and triggering in the sweep and list modes", on page 336.

"Auto" Generates the signal by processing the frequency/level value pairs of the list from the beginning to the end.
The list steps are performed automatically, controlled by the dwell time. If you switch from any mode to "Auto", signal generation always starts at the top of the list.

"Single / Extern Single"
Generates the signal by processing the frequency/level value pairs of the list once from the beginning to the end after a trigger event.
The list steps are performed automatically, controlled by the dwell time. If one cycle is completed, the instrument waits for the next trigger event.

"Step / Extern Step"
Generates the signal by processing the frequency/level value pairs of the list step-by-step, manually triggered.

Remote command:
`[:SOURce<hw>]:LIST:TRIGger:SOURce` on page 1011
`[:SOURce<hw>]:LIST:MODE` on page 1010

Dwell Time Mode
Selects either variable dwell times or a fixed dwell time to perform signal generation in list mode.

"Global" Uses the same dwell time for all lists steps, set with Global Dwell Time.

"From List" Uses the dwell times from the list.
You can define the dwell time for each frequency/level value pair individually, see Section 7.10.7, "List data editor", on page 366.

Remote command:
`[:SOURce<hw>]:LIST:DWELl:MODE` on page 1007

Global Dwell Time
Sets the dwell time for Dwell Time Mode > "Global".

Note: In case of considerable overrun conditions, the R&S SMM100A turns off the list mode.

See also "Dwell time" on page 349.

Remote command:
`[:SOURce<hw>]:LIST:DWELl` on page 1007

Run Mode
Selects whether the instrument generates the signal by processing the list directly, or by learning and replaying the data.

"Learned (Frozen RF Settings)"
Generates the signal with the previously learned and stored data from the temporary memory.

"Live" Generates the signal directly from the database.
The instrument reads the pairs of values from the list, calculates the hardware settings and generates the signal immediately.
See "Live list processing mode" on page 350.

Remote command:
`[:SOURce<hw>]:LIST:RMODe` on page 1009

Learn List Mode Data
Reads the settings from the list data table and calculates the associated hardware settings. The learned data is stored in the temporary memory.

See also "When to use the "Learn List Mode Data" function" on page 350.

Remote command:
`[:SOURce<hw>]:LIST:LEARn` on page 1010

Trigger Slope
For "Mode = Extern Step/Single", selects the polarity of the active slope of an applied instrument trigger.

Trigger signal is expected at the Inst Trig connector.

"Positive" The rising edge of the trigger signal triggers the instrument.

"Negative" The falling edge of the trigger signal triggers the instrument.

Remote command:
[:SOURce<hw>]:INPut:TRIGger:SLOPe on page 982

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

Reset
Resets the list to the starting point.

Remote command:
[:SOURce<hw>]:LIST:RESet on page 1014

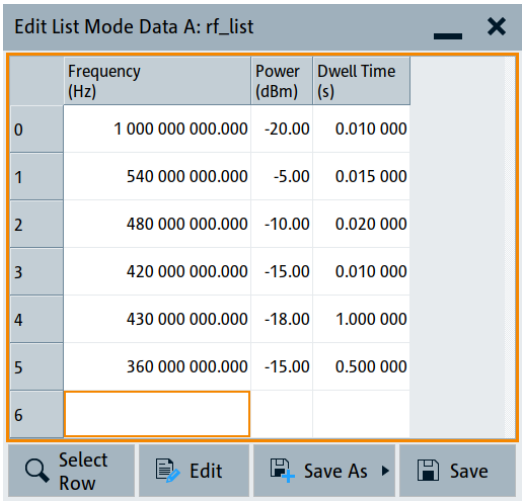
Execute Single
Manually starts list processing in "Single" mode.

Remote command:
[:SOURce<hw>]:LIST:TRIGger:EXECute on page 1011

7.10.6.2 List mode data settings

Access:

1. Select "RF" > "Sweep / List" > "List mode".
2. Select "List Mode Data".



This dialog contains the parameters required for creating and editing lists, activating the learning function and selecting the list processing mode.

Settings:

List Mode Data....364
Edit List Mode Data....364
List Range from/to....364

List Mode Data
Accesses the standard "Select List" dialog for selecting, creating and editing a list file. The currently loaded file is indicated.

You can create data lists with the internal editor or import externally created files, see "Creating and handling lists" on page 348.

Remote command:
`[:SOURce<hw>]:LIST:CATalog?` on page 1013
`[:SOURce<hw>]:LIST:SELect` on page 1014
`[:SOURce<hw>]:LIST:DELete` on page 1013
`[:SOURce<hw>]:LIST:DELete:ALL` on page 1013

Edit List Mode Data
Opens the build.-in table editor to define a new list data table or edit an exisitng one.

See also: Section 7.10.7, "List data editor", on page 366.

You find this function also in standard file select dialog, accessed via List Mode Data.

List Range from/to
Defines an index range in the current list by setting the start and stop index.

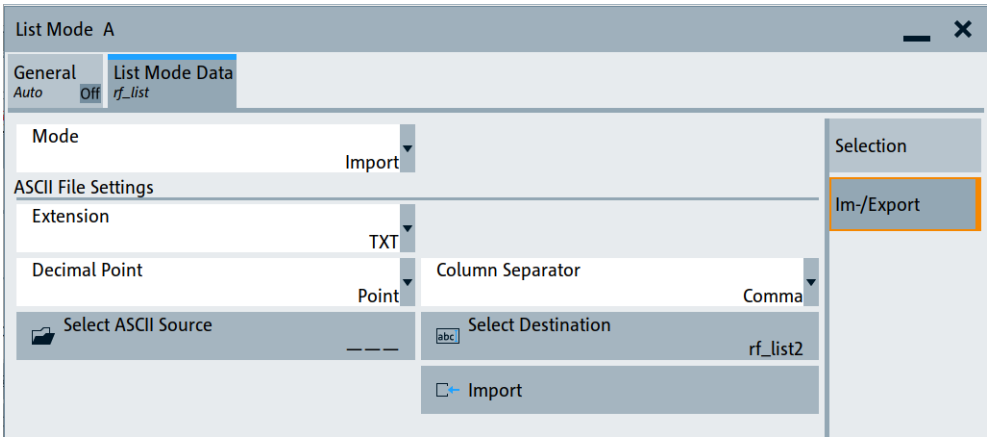
The instrument generates the signal with the values of the selected index range and ignores all other list entries.

Remote command:
`[:SOURce<hw>]:LIST:INDex:STARt` on page 1009
`[:SOURce<hw>]:LIST:INDex:STOP` on page 1009

7.10.6.3 Import/export settings

Access:

1. Select "RF" > "Sweep / List" > "List Mode".
2. Select "List Mode Data" > "Im-/Export".



The "Im-/Export" dialog provides the parameters for importing or exporting files with user data in standard ASCII `*.txt` or `*.csv` file format.

The table separators and the decimal floating point numbers are customizable.

Settings:

Mode....365
ASCII File Settings....365
Select (ASCII) Source/Select (ASCII) Destination....365
Select Source/Select ASCII Destination....366
Import / Export....366

Mode
Selects import or export of a data list file. The provided parameters vary according to the selected mode.

Remote command:
`[:SOURce<hw>]:LIST:DEXChange:MODE` on page 1016
`[:SOURce<hw>]:CORRection:DEXChange:MODE` on page 961

ASCII File Settings
Defines the format and the separators of the associated data file.

"Extension" Selects `*.csv` or `*.txt` format.

"Decimal Point" Sets "Point" (dot) or "Comma" as the decimal separator used in the ASCII data with floating-point numerals.

"Column Separator"
Sets the separator between the columns in an ASCII table.
Available are: "Tab", "Semicolon", "Comma" or "Space".

Remote command:
`[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension` on page 1015
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal` on page 1016
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn` on page 1016
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension` on page 960
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal` on page 960
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn` on page 960

Select (ASCII) Source/Select (ASCII) Destination
In "Mode > Import", access the file select dialog that provides standard file handling functions.

Where:
- "Select ASCII Source": defines the file to be loaded (imported)
- "Select ASCII Destination": selects the filename under that the loaded file is saved

Remote command:
`[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog?` on page 1015
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect` on page 1016
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog?` on page 959
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect` on page 960

Select Source/Select ASCII Destination
In "Mode > Export", access the file select dialog that provides standard file handling functions.

Where:
- "Select Source": selects the file to be exported
- "Select ASCII Destination": defines the filename and the file path for the exported file

Remote command:
`[:SOURce<hw>]:LIST:DEXChange:SELect` on page 1017
`[:SOURce<hw>]:CORRection:DEXChange:SELect` on page 961

Import / Export
Imports or exports the selected data list file, depending on the current mode.

Remote command:
`[:SOURce<hw>]:LIST:DEXChange:EXECute` on page 1016
`[:SOURce<hw>]:CORRection:DEXChange:EXECute` on page 961

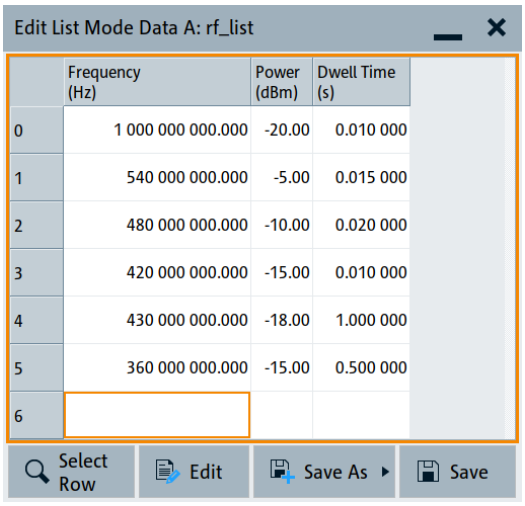
7.10.7 List data editor

The "List Mode" dialog provides a build-in list editor for defining the corresponding frequency and level value pairs. Prerequisite to define list mode data is that you have selected a file.

Access:

► "RF" > "Sweep / List" > "List Mode" > "List Mode Data" > "Edit List Mode Data"

The editor for list mode provides a table with RF frequency and power values, a column for defining variable dwell times, and standard navigation functions.



The remote commands required to define the list mode data are described in Section 13.17.13, "SOURce:LIST subsystem", on page 1004.

All columns in a row must contain values. Cells with missing values are therefore filled automatically, using the value of the previous row.

Once you enter a value, the editor automatically adds preset values in the other columns. This functionality protects against data loss, otherwise incomplete rows are lost when saving. You can simply override these values.

If you use **global dwell time in list mode**, consider also that the instrument uses the value set with Global Dwell Time for all list steps and not the values from the list.

Since the table and navigation functions can be assumed to be known, the following description contains a brief overview.

Settings:

Frequency (Hz)..... 367
Power (dBm)..... 367
Dwell Time (s)..... 367
Data handling keys.....367
└ Select Row.....367
└ Edit.....368
└ Save As/Save..... 368
Fill.....368

Frequency (Hz)
Sets the frequency values for list mode operation.

Remote command:
`[:SOURce<hw>]:LIST:FREQuency` on page 1008

Power (dBm)
Sets the level value for the selected frequency in list mode.

Remote command:
`[:SOURce<hw>]:LIST:POWer` on page 1011

Dwell Time (s)
Sets the dwell time values for the frequency power value pairs in list mode operation.

Remote command:
`[:SOURce<hw>]:LIST:DWELl:LIST` on page 1007

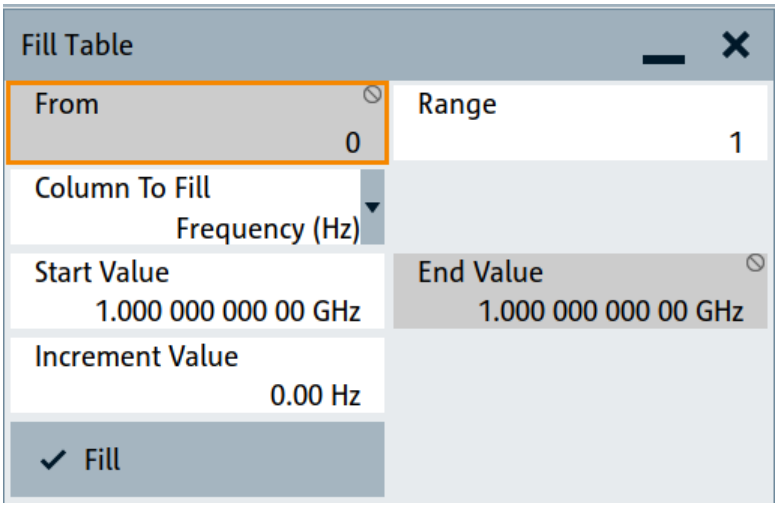
Data handling keys
Standard functions for file and data handling.

Select Row ← Data handling keys
Selects a row for editing.

Edit ← Data handling keys
Enables you to insert, or delete a row or ranges within the table, and provides access to a dialog for automatic filling, see "Fill..." on page 368.

Save As/Save ← Data handling keys
Saves the table in a file with user-defined name and predefined file extension. To save a copy or create a file, use the "Save as" function.

Fill...
Provides parameters for filling a table automatically with user-defined values.



To fill the table, select "Fill".

Note: Once you enter a value or fill a column, the editor automatically adds preset values in the other columns. This functionality protects against data loss, otherwise incomplete rows will be lost when saving. You can simply override these values.

"From / Range"
Defines the start line and number of lines to be filled.

"Column To Fill"
Selects, if the column is filled up with frequencies in Hz, levels in dBm or dwell times in s.

"Start Value / End Value"
Sets the start value for frequency, level or dwell time. The end value is read only and depends on the increment value and the range.

"Increment Value"
Determines the step size.

"Fill" Fills the column specified in "Column To fill".

7.10.8 How to generate a signal in list or sweep mode

This section shows you how to configure a varying RF output signal for both, the list and sweep modes.

To configure the frequency sweep signal

1. In the status bar, enter "Freq = 6 GHz" and "Lev = -25 dBm".
2. Select "RF" > "Sweep / List" > "RF Frequency Sweep"
3. Select "Mode > Auto".
4. Select "Spacing > Linear".
5. Set "Dwell Time > 15.0 ms".
6. In the "Frequency Range" tab, set "Start Freq > 200 MHz" and "Stop Freq > 600 MHz".
   (Alternatively you can set "Center Freq > 400 MHz" and "Span > 400 MHz".)
7. Set the step width "Step Lin > 10 MHz" and "Dwell Time > 10.0 ms".
8. In the "Advanced" tab, trigger the sweep "Auto".
9. In the "General" tab, select "State > On".

Example: Fast changing frequency and level settings in list mode

The following example shows you how to generate an amplitude modulated RF signal based on list mode data.

General workflow

Since any change of the hardware settings or list entries can affect the RF signal characteristics directly, we recommend that you proceed as follows:

1. Configure the modulation settings.
   Activate the RF signal.
2. Wait until the hardware settings have settled.
3. Create a list file.
4. Configure the list mode.
5. Activate list mode.

To configure amplitude modulation and switch RF on

1. Press [Preset] to start from an initial state.
2. Select "RF" > "Analog Modulation" > "Amplitude Modulation > On".
3. Select "RF > On" to activate RF signal generation.

To create list mode data

1. Select "RF" > "Sweep / List" > "List Mode".
2. In the "List Mode Data" tab, select "List Mode Data > New"
3. Enter the filename `ListMode_Test` for the data list and confirm with "Ok".

   The instrument creates a file and stores it in the `/var/user/` directory.

4. Select "Edit List Mode Data".
5. Enter the first values "Frequency > 2", "Power > 0" and "Dwell > 2".
6. Enter further frequency, power and dwell time values in the same way.
7. Select "Save" and close the dialog.

To configure the list mode and start signal generation

1. In the "General" tab, select "List Mode > Auto".
2. Select "Dwell Time Mode > From List".
3. Select "List Mode Data > Learn List Mode Data".
4. Switch state to "On".
5. Select "Run Mode > Learned (Frozen RF Settings)"
6. Select "General > State > On".

   The instrument continuously generates an amplitude-modulated RF signal whose frequency and level values change according to the dwell times, as defined in the list.

   With active list mode, the generator displays no frequency and level values in the status bar, but you can check the following parameters.
   - In the list mode dialog, the current index indicates the steps of the signal generation.
   - In remote control mode, you can query:
     – The current state with `[:SOURce<hw>]:LIST:RUNNing?`

7.11 Analog modulations

The R&S SMM100A supports AM (amplitude modulation), FM (frequency modulation), ΦM (phase modulation (PhiM)), and also PULM (pulse modulation).

It generates low frequency signals (LF) as sine, triangle, trapezoidal or square (pulse) waveform, that can be output and further processed by a downstream instrument.

Interactions and characteristics

- Some modulations exclude each other and cannot be performed simultaneously.
- For pulse modulated signals, you can select between fast or smoothed transitions, see "Transition Type" on page 377.
  This setting is available over the entire frequency range for all instruments with frequency options up to 6 GHz. For higher frequency options, the frequency range for the smoothed setting is limited.

For more information, refer to the specifications document.

- The settings of the modulation signal affect all analog modulations that use an internal modulation source.
- In sweep mode, LF frequency sweep is possible.
- You can feed an external LF signal in each of the two paths.
- An activated analog modulation automatically turns off:
  - I/Q modulation
  - Arbitrary waveform generation
  - Digital modulation
  - Digital standards

7.11.1 Required options

R&S SMM100A base unit equipped with the following options:

- Option pulse modulator (R&S SMM-K22)
- Option pulse generator (R&S SMM-K23)
  (supports generation of single and double pulse signals)
- Option multi-function generator (R&S SMM-K24)
- Option AM/FM/PhiM, up to 6 GHz (R&S SMM-K720)
- Option frequency R&S SMM-B1006

For more information, refer to the specifications document.

7.11.2 Modulation signals

The signal sources for the modulation signal are two internal generators, LF and Noise, and a pulse generator, but you can also use an externally supplied signal, see "Signal sources" on page 371.

You can perform the AM, FM and PhiM with the signal of any of the provided sources. Even more, you can merge two modulation signals, for example, to generate a two-tone signal. Similarly, you can forward the used modulation signal to the output.

Signal sources

If fully equipped, the R&S SMM100A modulates signals from the following sources:

- **Internal modulation source**

- *Two LF generators*
  Each of the LF generators provides a modulation signal with sine, pulse, triangle or trapezoid shape.
- *Noise generator*
  The noise generator supplies white noise with selectable bandwidth and distribution.
- *High-performance pulse generator*
  Generates single or double pulse signals.

- **External modulation source**
  - Amplitude, frequency or phase modulation signals are input at the Mod Ext connector.
  - Pulse modulation signals, at the User connector.

Signal output

You can perform AM, FM and PhiM with the signal of any of the provided sources. Moreover, you can combine two modulation signals and generate a two-tone signal. Regardless of the signal source, the generated signal can be output for further processing in a downstream instrument.

Current configuration is indicated in the "Analog Modulations > Overview" dialog; the output signal routing can be changed, too.

Input and output connectors

Direction	Modulation	Connector	Required option
Output	Pulse modulation from internal signal Loop through of pulse signal from User	User	R&S SMM-K22/-K23
	All analog modulations Marks the valid level and frequency	Signal Valid	
	LF generator	LF	
Input	AM, FM, PhiM	Mod Ext **)	R&S SMM-K720
	Pulse modulation from external source*) Or External trigger or gate signal*)	User**)	R&S SMM-K22

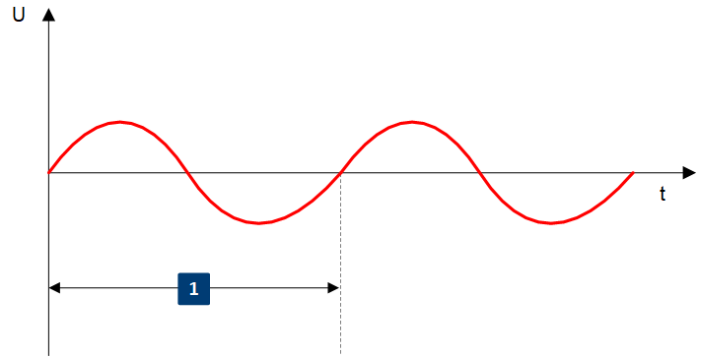
7.11.2.1 Modulation signal waveforms

The following graphs show the modulation signal waveforms of the R&S SMM100A.

LF Generator

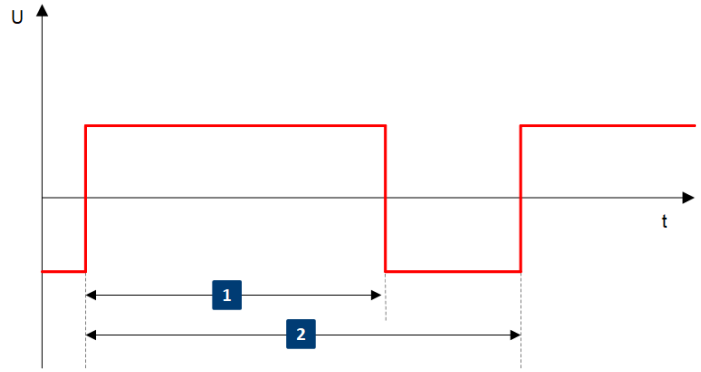
The LF and multifunction generators support the following signal shapes:

Sine



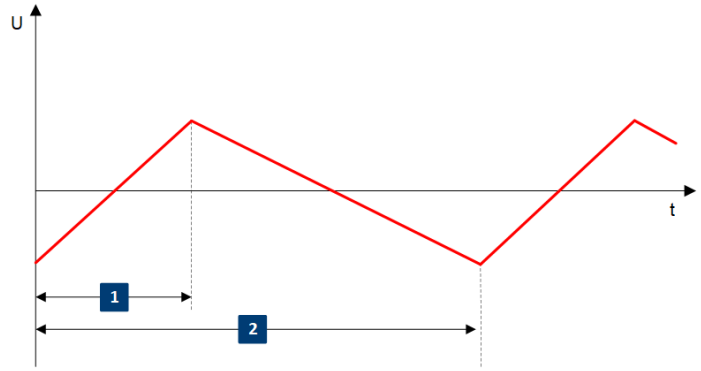
1 = Period

Pulse



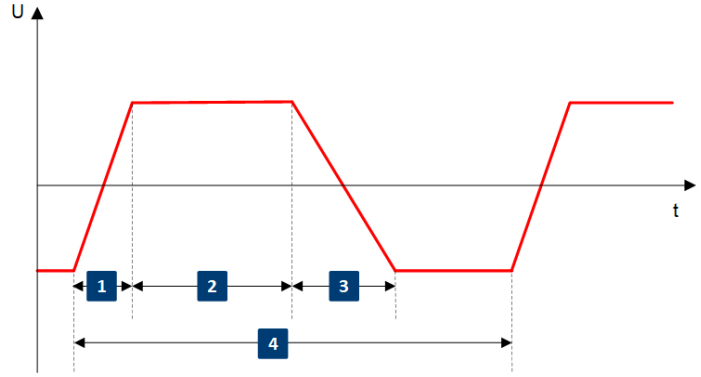
1 = Pulse period 2 = Pulse width

Triangle



1 = Triangle period 2 = Triangle rise

Trapezoid



1 = Trapezoid rise 2 = Trapezoid high

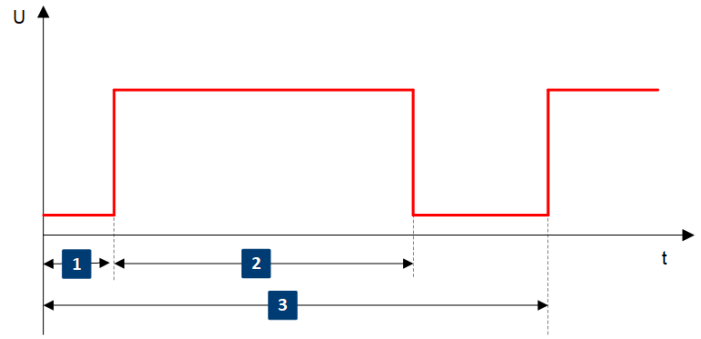
3 = Trapezoid fall 4 = Trapezoid period

To configure the associated parameters of a signal shape, see "Shape" on page 391.

Pulse Generator

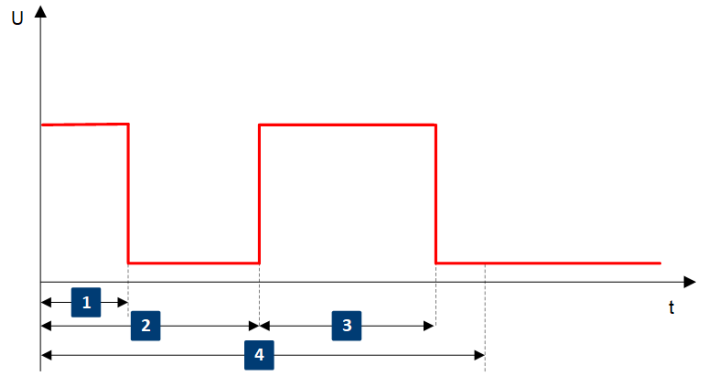
The high performance pulse generator enables you to generate single or double pulse signals.

Single



1 = Pulse delay 2 = Pulse width 3 = Pulse period

Double



1 = Pulse width 2 = Double pulse delay
3 = Double pulse width 4 = Pulse period

7.11.3 Activating analog modulations

► Use one of the following:

- Select "RF" > "Amplitude Modulation/Frequency Modualtion/Phase Modulation" > "State" > "ON".
- Select "Mod Off" > "Modulation On" in the status bar.
- Press the [Mod on/off] key on the front panel.

[Mod on/off]
Activate one or more analog modulations and press the [Mod on/off] key to toggle the state of them all.

Pressing the key again restores the status that was active before the last switch-off.

Remote command:
`[:SOURce<hw>]:MODulation[:ALL][:STATe]` on page 822

7.11.4 Modulation settings

Access:

► Select "RF > Analog Modulation".

The "Modulation" dialog contains all functions and settings to configure the analog modulations, the LF signal sources for performing a modulation, and the LF signal output.

The remote commands required to define these settings are described in:

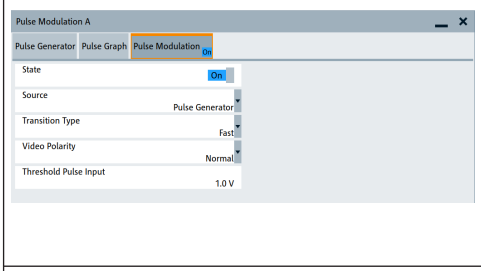
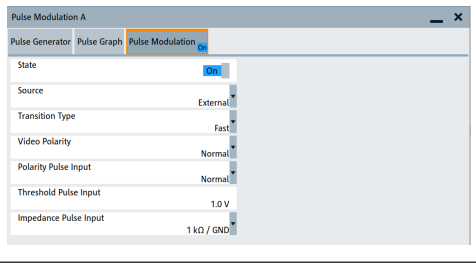
- Section 13.17.4.2, "SOURce:AM subsystem", on page 823
- Section 13.17.4.3, "SOURce:FM subsystem", on page 828
- Section 13.17.4.4, "SOURce:PM subsystem", on page 833
- Section 13.17.4.5, "SOURce:PULM subsystem", on page 837
- Section 13.17.12, "SOURce:LFOutput subsystem", on page 991

7.11.4.1 Pulse modulation settings

Access:

► Select "RF" > "Analog Modulation" > "Pulse Modulation".

Table 7-7: Pulse modulation

	
"Signal Source" > "Pulse Generator" (internal)	"Signal Source" > "External"

The "Pulse Modulation" dialog contains all parameters required to configure pulse modulation and pulse signal generation.
It also displays the pulse signal graphically.
The remote commands required to define these settings are described in Section 13.17.4.5, "SOURce:PULM subsystem", on page 837.

Settings:

State....377
Source....377
Transition Type....377
Video Polarity....377
Polarity Pulse Input....378
Threshold User4-6 Input/Threshold Pulse Input....378
Impedance Pulse Input....378

State
Activates pulse modulation.

Remote command:
[:SOURce<hw>]:PULM:STATe on page 841

Source
Selects between the internal "Pulse Generator" or an "External" pulse signal for the modulation.

"Pulse Generator"
Selects the internal generator.

See Pulse generator settings.

"External" Modulation source is fed to the input connector.

See "Signal sources" on page 371.

Remote command:
[:SOURce<hw>]:PULM:SOURce on page 841

Transition Type
Selects between "Fast" or "Smoothed" slew rate (slope).

"Fast" Enables fast transitions with shortest rise and fall times.

"Smoothed" Flattens the slew rate, resulting in longer rise / fall times. Use this mode if you are working with devices that are sensitive to steep slopes.

Note: The R&S SMM100A supports this functionality up to a certain frequency, depending on the installed frequency options, see also "Interactions and characteristics" on page 371.

For more information, refer to the specifications document.

For more information, refer to the specifications document.

For more information, refer to the specifications document.

Remote command:
[:SOURce<hw>]:PULM:TTYPe on page 841

Video Polarity
Sets the polarity of the internally generated pulse video (modulating) signal, related to the RF (modulated) signal.

This signal synchronizes the pulse generator signal and the RF signal.

"Normal" The video signal level follows the RF signal, that means it is high and low simultaneously with the RF signal.

"Inverse" Inverts the polarity between the video and the RF signal, that means it is high, when RF is low, and vice versa.

Remote command:
[:SOURce<hw>]:PULM:OUTPut:VIDeo:POLarity on page 842

Polarity Pulse Input
Sets the polarity of the active slope of a pulse input signal, that is the external pulse modulation signal.

Remote command:
`[:SOURce<hw>]:PULM:POLarity` on page 842

Threshold User4-6 Input/Threshold Pulse Input
Sets the high/low threshold in volts for the signal at the User4-6 connectors.

The input signal is defined with the parameter Signal. The same threshold applies for all 3 connectors and any input signal (e.g. external pulse modulation or trigger signal).

Remote command:
`[:SOURce]:INPut:USER:PULM:LEVel` on page 804

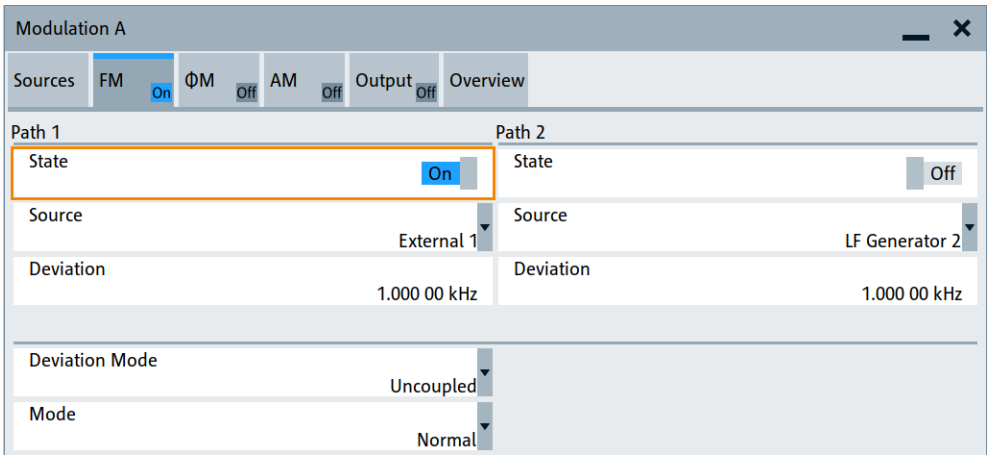
Impedance Pulse Input
Selects the input impedance for an external pulse modulation signal.

Remote command:
`[:SOURce<hw>]:PULM:IMPedance` on page 842

7.11.4.2 AM, FM and PhiM modulation settings

Access:

► Select "RF" > "Amplitude Modulation/Frequency Modualtion/Phase Modualtion".



The "FM", "Φ" and "AM" tabs contain the parameters per modulation type.
Since you need to determine an LF signal source for all modulations, "Source" and "State" are described in general. These parameters apply to the modulation modes AM, FM and ΦM. The following description explains the specific settings for the appropriate modulation modes.

State
Activates a modulation.

Note: Some modulations exclude each other and cannot be performed simultaneously.

For more information, refer to the specifications document.

Remote command:
[:SOURce<hw>]:AM<ch>:STATe on page 825
[:SOURce<hw>]:FM<ch>:STATe on page 830
[:SOURce<hw>]:PM<ch>:STATe on page 834

Source
Selects the LF signal source.

You can vary the signal sources for each of the modulations.

"LF Generator 1/2"
Selects one or both of the internally generated LF signals.

"External 1/2" Selects an externally supplied LF signal.

"Noise Generator"
Selects the internally generated noise signal.

Remote command:
[:SOURce<hw>]:AM<ch>:SOURce on page 826
[:SOURce<hw>]:FM<ch>:SOURce on page 830
[:SOURce<hw>]:PM<ch>:SOURce on page 835

FM settings
The following settings are dedicated to FM.

Deviation ← FM settings
Sets the frequency modulation deviation in Hz.

The maximal deviation depends on the RF frequency and the selected modulation mode.

Maximal possible deviation is selected automatically, if one of the following applies:
- The selected deviation is too high for the particular frequency
- The selected frequency is outside of the range where deviation is possible.

A warning message indicates this situation, too.

For more information, refer to the specifications document.

Remote command:
[:SOURce<hw>]:FM<ch>[:DEViation] on page 830

Deviation Mode ← FM settings
Enables you to couple the LF signal of both paths and determines the mode for fixing the total deviation.

The total deviation is the sum of both paths. When the sum is exceeded, the R&S SMM100A reports a settings conflict, but does not change the settings.

"Uncoupled" Enables you to adjust the deviation for each path independently.

"Fixed Total" Couples the deviation of both paths in per Hz. If you change the deviation of any path, the R&S SMM100A automatically adjusts the value of the other path. The sum always results in the set Total Deviation.

"Fixed Ratio" Couples the deviation ratio of both paths. If you change the deviation of any path, the R&S SMM100A adjusts the value of the other path.

Remote command:
[:SOURce<hw>]:FM:DEViation:MODE on page 831

Total Deviation ← FM settings
Sets the sum of the signal deviation for path 1 and path 2 in Hz when using combined sources in Deviation Mode > Fixed Total.

Deviation of both paths always sum up to the value of the total deviation.

Behavior when changing any depth settings:
- Changing the total deviation adjusts the deviation of both paths proportionally.
- Changing the deviation of one path adjusts the deviation of the other path. The sum always results in the set total deviation.

Remote command:
[:SOURce<hw>]:FM:DEViation:SUM on page 831

Ratio Path2/Path1 ← FM settings
Sets the deviation ratio (path2 to path1) in percent.

Example:

If the deviation in path1 is 10 kHz and the ratio is 50%, the deviation in path 2 is automatically set to 5 kHz.

Remote command:
[:SOURce<hw>]:FM:RATio on page 832

Mode ← FM settings
Selects the mode of the frequency modulation.

"Normal"	The maximum range for modulation bandwidth is available.
"Low Noise"	Phase modulation with phase noise and spurious characteristics close to CW mode. The range for modulation bandwidth and FM deviation is reduced. For more information, refer to the specifications document.

Remote command:
[:SOURce<hw>]:FM:MODE on page 832

PhiM settings
The following settings are dedicated to PhiM ("ΦM").

Deviation ← PhiM settings
Sets the phase modulation deviation in radians or degrees.

The maximal deviation depends on the RF frequency and the selected modulation mode.

For more information, refer to the specifications document.

Maximal possible deviation is selected automatically, if one of the following applies:
- The selected deviation is too high for the particular frequency
- The selected frequency is outside of the range where deviation is possible.

A warning message indicates this situation, too.

Remote command:
[:SOURce]:PM<ch>[:DEViation] on page 837

Deviation Mode ← PhiM settings
Enables you to couple the LF signal of both paths and determines the mode for fixing the total deviation.

The deviation sum 2 rad at a maximum. When the sum is exceeded, the R&S SMM100A adjusts the settings automatically.

"Uncoupled" Enables you to adjust the deviation for each path independently.

"Fixed Total" Couples the deviation of both paths. If you change the deviation of any path, the R&S SMM100A automatically adjusts the value of the other path. The sum always results in the setTotal Deviation.

"Fixed Ratio" Couples the deviation ratio of both paths. If you change the deviation of any path, the R&S SMM100A adjusts the value of the other path.

Remote command:
[:SOURce<hw>]:PM:DEViation:MODE on page 836

Total Deviation ← PhiM settings
In Deviation Mode = Fixed Total, sets the sum of the signal deviation for path 1 and path 2.

Deviation of both paths always sum up to the value of the total deviation.

Behavior when changing any depth settings:
- Changing the total deviation adjusts the deviations of both paths proportionally.
- Changing the deviation of one path adjusts the deviation of the other path. The sum always results in the set total deviation.

Remote command:
[:SOURce<hw>]:PM:DEViation:SUM on page 836

Ratio Path2/Path1 ← PhiM settings
Sets the deviation ratio (path2 to path1) in per cent.

Example:

If the deviation in path1 is 10 rad and the ratio is 50%, the deviation in path 2 is automatically set to 5 rad.

Remote command:
[:SOURce<hw>]:PM:RATio on page 836

Mode ← PhiM settings
Selects the mode of the phase modulation.

"High Bandwidth"
The maximum range for modulation bandwidth and PhiM deviation is available.
However, phase noise increases at low frequencies, and the range of PhiM deviation is limited. This mode is suitable if you process high frequencies.

"High Deviation"
The maximum range for PhiM deviation is available.
Phase noise is improved for low frequencies compared to the default mode. The range for modulation frequency is limited.
This mode is suitable for low modulation frequencies and/or high PhiM deviation.

"Low Noise" Frequency modulation with phase noise and spurious characteristics close to CW mode. The range for modulation bandwidth and FM deviation is reduced.

For more information, refer to the specifications document.

Remote command:
`[:SOURce<hw>]:PM:MODE` on page 835

AM settings
Provides the settings for amplitude modulation.

Depth ← AM settings
Determines the depth of the modulation signal in percent.

The depth is limited by the maximum peak envelope power (PEP).

Remote command:
`[:SOURce<hw>]:AM<ch>[:DEPTh]` on page 826

Sensitivity ← AM settings
Sets the input sensitivity of the external modulation signal.

Remote command:
`[:SOURce<hw>]:AM<ch>:SENSitivity` on page 827

Deviation Mode ← AM settings
Enables you to couple the LF signal of both paths and determines the mode for fixing the total deviation.

The deviation sum of both paths is 100% in total. When the sum is exceeded, the R&S SMM100A reports a settings conflict, but does not change the settings.

"Uncoupled" Enables you to adjust the deviation depth for each path independently.

"Fixed Total" Couples the deviation depth of both paths in per cent. If you change the depth of any path, the R&S SMM100A automatically adjusts the value of the other path. The sum always results in the set Total Depth.

"Fixed Ratio" Couples the deviation ratio of both paths. If you change the depth of any path, the R&S SMM100A adjusts the value of the other path.

Remote command:
`[:SOURce<hw>]:AM:DEViation:MODE` on page 827

Total Depth ← AM settings
Sets the sum of the signal Depth for path 1 and path 2 in per cent when using combined sources and Deviation Mode > Fixed Total.

Provided both signal paths are turned on, the depth of both paths always sum up to the value of the total depth.

Behavior when changing any depth settings:

- Changing the total depth adjusts the depths of both paths proportionally.
- Changing the depth of one path adjusts the depth of the other path. The sum always results in the set total depth.

Remote command:
`[:SOURce<hw>]:AM:DEPTh:SUM` on page 826

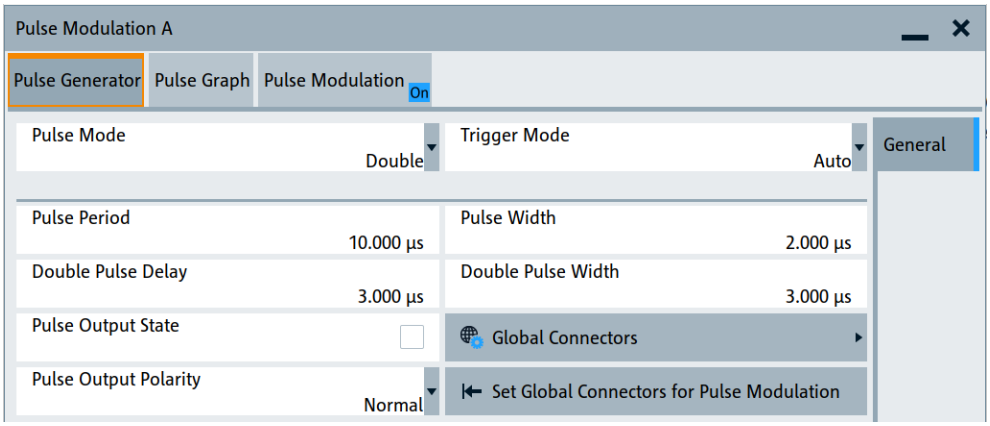
Ratio Path2/Path1 ← AM settings
Sets the deviaton ratio of the signal depth for path 2 to path 1 in per cent when using combined sources.

Remote command:
`[:SOURce<hw>]:AM:RATio` on page 827

7.11.4.3 Pulse generator settings

Access:

► Select "RF" > "Analog Modulation" > "Pulse Generator".



The "Pulse Generator" tab contains the settings for creating the pulse modulation signal internally.

Pulse generator > general settings

Access:

► Select "RF" > "Analog Modulation" > "Pulse Generator".

Settings:

Pulse Mode 384
Trigger Mode 384
Pulse Period 386
Pulse Width 386

Double Pulse Width....386
Pulse Delay....387
Double Pulse Delay....387
Pulse Output State....387
Pulse Output Polarity....387
Set Global Connectors for Pulse Modulation....387

Pulse Mode
Sets the operating mode of the pulse generator. Depending on the selection, the instrument displays the associated parameters.

"Single" Generates a single pulse in one pulse period.

"Double" Generates two pulses in one pulse period.

Remote command:
`[:SOURce<hw>]:PULM:MODE` on page 839

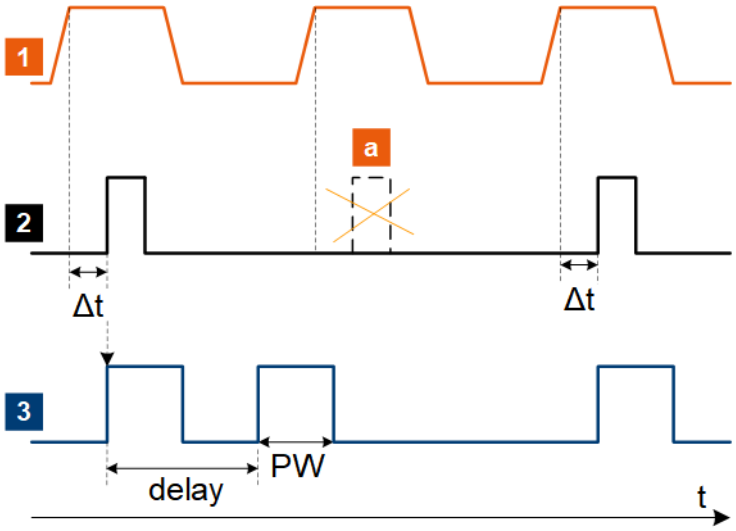
Trigger Mode
Selects between continuous triggering or triggering initiated by a trigger event from an external signal.

"Auto" Generates the internal modulation signal continuously.

"Ext Single" Generates a single pulse signal, triggered by an external signal.

"Ext Triggered" Generates the pulse signal each time an external trigger event occurs.

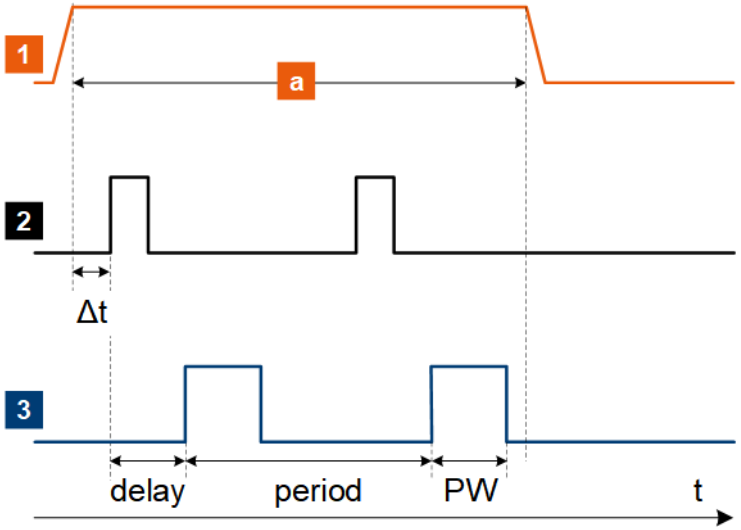
Example: Generation of double pulse signal ("Pulse Mode = Double") using "Trigger Mode = Ext Triggered"



1 = External trigger signal input with "Trigger Input Polarity = Normal" (the positive slope is active)
2 = Sync signal
3 = Pulse signal
a = Trigger signal during double pulse generation is without effect
Δt = Trigger delay between the trigger and the sync signal start.
delay = "Double Pulse Delay = 200 ns"; the first pulse starts without a delay
PW = "Double Pulse Width = 100 ns"

"Ext Gated" Generates the signal triggered by an external gate signal.

Example: Generation of single pulse signal ("Pulse Mode = Single") using "Trigger Mode = Ext Gated"



1 = External trigger signal input with "Trigger Input Polarity = Normal" (the positive slope is active)
2 = Sync signal
3 = Pulse signal
Δt = Trigger delay between the trigger and the sync signal start; see specifications document
delay = "Pulse Delay = 100 ns"
PW = "Pulse Width = 100 ns"
period = "Pulse Period = 300 ns" (time between the pulse start of two consecutive pulses)
a = Gate active duration (pulses are generated during the gate active part)

For more information, refer to the specifications document.

Remote command:
`[:SOURce<hw>]:PULM:TRIGger:MODE` on page 839

Pulse Period
Sets the repetition rate of the generated pulse signal.

Remote command:
`[:SOURce<hw>]:PULM:PERiod` on page 839

Pulse Width
Sets the pulse duration of the generated pulse signal.

Note: The pulse width must be at least 20 ns less than the set pulse period.

Remote command:
`[:SOURce<hw>]:PULM:WIDTh` on page 839

Double Pulse Width
Sets the width of the second pulse.

Remote command:
[:SOURce<hw>]:PULM:DOUBle:WIDTh on page 840

Pulse Delay
Sets the pulse delay. The pulse delay determines the time that elapses after a trigger event before pulse modulation starts. The pulse delay is not effective for double pulse generation.

Remote command:
[:SOURce<hw>]:PULM:DELay on page 840

Double Pulse Delay
Sets the delay from the start of the first pulse to the start of the second pulse.

Remote command:
[:SOURce<hw>]:PULM:DOUBle:DELay on page 840

Pulse Output State
Activates the output of the pulse modulation signal.

Remote command:
[:SOURce<hw>]:PGENerator:OUTPut[:STATe] on page 1021

Pulse Output Polarity
Sets the polarity of the pulse output signal.

Remote command:
[:SOURce<hw>]:PGENerator:OUTPut:POLarity on page 1021

Set Global Connectors for Pulse Modulation
Routes the pulse input signal and the pulse output signal to a global connector.

By default, routes the pulse input to "User 4" ("Signal" > "Pulse In") and the pulse output to "User 5" ("Signal" > "Pulse Out").

See also Section 11.2, "Configuring local and global connectors", on page 563.

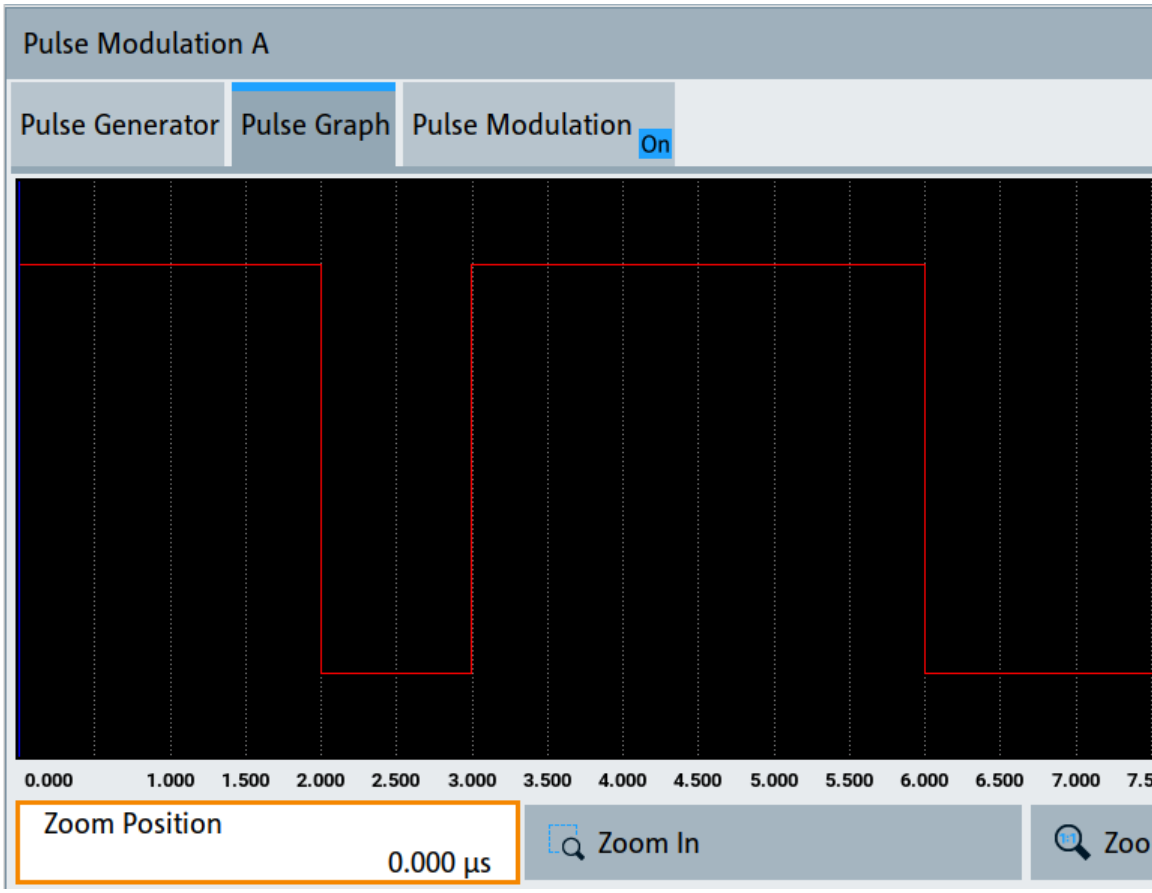
Remote command:
:SOURce<hw>:PGENerator:SET:GLB:CONNectors on page 1021

7.11.4.4 Pulse graph

Access:

► Select "RF" > "Analog Modulation" > "Pulse Modualtion > Pulse Graph".

The pulse graph is the graphical representation of the current pulse signal.



The height of the bars corresponds to the selected amplitude of the pulse signal.

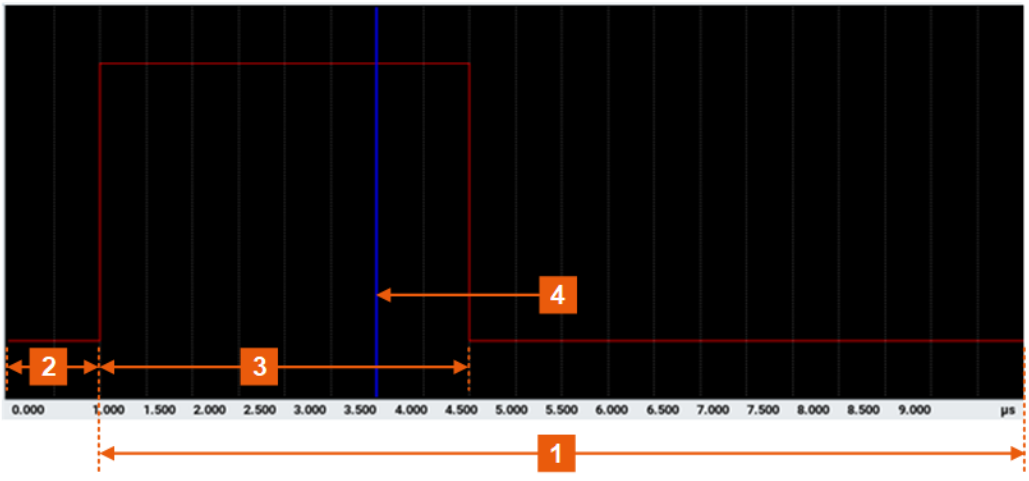


Figure 7-16: Pulse Graph - single pulse

1 = Pulse Period
2 = Pulse Delay
3 = Pulse Width
4 = Pulse Zoom Position

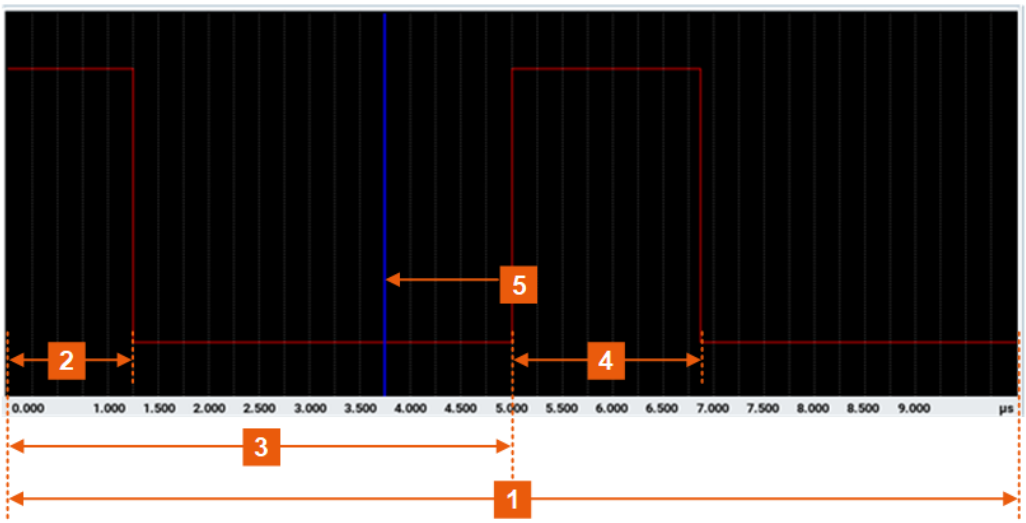


Figure 7-17: Pulse Graph - double pulse

1 = Pulse Period
2 = Pulse Width
3 = Double Pulse Delay
4 = Double Pulse Width
5 = Pulse Zoom Position

Settings:

Zooming 389

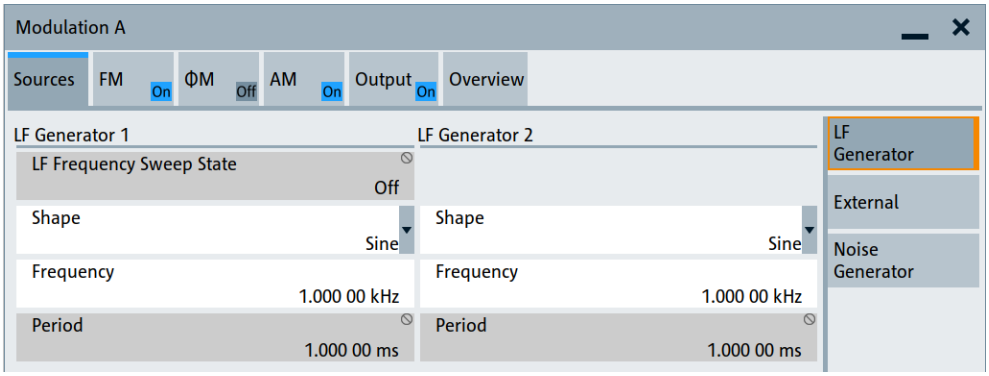
Zooming
You can zoom into the diagram to visualize the graph in more detail:

- "Zoom Position": Sets the focus on the time axis where to enlarge the graph.
- "Zoom In": Enlarges the graph at the selected position.
- "Zoom Out" for the reverse operation.

7.11.4.5 AM, FM and PhiM modulation sources

Access:

► Select "RF" > "Analog Modulation" > "Sources".



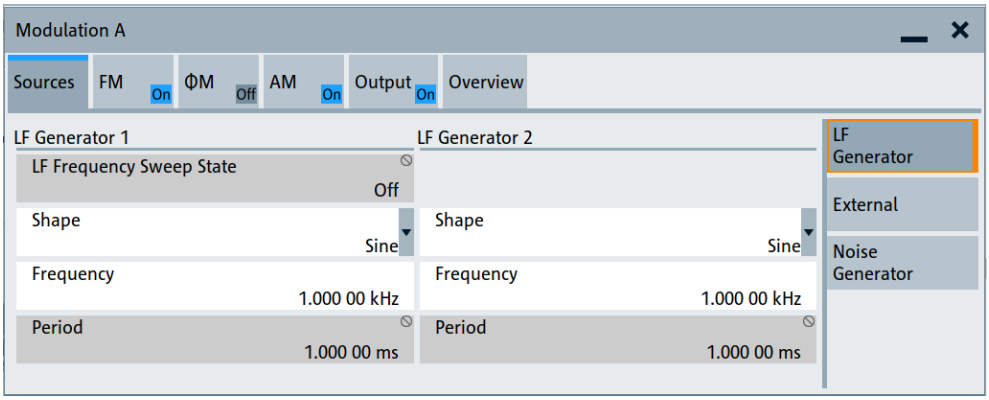
In the "Sources" tab, you can configure an LF modulation signal for performing analog modulations. It includes the setting parameters of the internal LF-and multi-function generators, the noise generator, and an external signal source.
To select an external signal, you can directly access the settings of the Connectors dialog.

The remote commands required to define these settings are described in Section 13.17.12, "SOURce:LFOutput subsystem", on page 991.

Source > LF generator settings

Access:

► Select "RF" > "Analog Modulation" > "Sources" > "LF Generator".



You can use the internal LF signal as modulation signal source for any of the analog modulations. The LF signal applies to all modulations which use the internal modulation signal. Therefore, any modification of the LF signal influences immediately all currently active modulations.

Settings:

State (LF frequency sweep)....391
Shape....391
Frequency....391
Period....391

Pulse Width....391
Pulse Duty Cycle....391
Triangle Rise....392
Trapezoid Rise / Fall....392
Trapezoid High....392

State (LF frequency sweep)
Status of the LF frequency sweep signal.

You find this parameter in two dialogs:

- "LF Frequency Sweep" turns on/off the signal generation.
  See Sweep mode settings for access.
- "Analog Modulation Sources" displays the current state (read-only). If it is turned on, this dialog provides the varying sweep frequency, see Current Frequency.

Note: Active RF frequency, RF level or RF combined sweep modes deactivate the LF sweep or List mode and vice versa.

Remote command:
`[:SOURce<hw>]:LFOutput:FREQuency:MODE` on page 995

Shape
Option: R&S SMM-K24.

Selects the waveform shape of the LF generator signal.

Remote command:
`[:SOURce<hw>]:LFOutput<ch>:SHAPe` on page 997

Frequency
Sets the frequency of the LF generator for sine signals.

Set the signal shape with the parameter Shape.

Remote command:
`[:SOURce<hw>]:LFOutput<ch>:FREQuency` on page 994

Period
Sets the repetition rate of the generated LF signal for triangle, trapezoid or pulse shapes, see Shape.

The period of sine signals is calculated from the selected Frequency

Remote command:
`[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:PERiod` on page 999
`[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRIangle:PERiod` on page 1000
`[:SOURce<hw>]:LFOutput<ch>:SHAPe:PULSe:PERiod` on page 998

Pulse Width
Sets the pulse duration of the generated pulse signal.

Remote command:
`[:SOURce<hw>]:LFOutput<ch>:SHAPe:PULSe:WIDTh` on page 998

Pulse Duty Cycle
Sets the ratio between the pulse duration and the pulse period in percent.

Remote command:
[:SOURce<hw>]:LFOutput<ch>:SHAPe:PULSe:DCYCle on page 998

Triangle Rise
Sets the time required for the triangle signal to change from low level to high level.

Remote command:
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRIangle:RISE on page 1000

Trapezoid Rise / Fall
Sets the time required for the trapezoid signal to change from low level to high level, and vice versa.

Remote command:
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:RISE on page 999
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:FALL on page 998

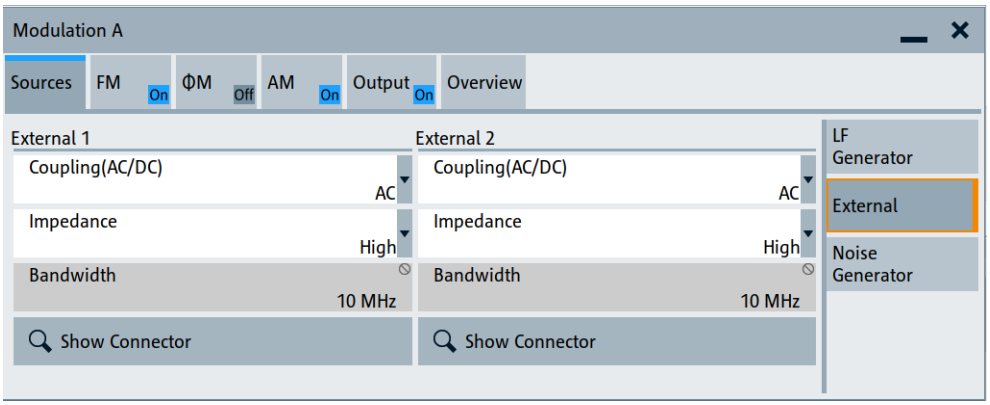
Trapezoid High
Sets how long the trapezoid signal is at high level.

Remote command:
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:HIGH on page 999

Source > external settings

Access:

► Select "RF" > "Analog Modulation" > "Sources" > "External".



The "External" settings section contains all parameters required to configure the signal of an externally supplied LF signal.

Settings:

Coupling (AC/DC)..... 393
Impedance..... 393
Bandwidth..... 393
Show/Show Connector.....393

Coupling (AC/DC)
Selects the coupling mode (AC or DC) for the external signal.

Note: You can set the coupling of the external modulation signal for AM, FM and ΦM separately.

Remote command:
`[:SOURce<hw>]:INPut:MODext:COUPling<ch>` on page 981

Impedance
Sets the impedance for the externally supplied signal.

Remote command:
`[:SOURce<hw>]:INPut:MODext:IMPedance<ch>` on page 982

Bandwidth
Displays the maximum bandwidth of the external LF signal.

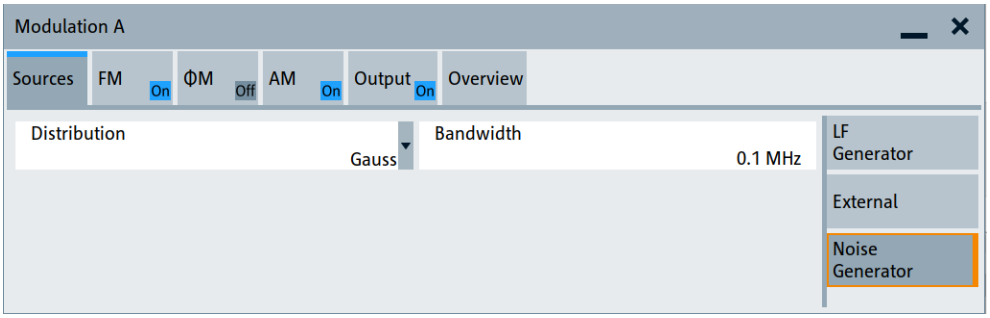
Remote command:
`[:SOURce]:LFOutput<ch>:BANDwidth?` on page 994

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

Source > noise generator settings

Access:

► Select "RF" > "Analog Modulation" > "Sources" > "Noise Generator".



The "Noise Generator" settings contain all parameters to configure the signal of the internal noise generator.

Settings:

Distribution 393
Bandwidth 394

Distribution
Selects the distribution of the noise power density.

"Gauss" Generates the noise power according to a Gaussian distribution.

"Equal" Generates an evenly distributed noise.

Remote command:
[:SOURce<hw>]:NOISe:DISTribution on page 1018

Bandwidth
Sets the noise bandwidth as distinct value.

You can set the bandwidth between 100 kHz and 10 MHz in 100 KHz steps.

The noise signal is generated within the set frequency bandwidth. The noise level in the frequency band is defined by "Noise Level (System Bandwidth)".

Remote command:
[:SOURce<hw>]:NOISe:BANDwidth|BWIDth on page 1018

7.11.4.6 Output settings

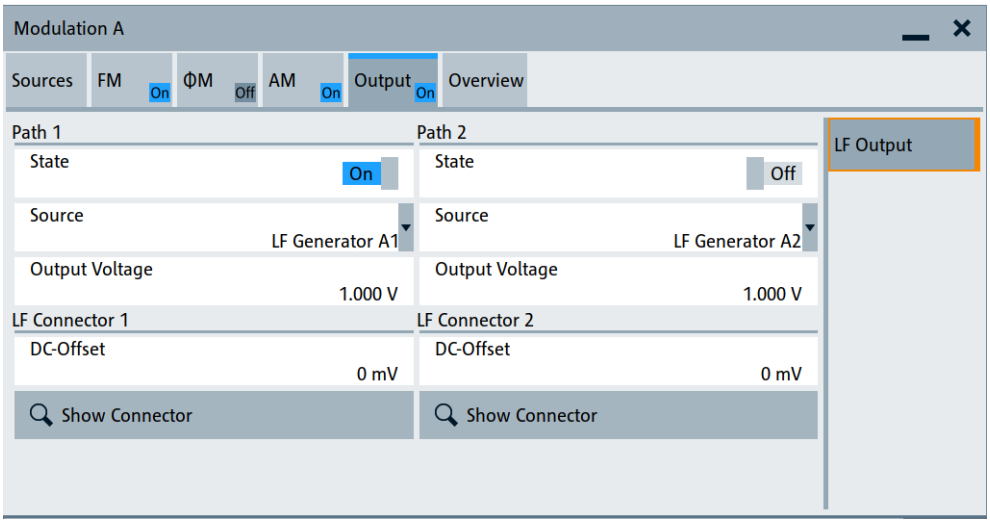
Access:

► Select "RF" > "Analog Modulation" > "Output".

LF output settings

Access:

► Select "RF" > "Analog Modulation" > "Output" > "LF Output".



In the "LF Output" side tab, you can configure the signal at the LF output, determine the output voltage or add a DC offset.

Settings:

State....395
Source....395
Output Voltage....395
DC-Offset....395
Show/Show Connector....395

State
Activates the output of the LF signal.

Remote command:
[:SOURce]:LFOutput<ch>[:STATe] on page 996

Source
Determines the LF signal to be synchronized of the corresponding path.

"LF Generator A1/2, B1/2"
Selects one of internally generated LF signals.

"AM A/B" Selects the AM signal.

"FM/ΦM A/B" Selects the signal also used by the frequency or phase modulations.

"Noise Generator A/B"
Selects the internally generated noise signal.

"External 1/2" Selects an externally supplied LF signal

Remote command:
[:SOURce]:LFOutput<ch>:SOURce on page 997

Output Voltage
Sets the peak to peak voltage of the selected LF output source.

This value, e.g. +1 V to -1 V refers to 50 Ohm at the RF output with high termination impedance at the LF output.

Remote command:
[:SOURce]:LFOutput<ch>:VOLTage on page 997

DC-Offset
Adds a DC offset to the LF output signal.

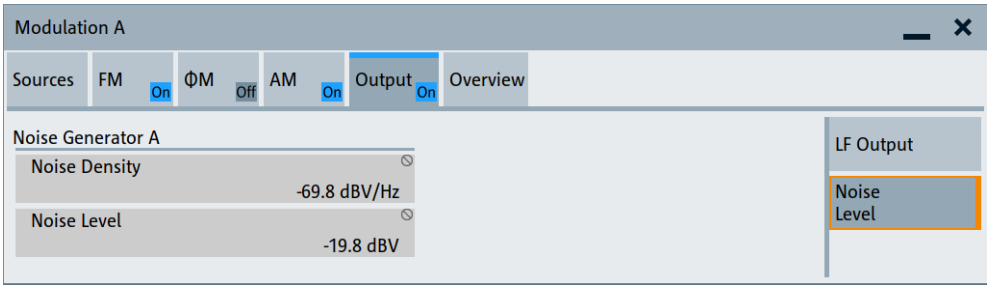
Remote command:
[:SOURce]:LFOutput<ch>:OFFSet on page 996

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

Noise level settings

Access:

1. Select "RF" > "Analog Modulation" >"Output" > "LF Output".
2. Set "Source" > "Noise Generator".
3. Select "Output" > "Noise Level".



In the "Noise Level" side tab, you can set the signal level and noise density.

Settings:

Noise Density 396
Noise Level 396

Noise Density
Indicates the level of the noise signal for a bandwidth of 1 Hz (relative).

Remote command:
`[:SOURce<hw>]:NOISe:LEVel:RELative?` on page 1018

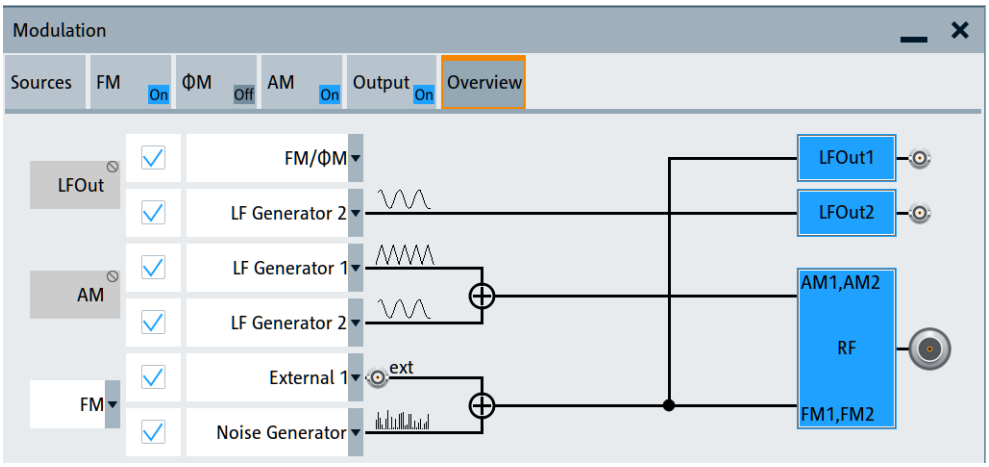
Noise Level
Indicates the level of the noise signal per Hz within the total bandwidth (absolute).

Remote command:
`[:SOURce<hw>]:NOISe:LEVel[:ABSolute]?` on page 1018

7.11.4.7 Overview

Access:

► Select "RF" > "Analog Modulation" > "Modulations" > "Overview".



Blue color = Active output signal (AM and FM)
Gray color = Inactive output signal (LF Out)
Miniature graph = Indicates an active source
Connectors = Indicate a connector (e.g. external signal) is involved in the path of the signal

The "Overview" tab is an interactive diagram that indicates the active modulations and the signal being output.

Here you can:

- Select the output signal ("LF Out") per path; the setting acts as the parameter "LF Output Source"
- Select the source for each modulation and modulation path; the setting acts as the parameter "Source"
- Activate modulation per path; the setting acts as the parameter "State"
  To generate a two-tone signal composed form the two paths of the same modulation type, activate both paths.
- Activate "FM" or "PhiM"; the two modulations are mutually exclusive.

See:

- Section 7.11.4, "Modulation settings", on page 376 for description of the related settings

Settings:

LFOut 397
AM 397
FM/PhiM 397

LFOut
Label for the LF output settings in the overview.

Remote command:
n.a.

AM
Label for the amplitude modulation settings in the overview.

Remote command:
n.a.

FM/PhiM
Selects the modulation signal to be assigned to the output. You can assign the frequency or phase modulated signal.

Remote command:
n.a.

7.11.5 How to generate a modulated signal

7.11.5.1 How to generate an amplitude modulated signal

The following examples use the internal LF generator.

To set the frequency and level of the RF signal

1. Press [Preset] to start from a defined state.
2. In the status bar, set "Frequency = 2 GHz".
3. Set "Level = -20 dBm".

To configure the modulation signal (LF generator)

1. Select "RF" > "Analog Modulation" > "Modulation Source".
2. In the "Sources" tab, select "Shape > Sine".
3. Set "Frequency = 20 kHz".
   The period is calculated automatically and indicates "Period = 50.00 µs".

To configure the amplitude modulation settings

1. In "Modulation" dialog, select the "AM" tab.
2. Set "Source = LF Generator1"
3. Set "Depth = 30%"
4. Select "State = I" to activate the modulation.
5. Set "RF > On" to enable signal output.

7.11.5.2 How to generate a pulse modulated signal

The following example uses the internal pulse generator.

To set the frequency and level of the RF signal

1. Press [Preset].
2. In the status bar, set "Frequency = 4 GHz".
3. Set "Level = -25 dBm".

To configure the pulse generator

1. Select "RF" > "Analog Modulation" > "Pulse Generator".
2. Select "Pulse Mode = Double".
3. Set "Pulse Period = 10 us".
4. Set "Pulse Width = 2 us".
5. Set "Double Pulse Width = 1.2 us".
6. Set "Double Pulse Delay = 4.5 us".
7. Activate "Pulse Output State".

8. Set "Trigger Mode = Auto".

   In the "Pulse Graph" tab, you can view the generated pulse signal graphically.

To enable pulse modulation

1. Select the "Pulse Modulation" tab.
2. Set "State = I" to activate pulse modulation.
3. Set "RF > On" to enable signal output.

7.12 Improving level performance

To adjust the RF output signal to specific needs in your application optimally, the R&S SMM100A provides different functions:

- **Attenuator**
  The R&S SMM100A is equipped with a step attenuator that enables you to vary the amplitude of the RF signal in a wide range. It is characterized by low VSWR (voltage standing wave ratio) over the full level and frequency range, and provides highest level accuracy and noise suppression.
  See Section 7.12.1, "Attenuator", on page 400.
- **Automatic Level Control (ALC)**
  The automatic level control system ensures stable RF signals with highest absolute level accuracy over temperature and time.
  See Section 7.12.2, "ALC - automatic level control", on page 402.
- **User correction (UCOR)**
  The user correction function allows you to compensate frequency responses of external setups (e.g. losses of cables) and achieve a stable input signal over frequency directly at the DUT.
  See Section 7.12.3, "User correction", on page 406.
- **Power sensors**
  The R&S NRP power sensors support RF signal level optimization by determining the attenuation characteristics of downstream devices or cables, or by monitoring the RF signal level at the output directly. The R&S SMM100A uses the readings of a sensor for compensation of losses and thus improving the accuracy of the RF signal level.
  You can configure the measurement parameters of a power sensor directly in the R&S SMM100A and monitor its readings, including calibration.

  See:
  – Section 7.12.4, "Using power sensors", on page 418
  – Section 7.12.5, "Improving the RF signal performance", on page 435
  – Section 7.12.4.2, "NRP power viewer", on page 420
  – Section 7.12.4.3, "NRP power control", on page 423
  – Section 7.12.4.4, "NRP sensor configuration", on page 427
  – Section 7.12.4.5, "NRP sensor mapping", on page 432

7.12.1 Attenuator

About the attenuator

The step attenuator is either an electronic or mechanical device. Instruments with frequency options up to 20 GHz use an electronic step attenuator, providing fast and wear free level settings. Instruments capable to generate higher frequency signals use mechanical step attenuators.

According to the requirements of your application, you can select different attenuator characteristics.

The following are examples of test requirements and the corresponding configuration:

- Automatic configuration
  Select standard operation mode ("Auto"), in which the generator adjusts the attenuation of the RF output signal automatically.
- DUT tests under low signal to noise conditions
  Low output power is suitable to test the behavior of a DUT under low signal to noise conditions.
- Uninterrupted level settings with constant VSWR
  A fix attenuation value is required for obtaining uninterrupted level settings with constant VSWR.
  The configuration "RF Off Mode > Unchanged" ensures that constant VSWR is maintained if you turn the signal off and on again.
- Highest level accuracy
  Enter the target level value in "Fixed" mode and activate ALC (automatic level control).
  In this operating mode, the generator adjusts the output level whenever the frequency or level setting changes.
- Noise sensitive applications
  The parameter "RF OFF Mode > Full Attenuation" sets maximum attenuation and thus suppresses noise when you turn off the RF signal.

Interactions and characteristics

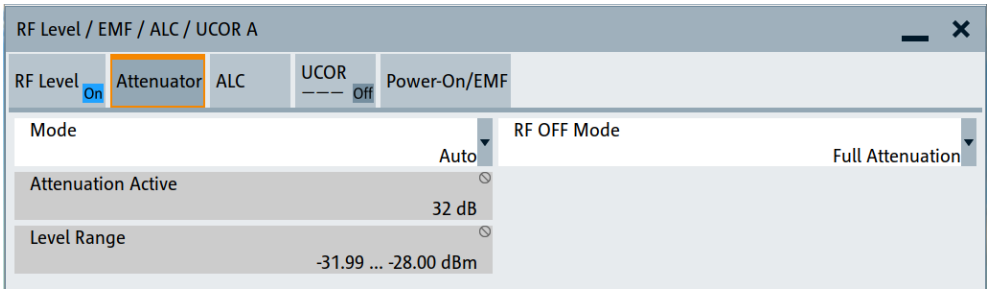
- The spectral purity of the RF output signal decreases with high attenuation.
- Fixed mode is effective when automatic level control is activated (ALC State = On).
- The setting of the RF OFF Mode > Full Attenuation has priority over the RF level Mode > Fixed or Manual, regardless of the selected settings characteristics.

7.12.1.1 Attenuator settings

Access:

► Select "RF" > "RF Level" > "Level > Attenuator".

In the "Attenuator" dialog, you can select the operating mode of the step attenuator, the instrument is equipped with.



The remote commands required to define these settings are described in Section 13.14, "OUTPut subsystem", on page 761 and Section 13.17.18, "SOURce:POWer subsystem", on page 1022.

Settings

Mode 401
Attenuation 401
Attenuation Active 401
Level Range 402
RF OFF Mode 402

Mode

Determines the operating mode of the step attenuator.

Note: RF OFF Mode > Full Attenuation has higher priority than "Fixed" or "Manual".

"Auto" Adjusts the attenuator settings automatically.

"Fixed" Fixes the attenuator and amplifier paths for the current RF level and provides signal output with constant output VSWR. The resulting level range is indicated under "Level Range" on page 318.
This mode is coupled with ALC, and therefore only effective when ALC is enabled.

"Manual" Allows you to set the Attenuation.
The user-specified nominal attenuation is useful for instruments equipped with a mechanical step attenuator.
Similar to "Fixed" mode, relays and amplifier stages keep the specified value, providing interruption-free signal output level.

Remote command:
`:OUTPut<hw>:AMODe` on page 762

Attenuation

Sets the nominal attenuation of the RF signal in Mode > Manual.

Remote command:
`[:SOURce<hw>]:POWer:ATTenuation` on page 1029

Attenuation Active

Displays the current level attenuation value in Mode > Auto | FIxed.

Remote command:
`[:SOURce<hw>]:POWer:AATTenuation?` on page 1029

Level Range
Shows the interruption-free range of the level that you can use in the selected mode.

Remote command:
:OUTPut<hw>:AFIXed:RANGe:LOWer? on page 763
:OUTPut<hw>:AFIXed:RANGe:UPPer? on page 763

RF OFF Mode
Determines the state of the step attenuator, when the RF signal is switched off.

The setting is not affected by an instrument preset ([Preset] key or *RST) and the "Save/Recall" function. It is reset only by factory preset.

"Unchanged" Freezes the setting of the step attenuator.
Use this mode if a constant VSWR (Voltage Standing Wave Ratio) is required.

"Full Attenuation"
Switches to the maximum attenuation.
Use this mode for applications that require a high level of noise suppression.
Note: "Full Attenuation" has higher priority than the RF level modes Mode > Fixed or Manual.

Remote command:
[:SOURce<hw>]:POWer:ATTenuation:RFOFf:MODE on page 1030

7.12.1.2 Reverse power protection

The instrument is equipped with a reverse power protection circuit.

The reverse power protection is tripped when the power of signals reflected from the load or external signals applied to the RF output get too high. A relay opens and interrupts the internal connection to the RF output. This condition is indicated in the status bar by the "Overload" status message.

Overload
If an "Overload" status message is indicated in the status bar, perform the following:
- Remove the cause for the overload
- Press the [RF on/off] key to reset the overload protection

The RF input is activated when the overload protection is reset.

Remote command:
:OUTPut<hw>:PROTection:TRIPped? on page 764
:OUTPut<hw>:PROTection:CLEar on page 763

7.12.2 ALC - automatic level control

The R&S SMM100A is equipped with an automatic level control (ALC) unit to obtain best RF level accuracy.

About ALC

ALC is an adaptive control system to stabilize the RF output level. It continuously monitors the current level and adjusts it to keep a steady state over temperature and time.

ALC is active in almost all applications by default. It is not active for frequencies below 200 kHz and if the optimization mode (IQ modulation) is different than "FAST".

Also note that ALC can detect incorrect values in **multi-transmitter** test setups. If multiple generators are coupled, reverse power can affect the ALC readings, which leads to an incorrect RF output power.

ALC states and their effects

The following description basically explains the ALC states and their principle of operation:

- "Auto"
  Adjusts the output level to the operating conditions automatically. ALC is active in almost all operating modes.
- "On"
  Activates the internal level control permanently, regardless of the operating conditions.
  Note: This mode is not useful for pulse modulation with narrow pulses and low repetition rates, since the automatic level control cannot settle in time. Set ALC "Auto" or "Table & On" instead.
- "Off (Sample & Hold)"
  Deactivates ALC, but still allows you to maintain a constant output level.
  The R&S SMM100A switches briefly in the CW mode and enables ALC to adjust the level to the set target value. The instrument freezes this setting, turns off ALC again, and switches back to the operating mode.
- "Sample & On"
  Initially the level control circuit uses a sample process to settle to the current level. When settled, it continues level control with highest level accuracy.
- "Off (Table)"
  Deactivates internal level control loop. The instrument calculates every level setting using the attenuation values from the internal (ALC) table. Level attenuation between two table values is done with linear interpolation. This mode enables you to perform a fast and strictly monotonic, but not quite as precise level adjustment.
- "Table & On"
  Starts with the associated value of the internal level table and then activates the automatic level control. This mode achieves maximum level accuracy and fast setting times.

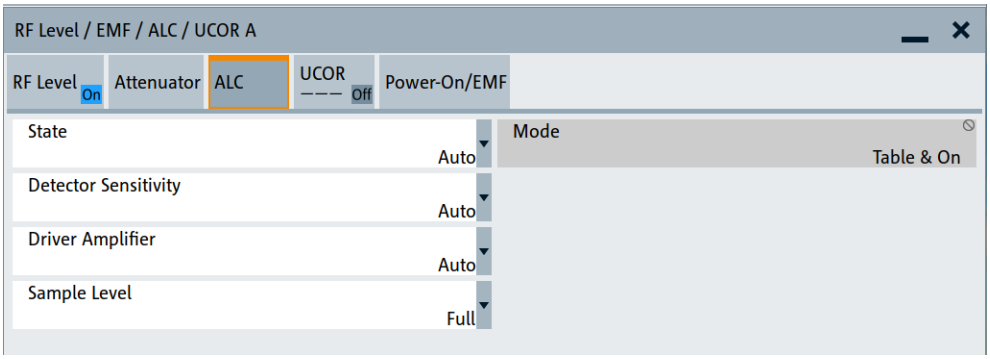
The R&S SMM100A displays the level control setting as a status message in the info line.

How to: See Section 7.12.2.2, "How to enable the ALC", on page 406.

7.12.2.1 ALC settings

Access:

► Select "RF" > "RF Level" > "Automatic Level Control".



In the "ALC" dialog, you can configure the settings for the automatic level control of the RF signal to achieve optimal accuracy.

The remote commands required to define these settings are described in Section 13.17.18, "SOURce:POWer subsystem", on page 1022.

How to: See Section 7.12.2.2, "How to enable the ALC", on page 406.

Settings

State....404
Mode....405
Detector Sensitivity....405
Driver Amplifier....405
Sample Level....406

State
Selects the internal level control mode.

"Auto" Selects the most appropriate ALC mode automatically.

"On" Activates ALC permanently.

"Off (Sample & Hold)"
Deactivates the ALC, but allows you to recalibrate the level at each frequency and level change. The value remains up to the next change.

"Sample & On"
Enables automatic level control after a short sample pulse.

"Off (Table)"
Controls the level using the attenuation values of the internal ALC table.

"Table & On"
Starts with the attenuation setting from the internal ALC table and continues with automatic level control.

For further details on the individual settings, an overview of the functionality and details on what is to be considered, see "ALC states and their effects" on page 403.

Note:
The ALC modes "Off (Sample & Hold)" and "Sample & On" use a short sample pulse to set the level control. To adjust the level of this sample pulse, see "Sample Level" on page 406 in the ALC dialog. It does not consider any signal headroom, e.g. applied to a user defined ARB waveform.

How to: See Section 7.12.2.2, "How to enable the ALC", on page 406.

Remote command:
`[:SOURce<hw>]:POWer:ALC[:STATe]` on page 1027

Mode
In ALC > State AUTO, the R&S SMM100A indicates the currently active ALC mode that is set automatically.

Remote command:
`[:SOURce<hw>]:POWer:ALC:MODE?` on page 1027

Detector Sensitivity
Determines the path of the internal level detector.

The level detector of the ALC has multiple paths distinguished by their sensitivity.

"Auto" Selects the detector path automatically, according to the given level. This mode is the recommended operation mode.

"Low" Selects the detector path with low sensitivity. This setting is intended for signals with high internal electronic levels.

"Med" Selects the path with medium sensitivity. This setting corresponds to normal mode. It is intended for signals with medium internal electronic levels.

"High" Selects the detector path with high sensitivity, intended for signals with low internal electronic levels.

"Fix" Fixes the last set sensitivity setting.

Remote command:
`[:SOURce<hw>]:POWer:ALC:DSENsitivity` on page 1028

Driver Amplifier
Selects the switching state of the driver amplifier, that means the switchable amplifier or step attenuator at the output.

"Auto" Switches the step attenuator automatically.

"On/Off" The driver amplifier is switched on, or off respectively.

"On (maximum Gain)"
The driver amplifier is switched on.
The R&S SMM100A supplies the maximum level at the output within the frequency range 6 GHz to 10 GHz.

Note: In this mode, the harmonics increase.

"Fix" Fixes the last setting.
The Readjust button switches the driver amplifier state first to automatic, calculates all level settings and then resets to fix.

Remote command:
`[:SOURce<hw>]:POWer:ALC:DAMPlifier` on page 1028

Sample Level
Determines the level at the output of the instrument during the sample process.

How to: See Section 7.12.2.2, "How to enable the ALC", on page 406.

"Full" Attenuates the sample level by the crest factor of the used I/Q modulation signal or 9 dB, whichever is lower. Additionally, an internal headroom of the signal is considered.

"Attenuated" Sets an additional attenuation of 40 dB.

"Minimum" Sets the attenuation to maximum.

Remote command:
`[:SOURce<hw>]:POWer:ALC:SLEVel` on page 1029

7.12.2.2 How to enable the ALC

1. Select "RF" > "RF Level" > "Automatic Level Control".
2. **NOTICE!** Risk of DUT damage due to high input power. The ALC modes "State" > "Off (Sample & Hold)" and "State" > "Sample & On" use a short sample pulse to set the level control. With the setting "Sample Level" > "Full", this sample pulse results in a CW RF pulse. Usually, the RMS value of this CW pulse equals the configured RMS level value of the signal, but it can also rise up to the PEP level.

   To protect the DUT from damage due to high input power, use the following setting combinations for the sampling states "Off (Sample & Hold)" or "Sample & On":
   - Set "Sample Level" > "Attenuated" or
   - Set "Sample Level" > "Minimum".
3. Set "RF" > "State" > "On".

7.12.3 User correction

The R&S SMM100A supports a correction function to compensate external losses, caused, for example, by the RF cable, to achieve a precise target input level at the DUT.

The signal at the RF outputs of the R&S SMM100A is flat. However, the DUT is usually not connected directly to the outputs of the instrument but rather via connecting cables. Components like cables, power combiners, switches or mixers can affect the signal flatness at the DUT input.

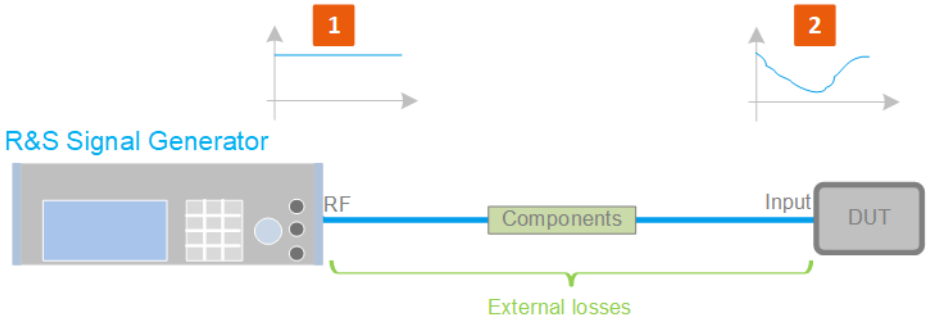


Figure 7-18: Effect of external losses on the signal flatness at the DUT input

DUT = Device under test
Components = Designation of all components between the measurement equipment and the DUT, e.g. cables
1 = Flat signal at the outputs of the R&S SMM100A
2 = Signal received at the DUT, incl. the external losses

About UCOR

User correction (UCOR) is a method that determines the external level loss of the RF output signal over a frequency range in advance, see Figure 7-19.

User correction relates to the RF center frequency only. It does not affect the baseband bandwidth.

The difference between the generator output level and the level at the DUT determines the correction value at the respective frequency. Alternatively, the attenuation characteristics over a certain frequency range of, for example, RF cables are also specified in the associated specifications document.

For more information, refer to the specifications document.

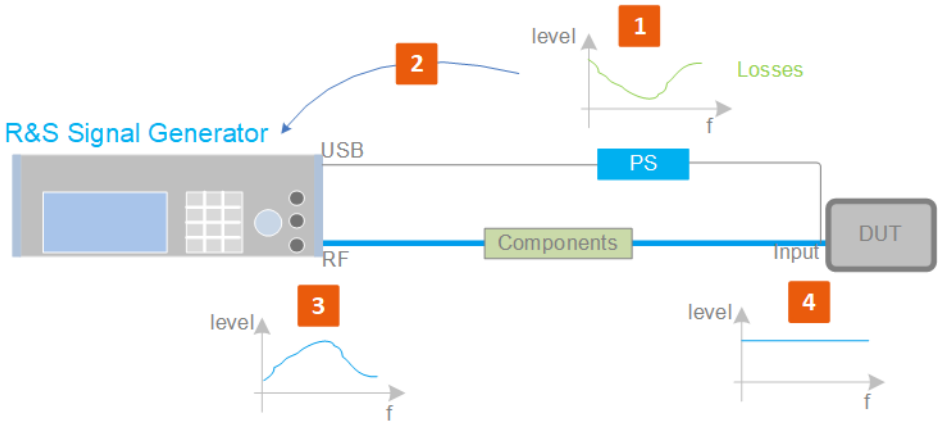


Figure 7-19: Understanding the principle of user correction

DUT = Device under test
Components = Designation of all components between the measurement equipment and the DUT, e.g. cables
PS = Power sensor, e.g. R&S NRP, connected at the DUT's input and the USB connector of the R&S SMM100A
1 = Power sensor measures the level over a frequency range, where the collected values correspond to the losses caused by the components between the R&S SMM100A and the DUT
2 = Obtain the correction data by inverting the collected data; load the correction parameters in the R&S SMM100A
3 = In the R&S SMM100A, the RF signal is pre-processed with the correction values so that the signal at the outputs is the inverted version of the external losses
4 = Received at the DUT input, the pre-processed signal if flat

With active **UCOR**, the generator adds the correction value internally and thus increases the output level by exactly the amount of the loss between its output and the DUT. For frequencies which are not contained in the list, the level correction is calculated by interpolation of the closest correction values.

Possible ways for configuring the user correction values

You can configure correction values in the following ways:

- **Internally**
  - Use the built-in table editor in the "UCOR > Edit User Correction Data" dialog. Once defined, user correction values can be saved in a file.
    Files with correction data can be exported, for example, to exchange configuration between instruments or to modify the file content with an external program and reload them again.
  - Using the corresponding remote-control commands.
    Note that you have to create a user correction file first.
- **Externally**
  Create a file with correction values as a CSV file with Microsoft Excel, with a Notepad or a similar tool and save it with the predefined extension. Transfer the file to and load it into the instrument.

UCOR file format

Files containing correction data are simple files in text or comma-separated value (CSV) file format. The filename is user-definable; the file extension is `*.ucor`.

The file contains a list of correction values, one row per frequency and correction value pair; a new line indicator separates the correction values.

For file handling, use the standard functions in the "File Manager", see Section 10.9, "Using the file manager", on page 540.

Collecting correction data

To fill the frequency and power values in the correction table, use one of the following options:

- **Manually**, row by row.
- Fill the table **automatically** with linearly interpolated values, calculated from value range and step size.
- Acquire the real frequency response characteristics of the used component with the **R&S NRP power sensor**, see Understanding the principle of user correction.

Using a power sensor for frequency response measurements

Consider the following when using R&S NRP power sensors to measure the correction values:

- Measure the level directly at the input of the DUT.
- Use the internal correction functions of an R&S NRP power sensor to increase the measurement accuracy.
- Use S-parameter to consider the impact of any two-port device like an adapter between the signal generator and the sensor input.

For information on the various possibilities of interoperability between Rohde & Schwarz power sensors and Rohde & Schwarz signal generators, see the application note 1GP141.

Interactions and characteristics

You can enable user correction in all operating modes.

However, user correction cannot be activated simultaneously with absolute level compensation based on user-defined frequency response values. These functions exclude each other; only one of them can be used at a time.

See the user manual "R&S SMM-K544 User-Defined Frequency Response Correction".

The RF output level ($Level_{RF}$) is the sum of the level value and the correction for the particular frequency:

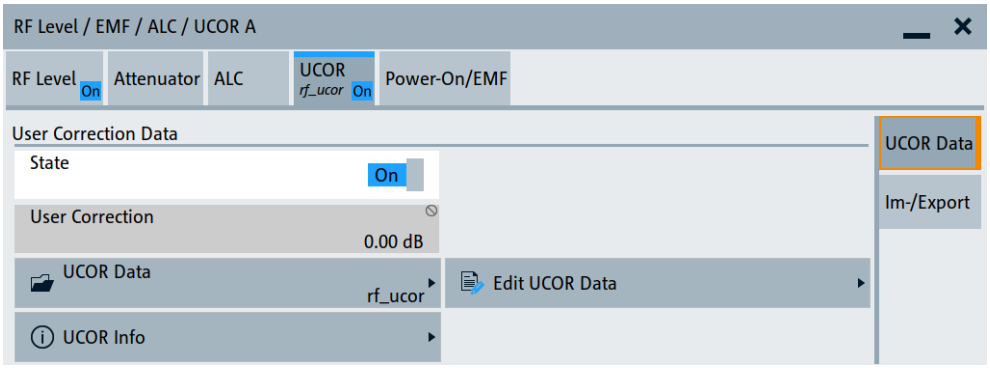
$Level_{RF}$ = "Status bar > Level" + "UCOR"

If enabled, the R&S SMM100A indicates user correction by the "Lev Ucor" icon in the status bar.

7.12.3.1 User correction settings

Access:

1. Select "RF" > "RF Level" > "User Correction".
2. If you already have created a file with user correction data:
   a) Select "UCOR Data" > navigate to the file "*.uco" > "Select".
   b) Proceed with step 4.
3. If you need to create a file:
   a) Select "UCOR Data" > "New".
   b) Enter the filename `UCOR_Data` and confirm with "Ok".
   c) Choose the file and confirm with "Select".
   d) Select "Edit UCOR Data".
   e) To fill the user correction data table, proceed as described in Section 7.12.3.2, "Ucor data editor", on page 411.
4. Select "UCOR" > "State" > "On".
5. Select block diagram > RF > "On".



The "UCOR" dialog contains all settings for creating and handling files with user-defined level correction values.

The remote commands required to define these settings are described in Section 13.17.6, "SOURce:CORRection subsystem", on page 954.

Settings:

State....410
User Correction....411
UCOR Data....411
Edit UCOR Data....411
UCOR Info....411

State
Enables user correction.

The R&S SMM100A displays the status icon "Lev Ucor" in the status bar.

You cannot enable both user correction and absolute level compensation based on user-defined frequency response values. These functions exclude each other.

See the user manual "R&S SMM-K544 User-Defined Frequency Response Correction".

Remote command:
`[:SOURce<hw>]:CORRection[:STATe]` on page 958

User Correction
Indicates the corrected level value for a specific frequency point.

Remote command:
`[:SOURce<hw>]:CORRection:VALue?` on page 958

UCOR Data
Opens the standard "File Select" function of the instrument. The provided navigation possibilities in the dialog are self-explanatory.

Files with user correction values are files with predefined file extension `*.uco`. If you select a file, the dialog indicates the filename.

You can create the file internally in the table editor or externally.

- To select an existing file, select "Select List", navigate to your user correction file and select the file.
- Use the general editor function to create a file or to edit an existing one.
- Use the standard file manager function to load externally created files to the instrument.

Remote command:
`[:SOURce]:CORRection:CSET:CATalog?` on page 959
`[:SOURce<hw>]:CORRection:CSET[:SELect]` on page 957
`[:SOURce]:CORRection:CSET:DELete` on page 959

Edit UCOR Data
Opens the build-in table editor to define a new correction table or edit an existing one.

See also:

- Section 7.12.3.2, "Ucor data editor", on page 411
- "Fill..." on page 368
- Section 7.12.3.3, "Fill with sensor", on page 414

UCOR Info
Opens a window with information on the user correction file.

The window shows the metadata of the file and the output level parameters that are relevant for user correction.

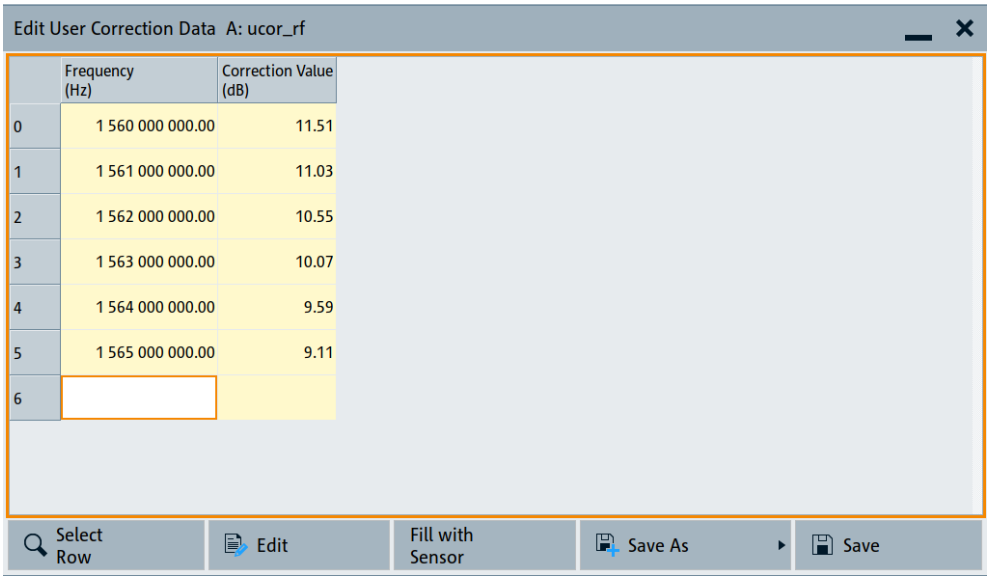
Remote command:
n.a.

7.12.3.2 Ucor data editor

The "User Correction" dialog provides a build-in list editor for defining the corresponding value pairs. Prerequisite to define correction values is that you have selected a file.

Access:

► "RF" > "RF Level" > "User Correction" > "Edit UCOR Data".



The editor for user correction data provides a table with RF frequency and level values and standard navigation functions.
The remote commands required to define the user correction data are described in Section 13.17.6, "SOURce:CORRection subsystem", on page 954.

All columns in a row must contain values. Cells with missing values are therefore filled automatically, using the value of the previous row.

Once you enter a value, the editor automatically adds preset values in the other columns. This functionality protects against data loss, otherwise incomplete rows are lost when saving. You can simply override these values.

Since the table and navigation functions can be assumed to be known, the following description contains a brief overview.

Settings:

Frequency (Hz)..... 412
Correction Value (dB)..... 413
User correction data handling keys..... 413
└ Select Row..... 413
└ Edit..... 413
└ Fill with Sensor..... 413
└ Save As/Save..... 413
Fill..... 413

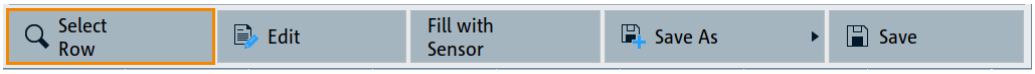
Frequency (Hz)
Sets the frequency for level correction.

Remote command:
[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency on page 956

Correction Value (dB)
Sets the level correction value for the selected frequency.

Remote command:
[:SOURce<hw>]:CORRection:CSET:DATA:POWer on page 957

User correction data handling keys
Standard functions for handling user correction data and files.



Select Row ← User correction data handling keys
Selects a row for editing.

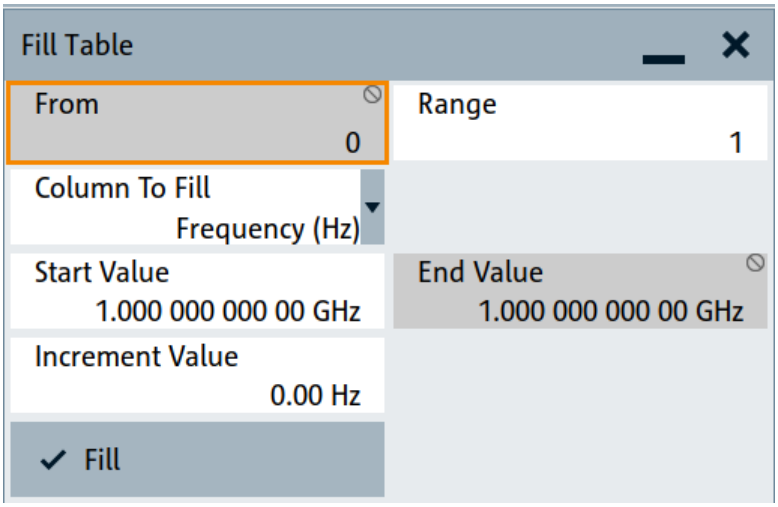
Edit ← User correction data handling keys
Enables you to insert, or delete a row or ranges within the table, and provides access to a dialog for automatic filling, see "Fill..." on page 368.

Fill with Sensor ← User correction data handling keys
Opens a dialog to configure the automatic filling of user correction data with an R&S NRP power sensor.

See Section 7.12.3.3, "Fill with sensor", on page 414

Save As/Save ← User correction data handling keys
Saves the table in a file with user-defined name and predefined file extension. To save a copy or create a file, use the "Save as" function.

Fill...
Provides parameters for filling a table automatically with user-defined values.



To fill the table, select "Fill".

Note: Once you enter a value or fill a column, the editor automatically adds preset values in the other columns. This functionality protects against data loss, otherwise incomplete rows will be lost when saving. You can simply override these values.

"From / Range"
Defines the start line and number of lines to be filled.

"Column To Fill"
Selects, if the column is filled up with frequencies in Hz, levels in dBm or dwell times in s.

"Start Value / End Value"
Sets the start value for frequency, level or dwell time. The end value is read only and depends on the increment value and the range.

"Increment Value"
Determines the step size.

"Fill" Fills the column specified in "Column To fill".

7.12.3.3 Fill with sensor

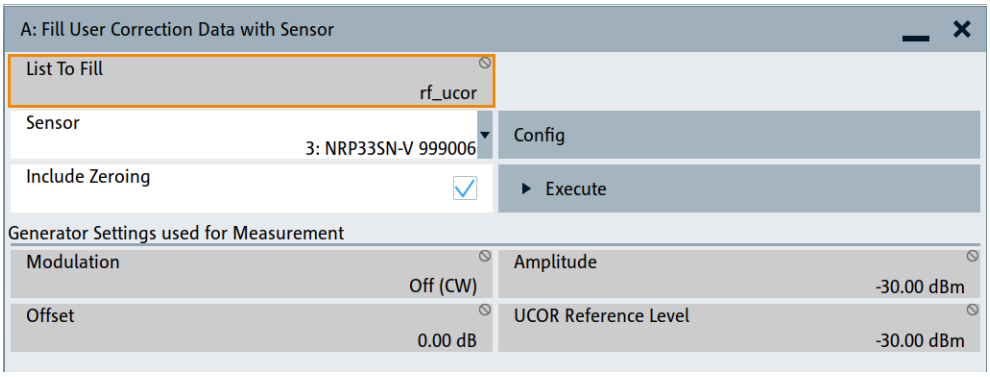
The fill with sensor function requires that you have connected a power sensor and also selected a file for user correction data before.

See:

- Section 7.12.4, "Using power sensors", on page 418
- "To create user correction data with an R&S NRP and the R&S SMM100A" on page 436

Access:

1. Select "RF" > "RF Level" > "User Correction".
2. Select "User Cor. Data > navigate to the file *.ucor > Select".
3. Select "Edit User Cor. Data > Fill With Sensor...".



This dialog contains parameters for filling a table automatically with sensor readings.

To fill the table, select "Execute".

For information on power sensors and how to use them, see Section 7.12.5, "Improving the RF signal performance", on page 435.

Settings:

Fill User Correction Data with Sensor 415
Generator Settings used for Measurement 415

Fill User Correction Data with Sensor

The "Execute" button is only enabled if a sensor is detected and the user correction list contains at least one frequency value.

"Sensor" Displays connected sensors for selection.

"List To Fill" Indicates the used list.

"Config" Opens the sensor configuration dialog to set the parameters for the selected power sensor.

"Include Zeroing"
Performs a zeroing procedure before acquiring the user correction data to improve precision.
No signal is applied to the sensor during zeroing. RF output is temporarily switched off during that time.
When unchecked, the zeroing procedure is skipped. However, the RF signal level can be blanked shortly. This setting is useful if blanking of RF is undesirable or the absence of power at the sensor cannot be guaranteed.

Remote command:
`[:SOURce<hw>]:CORRection:ZERoing:STATe` on page 958

"Execute" Triggers the sensor to measure and to return the data for user correction.
The "Execute" button is only enabled if a sensor is detected and the user correction list contains at least one frequency value.

Remote command:
`[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe` on page 957

Generator Settings used for Measurement

Displays the settings relevant for the measurement.

"Modulation" Indicates that modulation is off.
The R&S SMM100A disables modulation for the "Fill with sensor" process, even if you have enabled a modulation and if you have started "Fill with sensor".

"Amplitude" Displays the RF level amplitude.

Remote command:
`[:SOURce<hw>]:POWer:POWer` on page 1033

"Offset" Displays the RF level offset.

Remote command:
`[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet`
on page 1038

"UCOR Reference Level"
Displays the reference level for user correction.
This level is the sum of the RF level amplitude and RF level offset.

Remote command:
`[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:REFLevel`
on page 1039

7.12.3.4 Import/export list files

Access:

1. Select one of the following:
   - "RF" > "Sweep / List" > "List mode".
   - "RF" > "RF Level" > "User Correction".
2. Select "Import/Export".

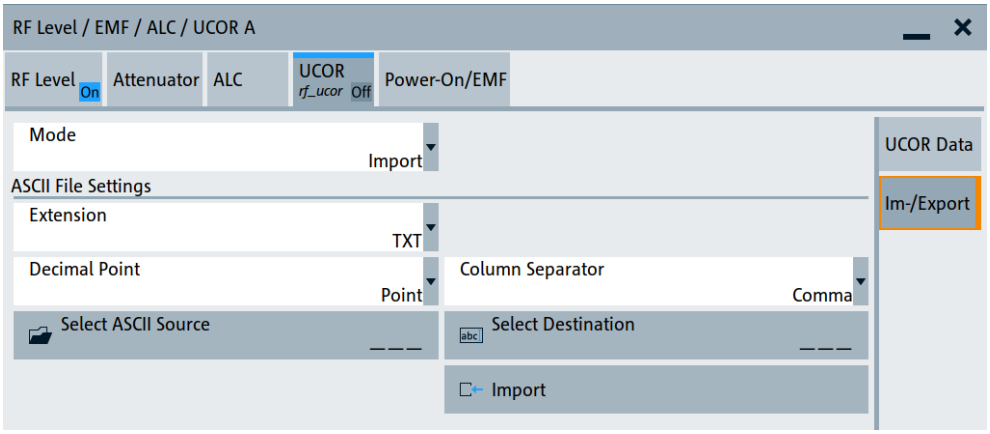


Figure 7-20: Im-/Export dialog (example with UCOR settings)

The "Import/Export" dialog contains all functions and settings to import externally created list data or to export it accordingly. You can process and store a list in the formats `*.txt` (ASCII), or `*.csv` (plain text with identical sequence of fields). The table separators and the decimal floating point numbers are customizable.

Settings:

Mode....417
ASCII File Settings....417
Select (ASCII) Source/Select (ASCII) Destination....417
Select Source/Select ASCII Destination....417
Import / Export....418

Mode
Selects import or export of a data list file. The provided parameters vary according to the selected mode.

Remote command:
[:SOURce<hw>]:LIST:DEXChange:MODE on page 1016
[:SOURce<hw>]:CORRection:DEXChange:MODE on page 961

ASCII File Settings
Defines the format and the separators of the associated data file.

"Extension" Selects *.csv or *.txt format.

"Decimal Point" Sets "Point" (dot) or "Comma" as the decimal separator used in the ASCII data with floating-point numerals.

"Column Separator"
Sets the separator between the columns in an ASCII table. Available are: "Tab", "Semicolon", "Comma" or "Space".

Remote command:
[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension on page 1015
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal on page 1016
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn on page 1016
[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension on page 960
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal on page 960
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn on page 960

Select (ASCII) Source/Select (ASCII) Destination
In "Mode > Import", access the file select dialog that provides standard file handling functions.

Where:
- "Select ASCII Source": defines the file to be loaded (imported)
- "Select ASCII Destination": selects the filename under that the loaded file is saved

Remote command:
[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog? on page 1015
[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect on page 1016
[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog? on page 959
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect on page 960

Select Source/Select ASCII Destination
In "Mode > Export", access the file select dialog that provides standard file handling functions.

Where:
- "Select Source": selects the file to be exported
- "Select ASCII Destination": defines the filename and the file path for the exported file

Remote command:
[:SOURce<hw>]:LIST:DEXChange:SELect on page 1017
[:SOURce<hw>]:CORRection:DEXChange:SELect on page 961

Import / Export
Imports or exports the selected data list file, depending on the current mode.

Remote command:
[:SOURce<hw>]:LIST:DEXChange:EXECute on page 1016
[:SOURce<hw>]:CORRection:DEXChange:EXECute on page 961

7.12.4 Using power sensors

The R&S SMM100A works with any of the R&S NRP power sensors and thus supports various application tasks. Using power sensors, you can for example determine attenuation characteristics of downstream equipment or cables. You can use the measured values to compensate the losses with internal control functions or with an external control circuit in real time.

For information on the various possibilities of interoperability between Rohde & Schwarz power sensors and Rohde & Schwarz signal generators, see the application note 1GP141.

R&S NRP power sensors are highly accurate standalone measuring devices, suitable for a wide range of applications. The power sensors communicate directly with the signal generator, calculate the average or peak power internally, include S-parameter correction and return the measurement results to the generator.

The R&S SMM100A supports up to four power sensors, allowing up to four power measurements simultaneously.

Check the firmware version of the R&S NRP sensors regularly. Update the firmware, if necessary.

For updates, see the Rohde & Schwarz website www.rohde-schwarz.com in section "Power Meters & Voltmeters".

For more information on working with power sensors, see the following topics:

- Section 7.12.4.1, "Connecting R&S NRP power sensors to the R&S SMM100A", on page 419
  Overview on the supported connectors, connection options and the required accessories.
- Section 7.12.4.2, "NRP power viewer", on page 420
  A function for measuring and monitoring the RF output power or a user-defined signal source.
- Section 7.12.4.3, "NRP power control", on page 423
  Controls a downstream closed loop power control circuit, to compensate frequency response characteristics.
- Section 7.12.4.4, "NRP sensor configuration", on page 427
  Parameter settings of the specific R&S NRP power sensor.

- Section 7.12.4.5, "NRP sensor mapping", on page 432
  Shows all R&S NRP sensors connected to the instrument, or in the LAN.

7.12.4.1 Connecting R&S NRP power sensors to the R&S SMM100A

R&S NRP sensors are connected to the R&S SMM100A in the following ways:

- Connection to the Sensor connector
  - R&S NRP-ZK6 (six-pole interface cable) for R&S NRPxx power sensors
  - No additional cable for R&S NRP-Zxx power sensors (cable is fixed on the sensor)
- Connection to the USB connector

  Requires the following cables, depending on the used sensor type:
  - R&S NRP-ZKU (USB interface cable) for R&S NRPxx power sensors
  - R&S NRP-Z3 or R&S NRP-Z4 (USB adapter cables) for sensors of the R&S NRP-Zxx family
- Connection via R&S NRP-Z5 sensor hub
  The R&S NRP-Z5 USB sensor hub (high-speed USB 2.0) can host up to 4 R&S NRP sensors.

  Requires additional cables, depending on the used output connector of the hub. Choose one of the following:
  - Short extension cable R&S NRP-Z2 for connection to the sensor connector. This six-pole connection provides the external trigger capability.
  - Standard USB cable (USB type A to USB type B) to any USB type A connector of the R&S SMM100A. This connection does not support external triggering.
- Connection via USB hub with external power supply unit

  Requires the following cables, depending on the used sensor type:
  - R&S NRP-ZKU (USB interface cable) for R&S NRPxx power sensors
  - R&S NRP-Z3 or R&S NRP-Z4 (USB adapter cables) for sensors of the R&S NRP-Zxx family
- Connection via LAN for R&S NRPxxxSN/xxxTN/xxxAN power sensors
  Using the Ethernet interface requires PoE (Power over Ethernet) to provide the electrical power.

  To establish the connection, you can use:
  - A PoE Ethernet switch, e.g. R&S NRP-ZAP1 and an RJ-45 Ethernet cable.
  - A PoE injector and an RJ-45 Ethernet cable.

For details, see the description R&S®NRP Power Sensors getting started.

Detection and mapping

The R&S SMM100A either detects a R&S NRP power sensor automatically or you can scan for available power sensors manually. The "NRP Sensor Mapping" dialog lists all detected R&S NRP power sensors, see Section 7.12.4.5, "NRP sensor mapping", on page 432. The dialog enables you to add, remove and map the sensors manually.

Depending on the connection interface, the R&S SMM100A detects and maps connected R&S NRP power sensors differently:

- Sensor socket
  Detects a sensor automatically and maps it with index "1" by default.
  If no sensor is connected to this socket, index "1" remains unassigned.
- USB interface
  Detects a sensor automatically and maps it with index "2" to index "4" according to the sequence of connection.
- LAN interface
  To detect sensors that are connected in the LAN, the instrument provides a scan function. When you start the function, scan searches in the LAN for available R&S NRP power sensors and adds all detected sensors to list. Assigning a mapping index activates the sensor for the measurement.

On connection, the R&S SMM100A immediately starts the measurement of the R&S NRP power sensor. If you preset the instrument ([Preset] key or `*RST`), the R&S SMM100A stops the measurement. The connection and the mapping of the power sensors remain.

7.12.4.2 NRP power viewer

The R&S SMM100A features the power viewer function for measuring or monitoring signals with R&S NRP power sensors.

About

The R&S SMM100A can perform up to four power measurements simultaneously.

Depending on the signal characteristic (CW, AM, pulsed, etc.) or the parameter to be measured (average, peak, etc.) a suitable R&S power sensor must be used.

About the measuring principle, averaging filter, filter length, and achieving stable results

A sensor measures the average or peak RF power of the source continuously. The measurement results are displayed in the "NRP Power Viewer" dialog.

The power viewer function uses **averaging filters** for getting a stable readout.

Measurement results could be interfered, for instance, by too much noise in your setup, by a bad suppression of harmonics or non-harmonics or when you reach the sensitivity level of your power sensor.

Measurements are continuously repeated in a predefined time window. The measurement result is obtained by averaging the measured values for the last 2N time windows. This approach is referred as a **two-step averaging process**.

The factor of 2 in the formula arises because the output signals from the microwave detector are chopped at the same rate as the time windows to suppress low-frequency noise. An independent measured value can only be obtained from two consecutive values.

The variable N in the formula indicates the **filter length**. The filter length then directly influences the measurement time. The filter length can be selected automatically or it can be manually set to a fixed value.

Follow the following general recommendation to find out the **optimum filter length**:

- Always start a measurement in auto mode ("Filter > Auto").
  Check if the measurement results are sufficient.
- If the power is not constant, select the filter length manually ("Filter > User").
  Trigger the "Auto Once" function to search for the optimum filter length for the current measurement conditions.
  The estimated value is indicated as filter length.
- If the target measurement accuracy value is known, select "Filter > Fixed Noise".
  The averaging factor is selected automatically and so that the sensor's intrinsic noise (two standard deviations) does not exceed the specified noise content.
- Depending on the R&S NRP power sensor type, the manual setting of the filter length varies in resolution.
- Different sensor types achieve the same filtering result with different filter and time window lengths.
  For most sensors, the time window length is fixed to 20 ms, whereas, e.g., for the R&S NRP-Z81 sensor, the time window length is 10 µs.

For more information, refer to the specifications document.

About zeroing

Activates the auto zero function.

Zeroing calibrates the external power sensor by adjusting its reading at zero signal power. For this purpose, the RF power source must be switched off or disconnected from the sensor. If a Rohde & Schwarz power sensor receives an input power during the zeroing process, it aborts zeroing and generates an error message. Zeroing takes a few seconds, depending on the sensor model. Refer to the documentation of your power sensor for more information.

Tips for zeroing

When to perform zeroing:

- During warm up after switching on or connecting the instrument
- After a substantial change of the ambient temperature
- After fastening the power sensor module to an RF connector at high temperature
- After several hours of operation
- When low-power signals are to be measured, e.g. less than 10 dB above the lower measurement limit.
- Switch off the RF power source for zeroing, but do not disconnect it from the power sensor. This proceeding keeps the thermal equilibrium, and the zeroing process also compensates the noise that superimposes the measured signal (e.g. from a broadband amplifier).

Related settings and functions

- Measurements-related settings, like results, filter, filter length:
  Section 7.12.4.4, "NRP sensor configuration", on page 427
- Closed loop power control of the output level:
  Section 7.12.4.3, "NRP power control", on page 423.
- Software version of the connected power sensor:
  `:SENSe<ch>[:POWer]:TYPE?` on page 778
- Assignment of the external signals and the output connectors:
  Section 11.2.4, "RF connectors settings", on page 568
- Acquisition of level correction data:
  Section 7.12.3, "User correction", on page 406.

Additional information

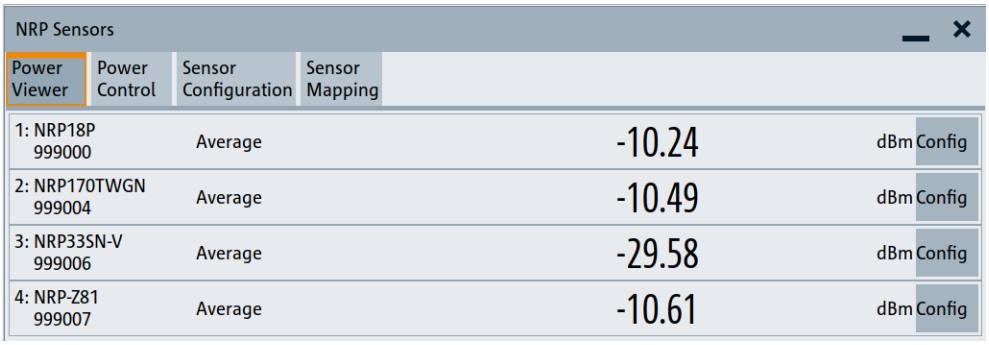
See the Rohde & Schwarz website www.rohde-schwarz.com, section "Power Meters & Voltmeters" for:

- R&S NRP power sensor manual.
- Information on the R&S NRP-Z5 sensor hub and the available accessories.
- Sensor software updates.

NRP power viewer settings

Access:

► Select "RF" > "RF Measurement" > "NRP Power Viewer".



The "Power Viewer" tab lists the mapped R&S NRP power sensors with the measured parameter mode and the current readings. The "Config" button leads you to the configuration dialog to set the parameters for each sensor.

Config.....422

Config
Opens the "Sensor Configuration" dialog.

See also Section 7.12.4.4, "NRP sensor configuration", on page 427.

7.12.4.3 NRP power control

The NRP power control function enables you to apply stable and accurate RF power to the DUT. For example, you can set up a downstream closed loop power control circuit to compensate spurious effects or losses caused by power amplifiers or cables.

Example: How to set up a closed loop power control

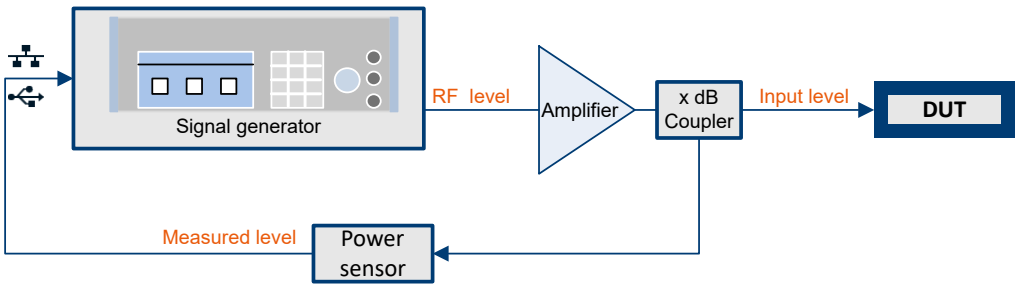


Figure 7-21: Example of a test setup with NRP power control

The signal generator applies the RF output signal to an amplifier and to the DUT. An intermediately connected coupler derivates the output power from the output signal and forwards it to the power sensor. Thus, the power sensor measures a proportional power in defined time intervals, and returns the results to the signal generator. If supported, the power sensor also includes given S-parameters. The signal generator compares the measured power with the set level value and adjusts the level of the output signal accordingly.

This closed loop power control enables you to control the external signal level continuously and reliably achieve a constant input power at the DUT in real time.

Impact of NRP power control and operating modes

Since the frequency and level of the RF output signal are continuously adjusted during "NRP Power Control", this operating mode interferes signal generation modes with varying frequency and level values. In addition, the setting time increases. The reason is the interaction between the signal generator and the R&S NRP power sensor in the control loop.

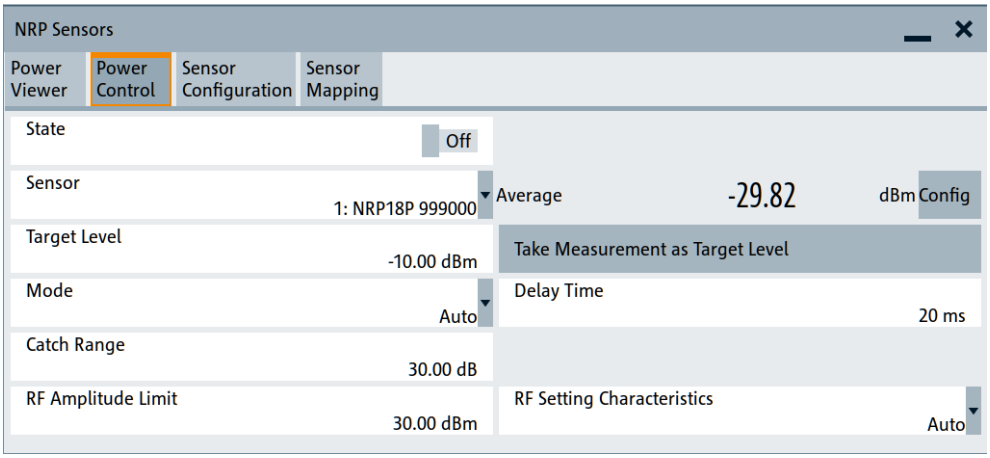
The operating modes impact each other as follows:

- Enabling the RF frequency sweep, RF level sweep or the list mode disables a running "NRP Power Control".
- A running list or RF sweep mode blocks "NRP Power Control".
- Modulated signals can deviate from the CW signal in mean power and peak power, and thus affect the "NRP Power Control".

NRP power control settings

Access:

► Select "RF" > "RF Measurement" > "NRP Power Control".



In this dialog you can configure the parameters of the power control setup for the selected power sensor.
The remote commands required to define these settings are described in Section 13.17.18, "SOURce:POWer subsystem", on page 1022.

Settings

State....424
Sensor....424
Measured Level....425
Target Level....425
Take Measurement as Target Level....425
Mode....425
Execute Single....425
Catch Range +/-....425
Delay Time....426
Limit....426
Setting Characteristics....426

State
Enables power control with the selected sensor.

The control loop periodically adjusts the generator output. After switching off, the running loop is completed.

Note: If you want to use another sensor, you must disable power control before. It is not possible to switch between sensors when power control is active.

Remote command:
`[:SOURce<hw>]:POWer:SPC:STATe` on page 1036

Sensor
Indicates the R&S NRP power sensor that is selected for power control.

To configure the power sensor parameters, see Section 7.12.4.4, "NRP sensor configuration", on page 427.

Remote command:
`[:SOURce<hw>]:POWer:SPC:SELect` on page 1035

Measured Level
Indicates the current reading of the selected power sensor.

Remote command:
:READ<ch>[:POWer]? on page 770
:SENSe<ch>:UNIT[:POWer] on page 771

Target Level
Specifies the nominal level expected at the input of the sensor. The signal generator adjusts the output power accordingly, to meet the target value at the sensor input, and thus the power required at the DUT.

Remote command:
[:SOURce<hw>]:POWer:SPC:TARGet on page 1036

Take Measurement as Target Level
Uses the currently measured level as reference and applies the value as target level, see "Target Level" on page 425.

This feature simplifies setting up the control loop after manual adjustment of the measurement configuration. To assign the measured level as reference level, you must switch off "NRP Power Control". It is not possible when the control loop is running.

Remote command:
[:SOURce<hw>]:POWer:SPC:MEASure on page 1035

Mode
Selects the measurement mode for acquiring the power values measured by the sensor.

"Auto"	Immediately starts and measures the power continuously.
"Single"	Starts when you manually select Execute Single, and executes one power measurement cycle. Note, that you can achieve the expected target power level at the DUT only with linear test setups. Non-linear test setups, for example, setups including an amplifier do not work.

Remote command:
[:SOURce<hw>]:POWer:SPC:MODE on page 1035

Execute Single
In mode "Single", starts one measurement cycle manually.

Remote command:
[:SOURce<hw>]:POWer:SPC:SINGle on page 1036

Catch Range +/-
Sets the capture range of the control system.

Within the range:

Target Level +/- Catch Range

the power control locks and tries to achieve the target level. Readings outside the range are not considered.

Remote command:
[:SOURce<hw>]:POWer:SPC:CRANge on page 1034

Delay Time
Sets a waiting period between the level adjustment of the generator and the next measurement of the power sensor.

With this parameter, you can bypass idle times in the controlled system.

Remote command:
[:SOURce<hw>]:POWer:SPC:DELay on page 1034

Limit
Sets an upper limit for the output power.

Note: The parameter "RF level" > **"Limit"** and "NRP power control" > **"RF Amplitude Limit"** are identical.

You can use this value to protect your DUT from damage due to high input power. If you enter an RF level above this value, the instrument limits the output power to this specified value, and generates the warning message:

"Pep value greater than the defined limit." However, the level indication in the status bar is not affected.

The setting is not affected by an instrument preset ([Preset] key or *RST) and the "Save/Recall" function. It is reset only by factory preset.

Remote command:
[:SOURce<hw>]:POWer:LIMit[:AMPLitude] on page 1031

Setting Characteristics
Selects additional quality characteristics to optimize the behavior of the RF signal level for the specific application.

"Auto" Sets the RF output level automatically according to the selected mode.
In this mode, the instrument provides the highest dynamic range and fastest setting times.
The RF signal is shortly blanked when the step attenuator is switching.

For more information, refer to the specifications document.

"Uninterrupted"
Suppresses blanking at level transitions. Frequency transitions can lead to an RF level blanking due to hardware-specific switching points.
This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

Note:
Do not enable both the I/Q optimization mode "High Quality" and the RF signal level optimization mode "Uninterrupted" or "Strictly Monotone". The high-quality I/Q optimization mode leads to an RF signal interruption which blocks the RF signal level optimization.

"Strictly Monotone"
Executes signal level changes monotonically increasing or decreasing.
The setting makes sure that increasing the level value exclusively results in an increased output level, and vice versa.
All electronic switches, which can affect the monotonicity are fixed.
The operation mode is useful for applications using level searching algorithms which rely on a strictly monotonous behavior.

"Constant-VSWR"
Suppresses output impedance variations at the RF output connector, due to changed level settings.

"Continuous-Phase"
Suppresses phase discontinuities.
This mode reduces the dynamic range of the instrument and the step attenuator is fixed (equates to "Strictly Monotone").

"Constant-Phase"
This mode keeps the phase constant by coupling the digital attenuation directly to the level setting.

Note: The coupling is only active when the I/Q modulator is in operation.

Pressing Readjust adds the value of the digital attenuation to the level setting, and sets the Digital Attenuation = 0. In total, the level value remains constant.

"User"
Selects this entry automatically when you change one of the following parameters from the default setting:
- "Attenuator" > Mode
- "ALC" > State, Detector Sensitivity or Driver Amplifier

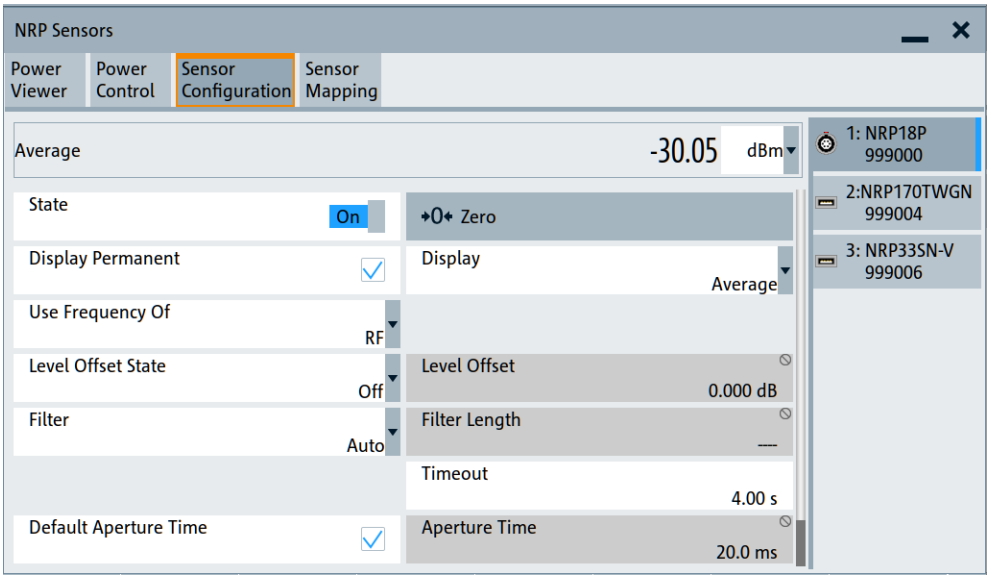
Note: If you select another setting characteristic, the R&S SMM100A presets the modified attenuator and ALC parameters.

Remote command:
`[:SOURce<hw>]:POWer:LBEHaviour` on page 1031

7.12.4.4 NRP sensor configuration

Access:

► Select "RF" > "RF Measurement" > "NRP Sensor Configuration".



In this dialog you can configure the parameters for each mapped R&S NRP power sensor in separate tabs.

The remote commands required to define these settings are described in Section 13.15, "SENSe, READ, INITiate and SLISt subsystems", on page 764, including the triggering of the measurement and the retrieval of measurement results.

Settings:

Sensor type and serial number 428
Level (Peak) / Level (Average) 429
State 429
Zero 429
Display 429
Display Permanent 429
Use Frequency Of 429
Frequency 430
Level Offset State,Level Offset 430
Filter 430
Filter Length 431
Auto Once 431
Noise/Signal Ratio 431
Timeout 431
Default Aperture Time 431
Aperture Time 431
S-Parameter 432
Enable Logging 432

Sensor type and serial number
The side tab label indicates type and serial number of an R&S NRP power sensor and its mapping index.

The Level (Peak) / Level (Average) values display the current readings of the sensor.

Remote command:
:SENSe<ch>[:POWer]:TYPE? on page 778
:SENSe<ch>[:POWer]:SNUMber? on page 777

Level (Peak) / Level (Average)
Indicates the measured peak or average level value.

You can also change the unit for the results display: Watt, dBm or dBµV.

Note: Peak level measurements are provided if the power sensor supports this feature.

Remote command:
:READ<ch>[:POWer]? on page 770
:SENSe<ch>:UNIT[:POWer] on page 771

State
Enables level measurement of the R&S NRP power sensor.

Remote command:
:INITiate<hw>[:POWer]:CONTinuous on page 770
To query the availability of a sensor at a given connector, use the command :SENSe<ch>[:POWer]:STATus[:DEVice]? on page 777.

Zero
Activates the auto zeroing.

For details, see "About zeroing" on page 421.

Remote command:
:SENSe<ch>[:POWer]:ZERO on page 778

Display
Sets the display of results on mean or peak power.

Remote command:
:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority on page 772

Display Permanent
Enables the display of the power sensor with the currently measured value in the task bar.

The task bar label shows the measurement result, the channel, the sensor is mapped to and its serial number. Optionally, "(Offset,Peak)" appear when you have set these parameters.

You can activate the permanent display for several sensors.

Remote command:
:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe on page 773

Use Frequency Of
Selects the source for measurement.

"RF" The R&S SMM100A transfers the RF frequency and level settings to the R&S power sensor automatically. Thus you achieve power readings of high accuracy, irrespective from the connected sensor type.

"User" Sets a user defined frequency.

Example:

If you have a frequency converting device between the generator and the DUT. If the frequency converter doubles the frequency, you can set twice the frequency in the R&S SMM100A. The R&S power sensor considers this RF frequency setting.

Set the parameter Frequency to the measurement's frequency.

Remote command:
`:SENSe<ch>[:POWer]:SOURce` on page 777

Frequency
Defines the frequency value if "Source > User" is used.

Remote command:
`:SENSe<ch>[:POWer]:FREQuency` on page 775

Level Offset State,Level Offset
Activates and defines a level offset which is considered in the power measurement result. The level offset value is always expressed in dB, irrespective of the display of the measurement result.

This function allows you to consider, for example, an attenuator in the signal path.

Remote command:
`:SENSe<ch>[:POWer]:OFFSet` on page 776
`:SENSe<ch>[:POWer]:OFFSet:STATe` on page 776

Filter
Selects the way the length of the used filter is defined.

See also "About the measuring principle, averaging filter, filter length, and achieving stable results" on page 420.

"Auto" Selects the filter length automatically and adjusts it to the measured value. The value is indicated with the parameter Filter Length.
When high output power is applied, the filter length and therefore the measurement time can be short.
When low output power is applied, the filter length and therefore the measurement time is increased which reduces the considered noise content in your measurement.

"User" The filter length is defined manually, with the parameter Filter Length.
As the filter length works as a multiplier for the time window, constant filter length results in a constant measurement time.
Values 1 and 2N are allowed.

"Fixed Noise" The averaging factor is taken automatically in accordance to the value Noise/Signal Ratio. Thus, the sensor's intrinsic noise (2 standard deviations) does not exceed the specified noise content.
To avoid long measurement times when the power is too low, set a Timeout.
Timeout is the maximum acceptable measurement time which limits the averaging factor and therefore leads to a more unstable readout.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:TYPE` on page 775

Filter Length
Sets or indicates the filter length, depending on the selected filter mode.
- "Filter > Auto" indicates the automatically adjusted filter length.
- "Filter > User" enables you to set the filter length manually.
- "Filter > Fixed Noise" hides the setting parameter.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO?` on page 773
`:SENSe<ch>[:POWer]:FILTer:LENGth[:USER]` on page 773

Auto Once
Searches the optimum filter length for the current measurement conditions. The result is indicated with the parameter Filter Length.

See also "About the measuring principle, averaging filter, filter length, and achieving stable results" on page 420.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:SONCe` on page 774

Noise/Signal Ratio
For Filter > Fixed Noise, sets the noise content.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:NSRatio` on page 774

Timeout
Sets a time limit for the averaging process.

The setting is bound to the timeout of the connected sensor.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe` on page 774

Default Aperture Time
The sensor default setting is sufficient. Disable this parameter to specify a user-defined aperture time per sensor, if, for example, the readings vary.

To obtain stable readings, set the Aperture Time exactly to one modulation period.

Remote command:
`:SENSe<ch>[:POWer]:APERture:DEFault:STATe` on page 771

Aperture Time
If "Use Default Aperture Time > Off", defines the acquisition time per sensor.

For example, to obtain a sufficient low average value, set the aperture time exactly to one modulation period.

Remote command:
:SENSe<ch>[:POWer]:APERture:TIMe on page 771

S-Parameter
Activates the use of the S-Parameter correction data of the connected power sensor. For sensors with attenuator, this function is automatically activated.

S-Parameter correction is used to mathematically shift the reference plane to the DUT by considering the S-parameters for any components connected upstream of the sensor.

The S-Parameter table can be changed with the S-Parameters tool, provided as part of the free R&S NRP Toolkit software. For more information, refer to the manual of the connected R&S NRP power sensor.

Remote command:
:SENSe<ch>[:POWer]:CORRection:SPDevice:STATe on page 772
:SENSe<ch>[:POWer]:CORRection:SPDevice:LIST? on page 772
:SENSe<ch>[:POWer]:CORRection:SPDevice:SELect on page 772

Enable Logging
Activates recording of R&S NRP power sensor readings in a log file.

There is 1 log file per sensor. The log files are created automatically and filled in continuously. They are text files with predefined filename `SensLog<n>.txt`, where `<n>` indicates the connected sensor. Log files are stored on the internal memory, in the directory `/var/user/SensorLogging`.

Each log file contains the measured value (2 readings when you work with peak sensors), the sensor type, and the measurement time (timestamp). Logged data is not overwritten. When a new measurement is started, the collected logging data is appended in the log file.

Check the used disc space regularly and remove log files to maintain storage capacity.

Note: The logging function is intended for measurements with long time intervals. It is suitable source for data reconstructions if the connection to the sensor was interrupted.

Remote command:
:SENSe<ch>[:POWer]:LOGGing:STATe on page 776

7.12.4.5 NRP sensor mapping

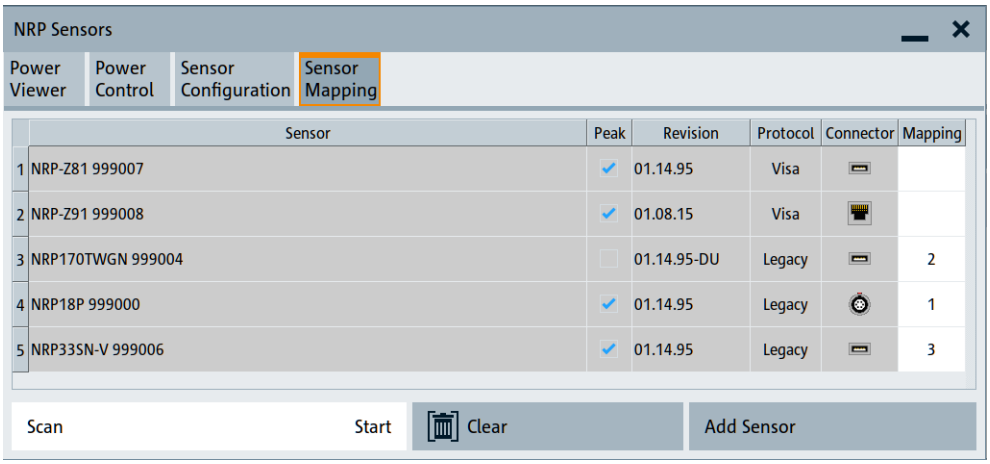
The "NRP Sensor Mapping" lists the sensors detected by the instrument.

Any R&S NRP sensor that supports the USB legacy protocol and is connected to one of the USB interfaces, is detected automatically and added to the list. When you disconnect a power sensor, the R&S SMM100A removes it from the list accordingly.

R&S NRP power sensors that are connected in the LAN or use the USBTMC protocol are only detected by the scan search function.

Access:

► Select "RF" > "RF Measurement" > "NRP Sensor Mapping".



The dialog lists all detected R&S NRP sensors for selection and mapping. You can also browse the network for sensors.
The list informs on the sensor type with serial number, specific features and the revision of the sensor firmware.
For each sensor, you find the used protocol and the connector icon of the interface.
In the "Mapping" column, you can assign a mapping index to enable the sensor for use. The list can contain several entries but the R&S SMM100A can only use up to four sensors simultaneously.
The remote commands required to define these settings are described in Section 13.15, "SENSe, READ, INITiate and SLISt subsystems", on page 764.

Settings

Sensor Mapping List 433
Scan 434
Clear 434
Add Sensor 434
Add LAN Sensor 434
Add USBTMC Sensor 435

Sensor Mapping List

Shows the sensors that are connected to the R&S SMM100A.

The table informs on the sensor type, specific features and the installed sensor firmware. It also shows the interface the sensor is connected to, including the communication protocol and the mapping index.

Remote command:
`:SLISt[:LIST]?` on page 767
`:SLISt:ELEMent<ch>:MAPPing` on page 769
`:SLISt:SENSor:MAP` on page 769

Scan
Scans the network and the USB connections for sensors connected using the VISA communication protocol, i.e. sensors that are addressed over LAN or USBTMC.

The instrument detects sensors communicating over the USB legacy protocol automatically.

Remote command:
`:SLISt:SCAN[:STATe]` on page 767

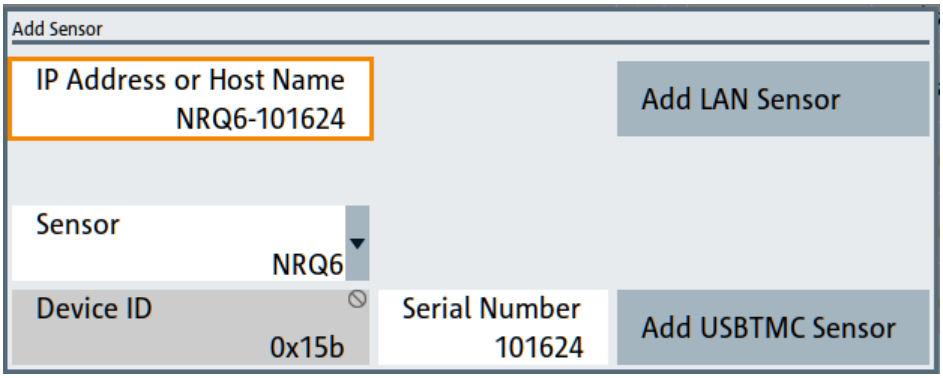
Clear
Removes all entries of R&S NRP power sensors using the VISA communication protocol (USB or LAN) from the sensor mapping list.

The setting does not affect sensors communicating over USB legacy protocol. To remove a USB legacy sensor from the list, disconnect it from the interface.

Note: With the remote control commands `:SLISt:CLEar:LAN` and `:SLISt:CLEar:USB`, you can remove the power sensors of the corresponding VISA interface selectively.

Remote command:
`:SLISt:CLEar:LAN` on page 768
`:SLISt:CLEar:USB` on page 768
`:SLISt:CLEar[:ALL]` on page 769

Add Sensor
Shows or hides the "Add Sensor" dialog to configure power sensors connected to the R&S SMM100A over USB or LAN.



Add LAN Sensor
Configures settings to add sensors connected to the R&S SMM100A over LAN.

"IP Address or Host Name"
Displays the host name or the IP address of a R&S NRP power sensor.
If the R&S SMM100A does not detect a connected R&S NRP sensor, you can assign the address information manually.

"Add LAN Sensor"
Adds a detected R&S NRP sensor connected in the LAN to the list of sensors, including its device ID or name and its serial number.

Remote command:
:SLISt:SCAN:LSENsor on page 767

Add USBTMC Sensor
Configures settings to add sensors connected to the R&S SMM100A over USB.

If the R&S SMM100A does not detect a connected R&S NRP sensor, you can assign the device ID manually.

"Sensor"
Selects the name of the R&S NRP power sensor.
If the R&S SMM100A does not contain the R&S NRP power sensor you use, select "<from Device ID". The "Device ID" entry field switches in edit mode where you can enter the ID of your product manually.

"Device ID"
Displays the device identifier of a selected R&S NRP power sensor.
If you want to assign the device ID manually, get the information in the user documentation of your power sensor.

"Serial Number"
Displays the serial number of the R&S NRP power sensor.
If the R&S SMM100A does not detect a connected R&S NRP sensor, you can assign the serial number manually.

"Add USBTMC Sensor"
Adds a detected R&S NRP sensor connected at the USB interface to the list of sensors, including its device ID or name and its serial number.

Remote command:
:SLISt:SCAN:USENsor on page 768

7.12.5 Improving the RF signal performance

To achieve an accurate input level at the DUT, you can compensate losses, e.g. caused by cables between the RF output and the DUT over a frequency range.

Using the user correction function and e.g., a R&S NRP power sensor, the R&S SMM100A utilizes the readings of the power sensor and creates a correction value table for controlling the output level during operation.

To connect the R&S NRP to the R&S SMM100A

1. Connect the power sensor.
   See Section 7.12.4.1, "Connecting R&S NRP power sensors to the R&S SMM100A", on page 419.
2. Select "RF" > "RF Measurement" > "NRP Sensor Mapping".
3. If the sensor is not detected automatically, select "Scan > Start".

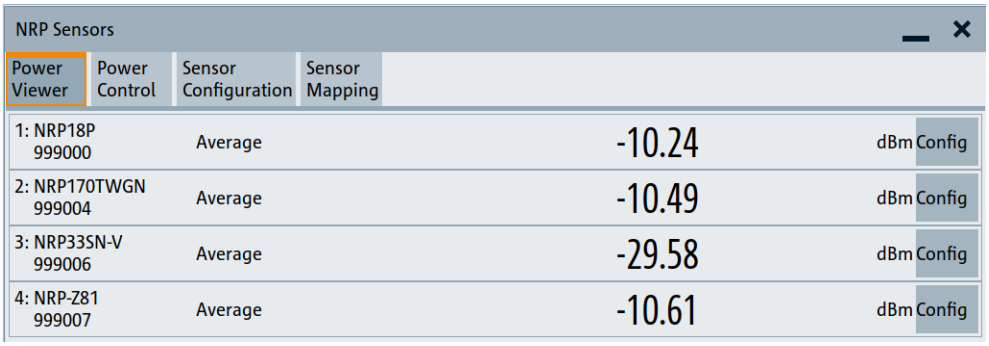
   The instrument scans the network and the USB connections for connected sensors and lists all detected R&S NRP sensors in the mapping table.

4. In the "Mapping" column, assign the sensor to a sensor channel, see Section 7.12.4.5, "NRP sensor mapping", on page 432.
5. Close the dialog.

To configure and calibrate the R&S NRP in the R&S SMM100A

Provided the power sensor is connected to the R&S SMM100A and is assigned to a sensor channel, we recommend that you calibrate and configure the power sensor.

1. In the block diagram > RF, turn off the RF output signal.
2. Select "RF" > "RF Measurement" > "NRP Power Viewer".

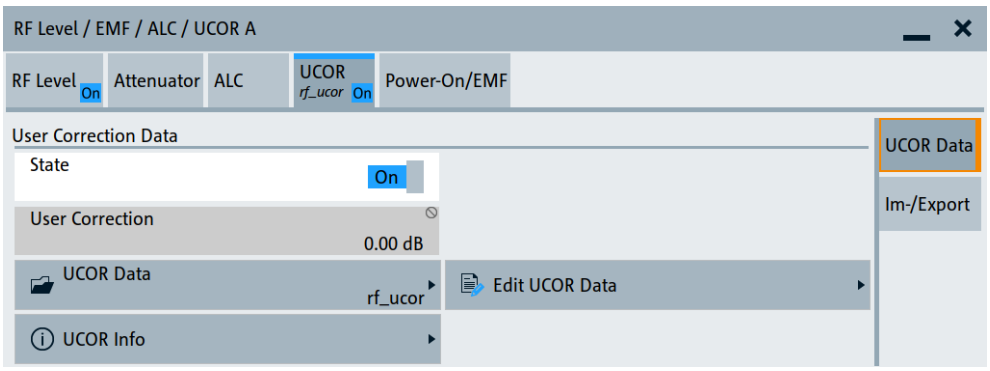


3. To configure a sensor, select "Config".
4. Select "Zero" to start zeroing of the sensor.
   Note: Always turn the RF power off or disconnect the sensor from RF before zeroing, since the function calibrates the power sensor at zero signal power.
   The zeroing process takes a few seconds, depending on the power sensor type.
5. Configure additional parameters for the selected sensor as required.
6. Select "State > On".
7. Close the dialog.

To create user correction data with an R&S NRP and the R&S SMM100A

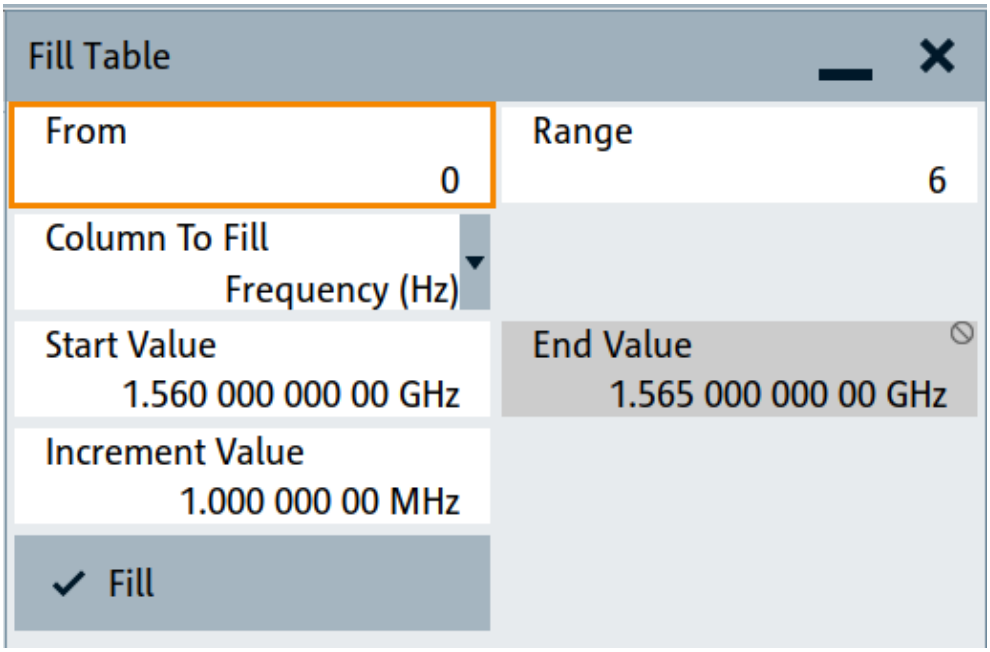
We assume, that the power sensor is connected, assigned and ready for operation.

1. Select "RF" > "RF Level" > "User Correction".



2. Select "UCOR Data" > "UCOR Data...."
3. Create a file: "New" > Filename and confirm with "OK".
4. Select the new file with "Select".
5. Select "Edit UCOR Data...".
6. Select "Edit" > "Fill".

   The "Fill Table" dialog enables you to fill in the values of the columns automatically.
7. To fill in the frequency column:

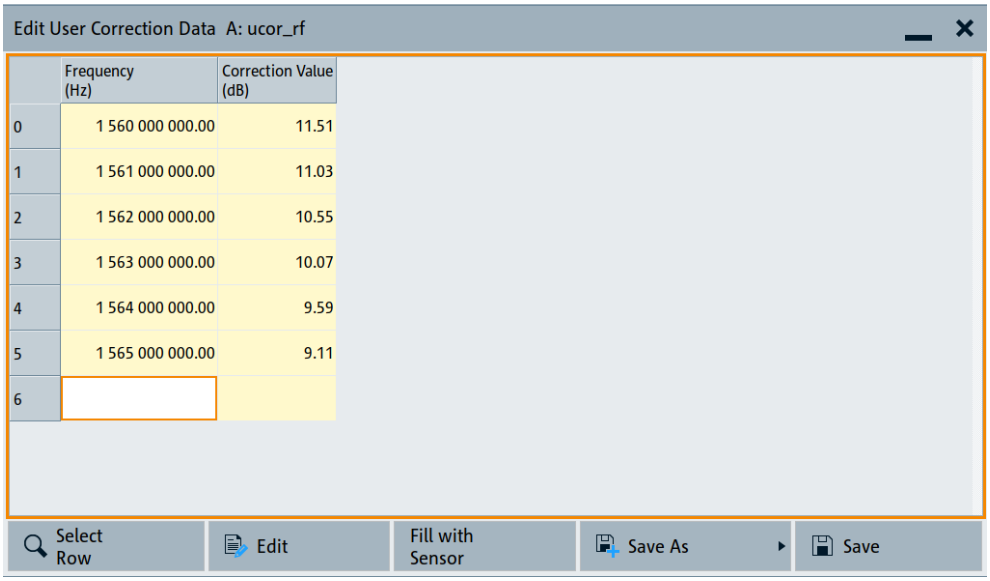


   a) Select "Select Column To Fill > Frequency / Hz".
   b) Select "Range > e.g. 15" to determine the number of values.
   c) Select "Start Value > e.g. 1.56 GHz".
   d) Select "Increment Value > e.g. 1 MHz", to determine the frequency steps.
   e) Select "Fill", to insert the frequency values.

   The "Fill" function also fills the column of the "Correction Value / dB" values with a predefined value, since empty cells lead to the data loss of the entire line. If you need different values, you can change them manually, or you can use the automatic function "Fill with Sensor" as described in the next steps.
8. Select "Fill with Sensor".

   The "Fill User Correction Data With Sensor" dialog provides an overview of the sensor configuration.
9. Select "Execute".

   The R&S SMM100A successively sets each frequency point, reads the measured power of the sensor and fills in the value in the correction table.



10. Select "Save" to save the data in the file.
11. Close the dialog.

To calibrate the power level with user correction data

We assume that a user correction file is available in the user directory of the R&S SMM100A or on a memory stick or in a shared directory.

If you have created and saved the file immediately before this step, the file is loaded in the "User Correction" dialog automatically. Otherwise you can load a previously saved file.

1. Select "RF" > "RF Level" > "User Correction".
2. Select "UCOR Data" > "UCOR Data...", if there is no file loaded already.
3. Select the directory and file you want to use.
4. Load the file with "Select".
5. To view the file content, select "Edit UCOR Data...".
6. Select "UCOR Data" > "State" > "On" to apply the user correction values.

   When you activate the RF output, the R&S SMM100A considers the user correction data and adjusts the signal level accordingly to compensate external frequency responses.

7.13 Multiplying RF output frequencies

7.13.1 About frequency multipliers

The R&S SZM multiplies the input frequency by its multiplication factor. Depending on the R&S SZM base unit, you can optionally install high output power, an attenuator or an isolator. All three options are integrated in the same housing as the frequency multiplier, which simplifies setups and the operation compared to conventional setups.

In addition, you can connect an optional external test port adapter (TPA) which is a straight waveguide and simplifies connection of the DUT. The TPA protects internal assemblies and their flange and if damaged, you can replace it.

The R&S SMM100A signal generator can communicate with an R&S SZM via USB. For the USB communication between the R&S SMM100A and the frequency multiplier R&S SZM, the R&S SMM-K554 key must be installed on the R&S SMM100A. In case a mechanically or electronically controlled attenuator is installed, the pre-calibrated frequency response values of the multiplier are read out via USB by the R&S SMM100A. Also the multiplication factor is automatically set in the R&S SMM100A and the correct incident power of +7 dBm to the R&S SZM. Therefore, the instruments are able to provide a precise R&S SZM output signal for the DUT for a specific frequency.

Installation

You can find detailed installation instructions in the delivery of the option or in the R&S SMM100A service manual.

Required options

- For operation of the R&S SZM with the R&S SMM100A via USB the R&S SMM-K554 option Multiplier Control must be installed on the R&S SMM100A.
- Depending on the frequency multiplier used and its multiplication factor, different input frequency ranges are required. The R&S SMM100A must at least cover this input frequency range.
  For details on the R&S SZM input frequency ranges, see the R&S SZM specifications document.

Control of the R&S SZM via USB

If the control connection between R&S SMM100A and R&S SZM is established, the following features are available:

- The right multiplication factor and incident power on the R&S SMM100A is automatically set in accordance to the connected R&S SZM.
- The connected R&S SZM is shown in the R&S SMM100A taskbar. If the mechanically controlled attenuator option is installed on the R&S SZM, the value of the micrometer screw for the correct R&S SZM output power is shown in the taskbar.
- Read out of the frequency response of the connected R&S SZM without internal attenuator option.

- Read out the calibration data of the R&S SZM if an internal attenuator option is installed
- You can correct cable losses of the connecting cable between the frequency multiplier and the R&S SMM100A.

Impact of operating modes and functions

The output level of the RF signal is determined by the operation mode that the instrument generates the signal and also by the level correction functions the generator provides to optimize the accuracy of the level.

Some of these functions affect the operation with an R&S SZM. To avoid impact, the generator automatically switches off the associated operating modes once an R&S SZM is connected via USB.

Interactions and special characteristics to the operating modes of the R&S SMM100A when an R&S SZM is connected:

- AM (amplitude modulation): blocked
- List mode: blocked
- Sweep mode: It is recommended that you use an R&S SZM with electronically controlled attenuator to generate an RF signal in frequency or level sweep mode. Also note the response times of the dwell time in the specifications document of the R&S SZM.

7.13.2 Operating frequency multipliers

This section provides an overview on step-by-step instructions related to connecting and configuring frequency multipliers.

It includes the following:

- Test setup....440
- Connecting a frequency multiplier....441
- Controlling the frequency multiplier....442
- Generating RF output signals....446

7.13.2.1 Test setup

The R&S SMM100A supports the following frequency multiplier types:

- R&S SZM

For details, see the specifications document of the R&S SMM100A.

OTA microwave test setup

Typically, mmWave signals are transmitted and received over-the-air (OTA) inside an RF shield box. The figure below illustrates a test setup with a frequency multiplier connected to a signal generator and an antenna that is mounted inside an RF shield box.

The signal generator provides the IF signal to the frequency multiplier. The frequency multiplier multiplies the IF signal from the signal generator and transmits the RF signal to the DUT.

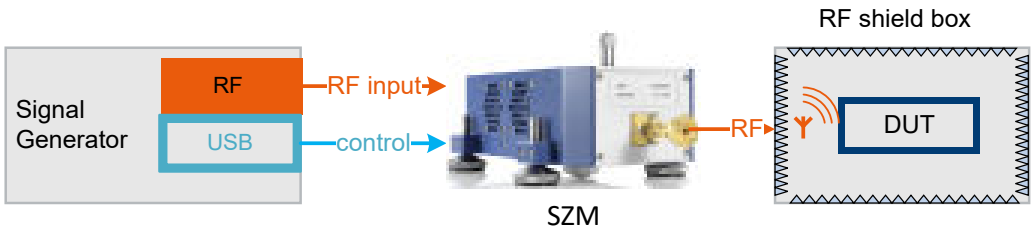


Figure 7-22: Typical setup using a frequency multiplier

Frequency multiplier connection

You can control a frequency multiplier via USB by one R&S SMM100A that exclusively controls the frequency multiplier.

The R&S SMM100A

- Reads out the frequency multiplication factor of the R&S SZM
- Reads out the serial number of the R&S SZM
- Sets the R&S SZM incident power on the R&S SMM100A RF output

7.13.2.2 Connecting a frequency multiplier

This section provides step-by-step descriptions for connecting a frequency multiplier. Connecting procedures for relevant connector types are described for the R&S SZM as an example.

To connect an R&S SZM

The following procedure describes how to connect the R&S SMM100A to an R&S SZM using the "RF" connector as IF signal output. The R&S SZM and R&S SMM100A are connected to power and switched on.

1. Use all cables delivered with the R&S SZM. Other connections can require additional cables.
   For the control connection, use the high-quality USB cable provided with the delivery.
   For the IF connection, we recommend using a coaxial cable with K connectors, 50 Ω, length 1.0 m. The cable is available under order number 1348.3850.00 (see recommended extras in the R&S SZM specifications document).
   See "Cable selection to minimize electromagnetic interference" on page 28.
2. **NOTICE!** Risk of SMA connector damage and cable damage. Excessive tightening can damage the connecting cable, the SMA connectors and components inside the R&S SMM100A.
   Connect the "RF" connector of the R&S SMM100A with the "RF In" connector of the R&S SZM.

See also Section 3.1.9, "Connecting to RF coaxial connectors", on page 30.

3. Connect the "USB" connector with the "USB" connector of the R&S SZM.

   Table 7-8 and Figure 7-23 provide an overview on connections and a test setup.

Table 7-8: Signals and connections

Signal	R&S SMM100A	R&S SZM
Control	USB connector	"USB"
RF	"RF 50Ω"	"RF In"

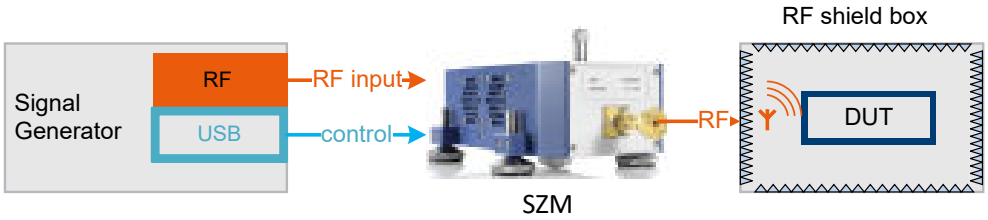


Figure 7-23: Test setup with R&S SMM100A, R&S SZM and RF shield box

Signal generator = R&S SMM100A

7.13.2.3 Controlling the frequency multiplier

This section provides step-by-step descriptions for controlling, updating and operating a frequency multiplier with the R&S SMM100A. For controlling the frequency multiplier R&S SZM via USB, the R&S SMM-K554 key must be installed on the R&S SMM100A.

The descriptions cover the following topics:

- "To configure the R&S SMM100A" on page 442
- "To configure for R&S SZM with no attenuator option installed" on page 444
- "To configure for R&S SZM with electronically attenuator option installed" on page 444
- "To configure for R&S SZM with mechanically attenuator option installed" on page 445

To configure the R&S SMM100A

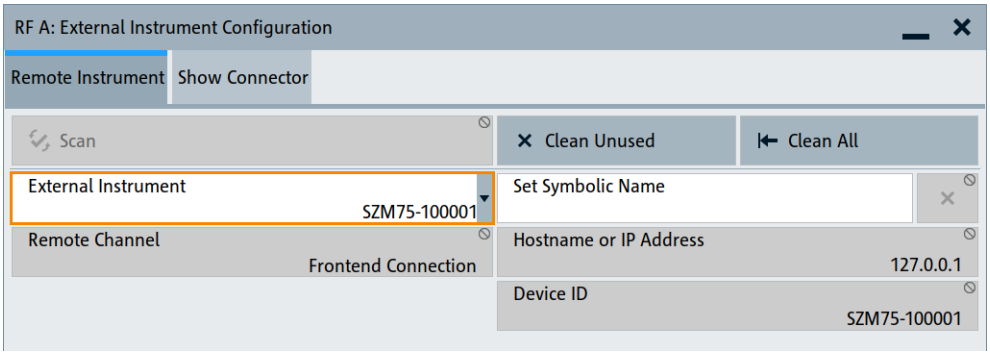
The following procedure describes how to configure the R&S SMM100A to establish a control connection between R&S SMM100A and a frequency multiplier.

The R&S SMM100A is connected to the R&S SZM, see "To connect an R&S SZM" on page 441.

1. In the taskbar, select "System Config" > "System Configuration" > "External RF and I/Q".
2. Select "RF" > "External Instrument" > "Config".

   The "Remote Instrument" dialog opens.

3. Select the R&S SZM from the "External Instrument" list.



4. Select "Apply and Connect".

   A message displays if the remote connection to the external frontend is successfully established.

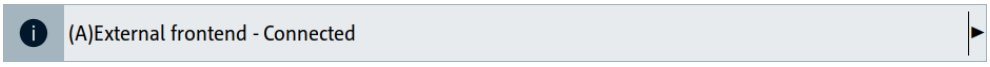


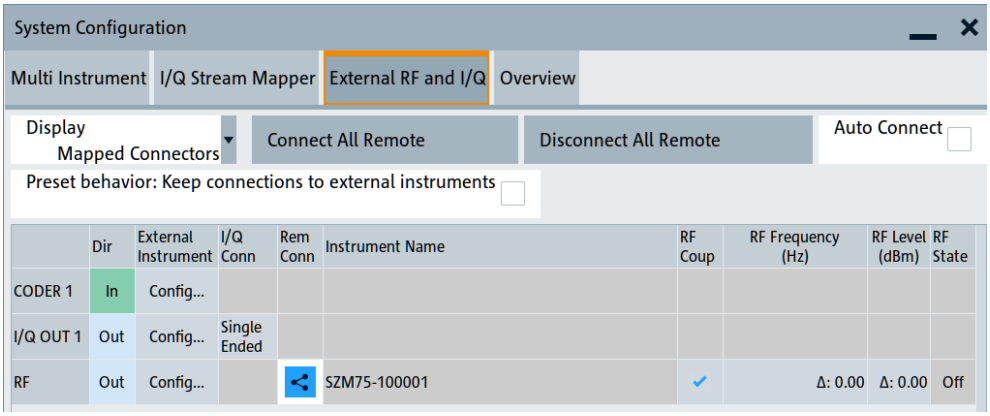
Figure 7-24: Message displaying an established remote connection

5. Configure the connection mode between R&S SZM frequency multiplier and R&S SMM100A:

   a) Click "Frontend Configuration".

   b) Check the "Settings".
   See "General settings" on page 449.
   c) Check the "Versions/Options".
   See "Versions and options information" on page 449.
   d) If necessary, activate "Cable Correction".
   See "Cable correction settings" on page 451.

6. In the "System Config" > "System Configuration" > "External RF and I/Q" dialog, check the control connection state.



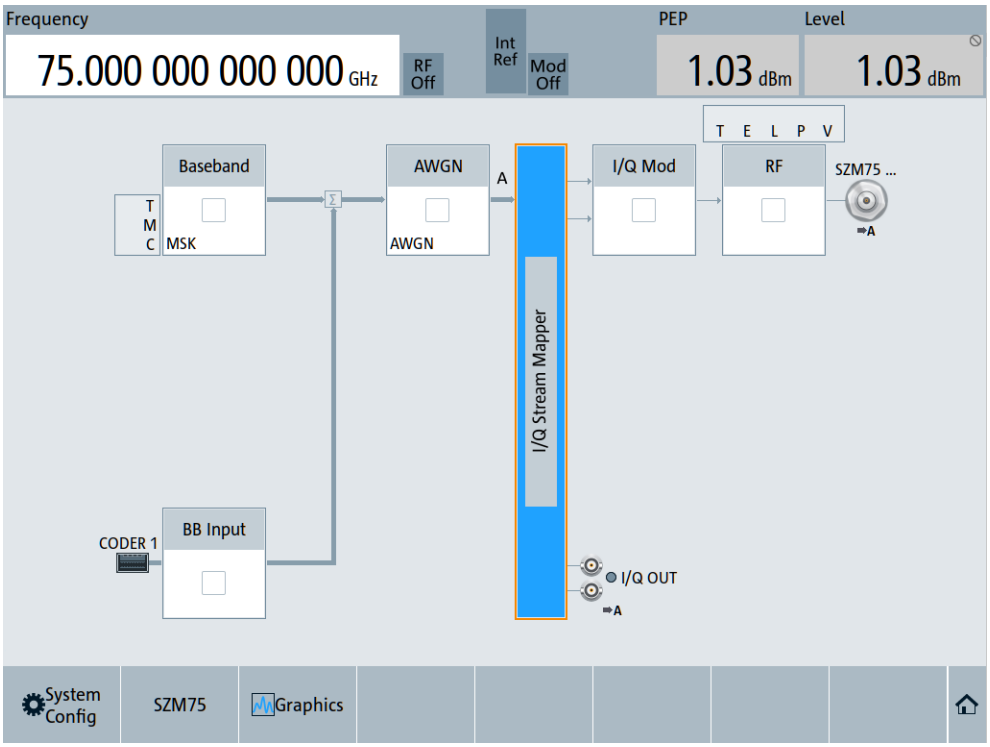
The "RF" > "Rem Conn" field displays an active control connection:

7. Optionally, specify connection characteristics:
   a) Select "Auto Connect" > "On".
      If you select this setting, you do not need to execute steps 1 to 6 each time you reconnect the R&S SZM to the R&S SMM100A via USB.
   b) Select "Preset behavior: Keep connections to external instruments" > "On".

To configure for R&S SZM with no attenuator option installed

When using a base instrument without the attenuator option R&S SZM-BxxE or R&S SZM-BxxM installed:

1. Enter the "Frequency" value in the "Frequency" field in the status bar.



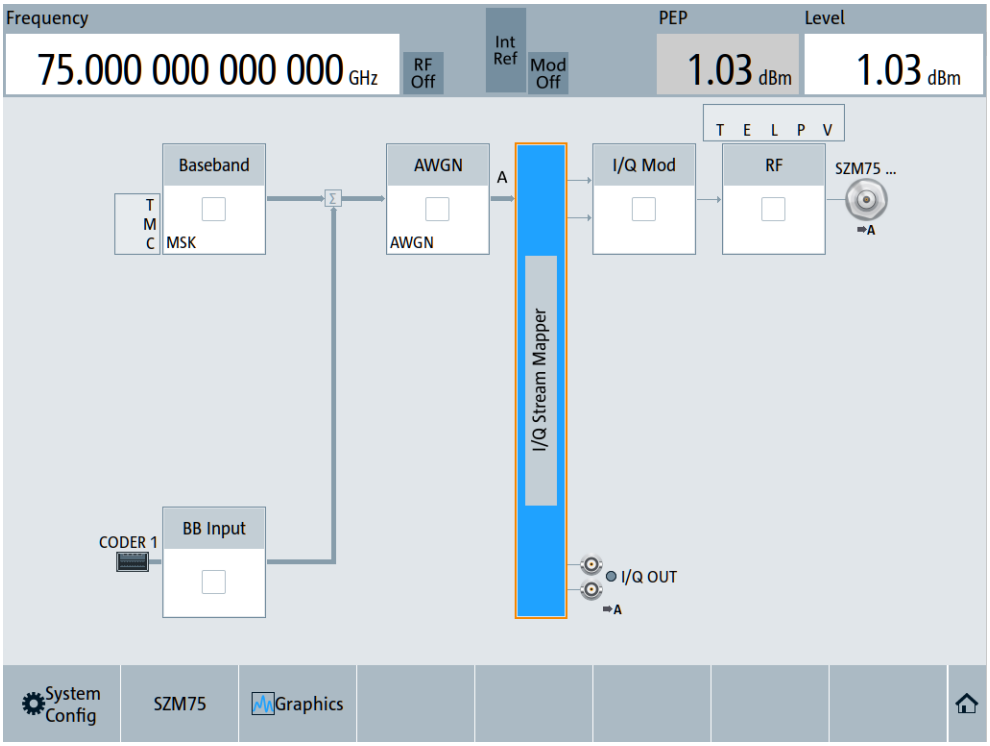
Note: The "Level" field is grayed out and shows the output power of the R&S SZM. The R&S SMM100A reads out this number from a calibration table internally stored on the R&S SZM.

2. Select "RF" > "On".

To configure for R&S SZM with electronically attenuator option installed

When using a base instrument with the attenuator option R&S SZM-BxxE installed:

1. Enter the "Frequency" value in the "Frequency" field in the status bar.
2. Enter the "Level" value in the "Level" field in the status bar.

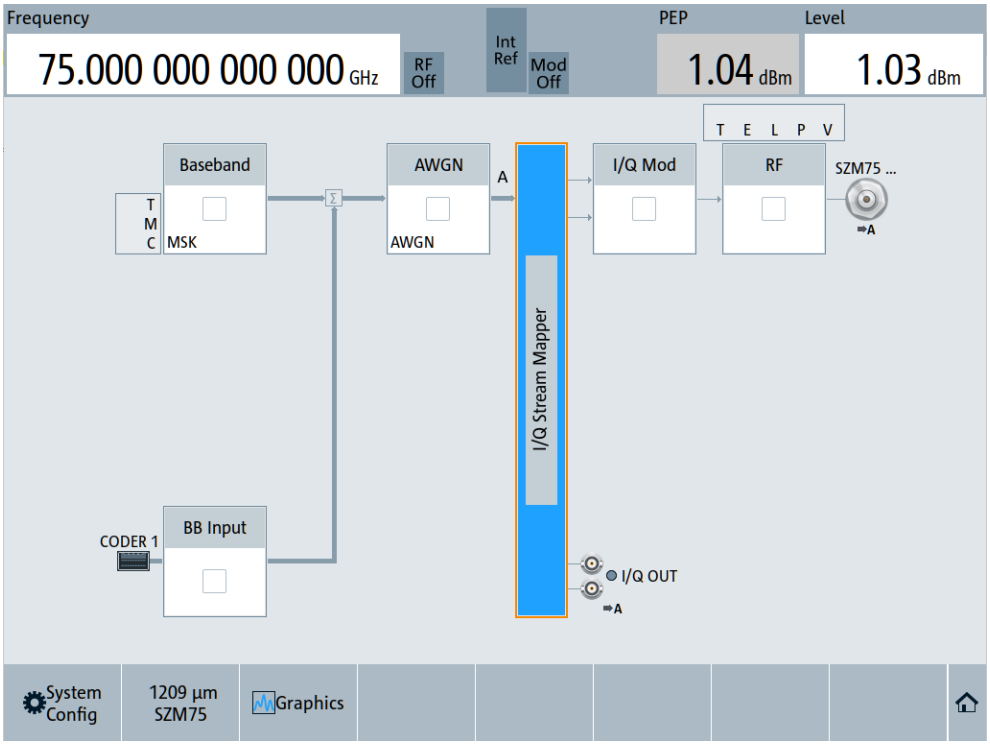


3. Select "RF" > "On".

To configure for R&S SZM with mechanically attenuator option installed

When using a base instrument with the attenuator option R&S SZM-BxxM installed:

1. Enter the "Frequency" value in the "Frequency" field in the status bar.
2. Enter the "Level" value in the "Level" field in the status bar.
3. Set the micrometer screw to the value displayed in the taskbar.
   After setting the micrometer screw to the displayed value, the previously set level and the corresponding frequency is output at the R&S SZM.



Note: Position 0 µm is equivalent with maximum attenuation that means minimum signal level according to the set frequency.

4. Select "RF" > "On".

7.13.2.4 Generating RF output signals

To multiply the RF output signal frequency

This manual operation is only necessary if there is no USB connection between R&S SMM100A and R&S SZM.

To multiply the input frequency by individual factor due to the frequency range:

1. Select "RF" > "RF Frequency".
2. Select "Frequency".
3. Enter the "Multiplier" value.

To output the external frontend RF signal

The procedure assumes, that a remote control connection between R&S SMM100A and R&S SZM is established.

See "To configure the R&S SMM100A" on page 442.

► Activate the RF output.

See "To activate the RF output" on page 309

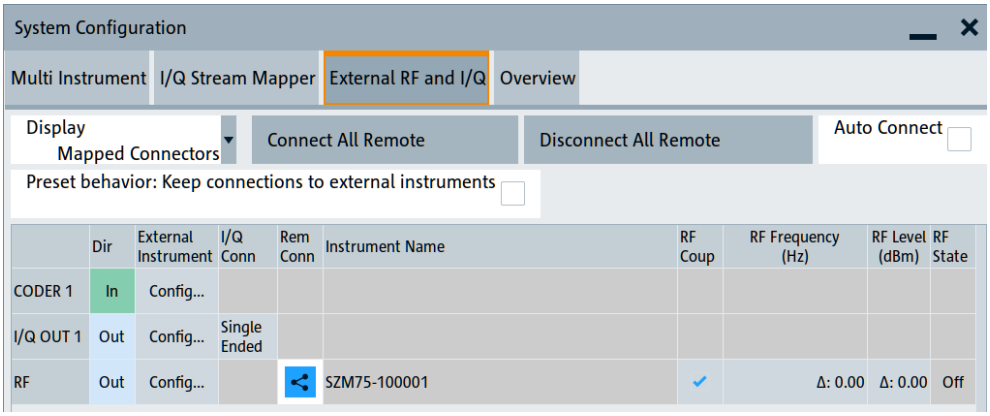
7.13.3 Frequency multiplier configuration and settings

- External RF and IQ settings....447
- Remote instrument settings....448
- RF frontend settings....448

7.13.3.1 External RF and IQ settings

Access:

► On the taskbar, select "System Config" > "System Configuration" > "External RF and I/Q".

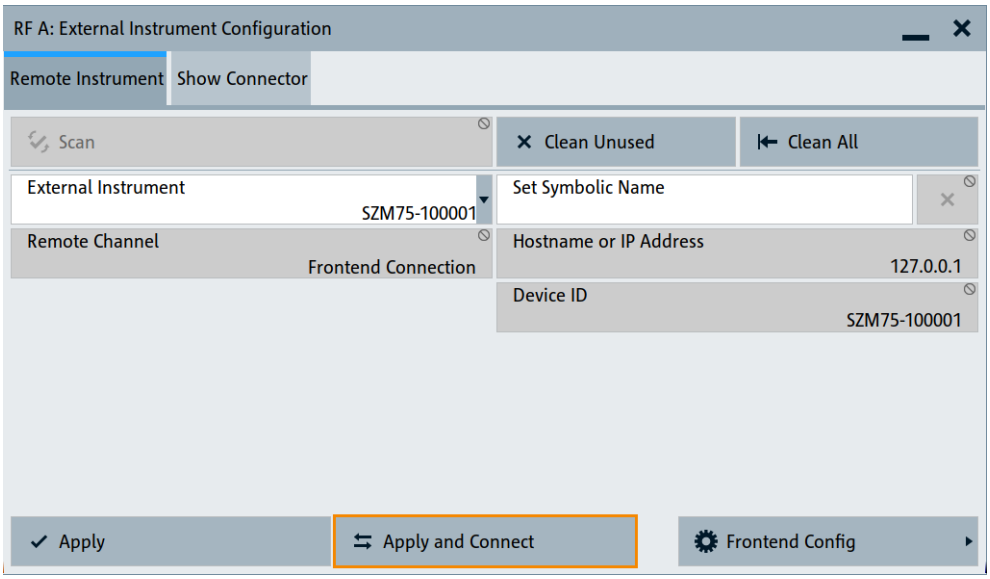


For parameter description see Section 9.5.2, "External RF and I/Q settings", on page 492.

7.13.3.2 Remote instrument settings

Access:

► Select the "System Configuration" tile > "System Configuration" > "External Instrument" > "Config".



The "Remote Instrument" tab provides settings to connect the frequency multiplier. For parameter description see Section 9.5.3.1, "Remote instrument settings", on page 498.

7.13.3.3 RF frontend settings

Access:

► In the block diagram, open the RF frontend settings dialog in one of the following ways:
- Select "RF" > "RF Frontend" > "Frontend Device".
- Click the "SZM..." icon to the right of the "RF" block.

The "RF Frontend" dialog provides tabs for settings and information about the external instrument.

The remote commands required to define the settings are described in Section 13.17.7, "SOURce:EFRontend subsystem", on page 967.

To operate a frequency multilpier with the R&S SMM100A

See Section 7.13.2, "Operating frequency multipliers", on page 440.

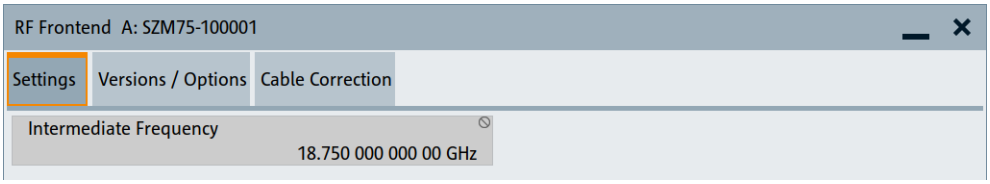
Settings:

- General settings....449
- Versions and options information....449
- Cable correction settings....451

General settings

Access:

1. Select "RF" > "RF Frontend" > "Frontend Device".
2. Select "Settings".



The "Settings" tab provides information about the intermediate frequency for the connected frequency multiplier, e.g., R&S SZM.

Intermediate Frequency
Displays the frequency of the IF signal that is the frequency at the RF connector.

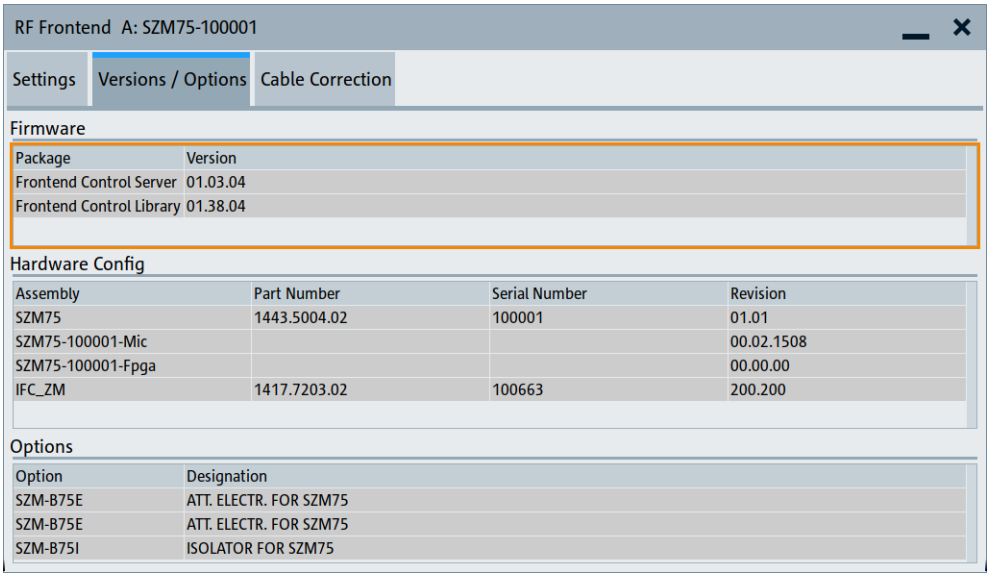
Remote command:
`[:SOURce<hw>]:EFRontend[:FREQuency]:IFRequency[:VALue]?`
on page 970

Versions and options information

Access:

1. Select "RF" > "RF Frontend" > "Frontend Device".

2. Select "Version / Options".



The "Versions / Options" tab displays information on the firmware and hardware of the connected external frontend.

Settings:

Firmware 450
Hardware Config 450
Options 451

Firmware
Displays firmware information on the control server and control library of the external frontend. The information is displayed in a table and consists of installed packages and versions.

"Package" Comprises the frontend control server and frontend control library.

"Version" Denotes the version of the installed package.

Remote command:
n.a.

Hardware Config
Displays hardware information of the hardware components of the external frontend. The information is displayed in a table and consists of component name, its part number and serial number, and revision version.

"Assembly" Displays the assembly part name for hardware component.

"Part Number" Displays the part number for each hardware component.

"Serial Number"
Displays the serial number for each hardware component.

"Revision" Displays the revision version for each hardware component.

Remote command:
[:SOURce<hw>]:EFRontend:IDN? on page 971

Options
Displays the frontend options installed on the frequency multiplier.

"Option" Displays the name of the frontend option.

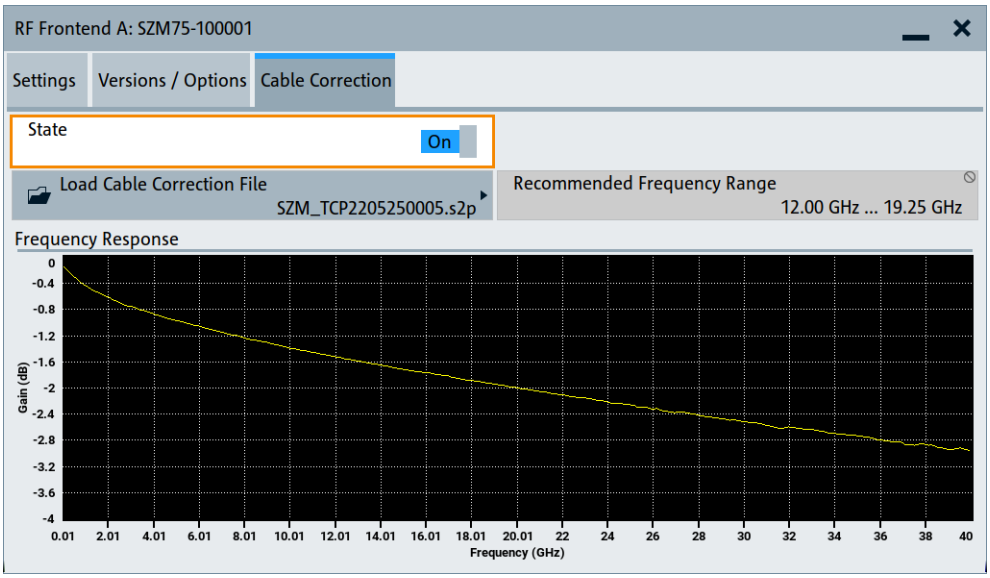
"Designation" Displays a short description of the frontend option.

Remote command:
[:SOURce<hw>]:EFRontend:OPT? on page 971

Cable correction settings

Access:

1. Select "RF" > "RF Frontend" > "Frontend Device".
2. Select "Cable Correction".



The "Cable Correction" tab provides settings necessary to configure the frequency response correction of the IF signal path.

You can load correction data to compensate for signal losses in the cable occurring at different IF signal frequencies. Files containing correction data have the extension `*.s2p` or `*.uco`. The following descriptions are exemplary with `*.s2p` files. Working with `*.uco` files is analogous.

Settings:

State....452
Load Cable Correction File....452
Recommended Frequency Range....453

State
Activates correction of the IF signal for different IF signal frequencies.

Activation requires loading of a valid cable correction file, see "Load Cable Correction File" on page 452.

Remote command:
[:SOURce<hw>]:EFRontend:ALIGnment[:STATe] on page 972

Load Cable Correction File
Accesses a standard file-select dialog to load correction data to compensate for signal losses in the cable occurring at different IF signal frequencies.

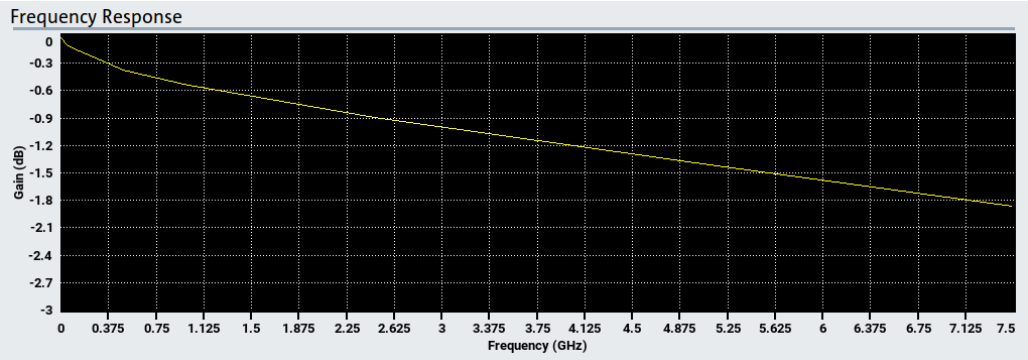
If a correction file is loaded, the button also displays the filename.

You can load predefined cable correction files from frontend-specific folders. The predefined cable correction files stored on the R&S SMM100A contain correction data for the recommended standard R&S IF cable, using the S-parameter S21.

Example: Displaying file correction data

The example for the `*.s2p` file below comprises correction data for frequencies from 0 GHz to 7.5 GHz.

```
# HZ S DB R 50.00
! Date: 2020-06-12;11:48:28
! freq[Hz] db:S11 ang:S11 db:S21 ang:S21 db:S12 ang:S12 db:S22 ang:S22
100000.0 0.001 0 -0.018267469344920073 0 -0.018267469344920073 0 0.001 0
50000000.0 0.001 0 -0.10438567392872056 0 -0.10438567392872056 0 0.001 0
100000000.0 0.001 0 -0.1402532552881901 0 -0.1402532552881901 0 0.001 0
500000000.0 0.001 0 -0.37850173705964973 0 -0.37850173705964973 0 0.001 0
1000000000.0 0.001 0 -0.5387899823157998 0 -0.5387899823157998 0 0.001 0
2500000000.0 0.001 0 -0.8994010660064706 0 -0.8994010660064706 0 0.001 0
5000000000.0 0.001 0 -1.3888357992535698 0 -1.3888357992535698 0 0.001 0
7500000000.0 0.001 0 -1.8624967962088599 0 -1.8624967962088599 0 0.001 0
```



Remote command:
[:SOURce<hw>]:EFRontend:ALIGnment:FILE:CATalog? on page 971
[:SOURce<hw>]:EFRontend:ALIGnment:FILE[:SELect] on page 972

Recommended Frequency Range
Displays the recommended frequency range of the IF signal that the external frontend requires.

We recommend that you cover this range in the cable correction file. See Example "Displaying file correction data" on page 452.

Remote command:
`[:SOURce<hw>]:EFRontend:ALIGnment:FILE:FREQuency:RANGe:LOWer?`
on page 971
`[:SOURce<hw>]:EFRontend:ALIGnment:FILE:FREQuency:RANGe:UPPer?`
on page 971

8 Monitoring baseband signal characteristics

Instead of analyzing the baseband signal characteristics with an external instrument, the R&S SMM100A can also visualize a subset of these signal characteristics with the built-in graphical signal display function. Also, this function evaluates signal measurement quantities and displays signal characteristics graphically in real-time.

8.1 Required options

The minimum equipment layout for using this function includes the base unit.

8.2 About the graphical signal display

To ease the setting and routing of baseband signals, R&S SMM100A is able to capture these signals and display them graphically in different ways: as I/Q, vector, eye or constellation diagram, as power spectrum or as statistical evaluations.

In the digital domain, the measurements are based on recorded I/Q samples. The sources of these samples are selectable points (acquisition points) in the signal flow. You can configure and display the signal characteristics simultaneously in up to dia-
grams.

8.2.1 Available diagrams

This section focuses on graphical signal displays, their content and application. See Table 8-1 for an overview of the signal characteristics that you can monitor.

Table 8-1: Graphics modes overview

Graphics modes	Domain	Measurement instrument
I/Q diagram	Time	Oscilloscope (standard mode)
Vector diagram	Time	Oscilloscope (XY mode)
Constellation diagram	Time	Oscilloscope (XY mode)
Eye diagram	Time	Oscilloscope (triggered to symbol clock and showing repetitive traces)
CCDF display	Statistical representation of peaks	Peak power analyzer
Power spectrum	Frequency	Spectrum analyzer

8.2.1.1 I/Q diagram

The I/Q diagram displays the in-phase component (i[t]) and quadrature component (q[t]) of the I/Q signal over time.

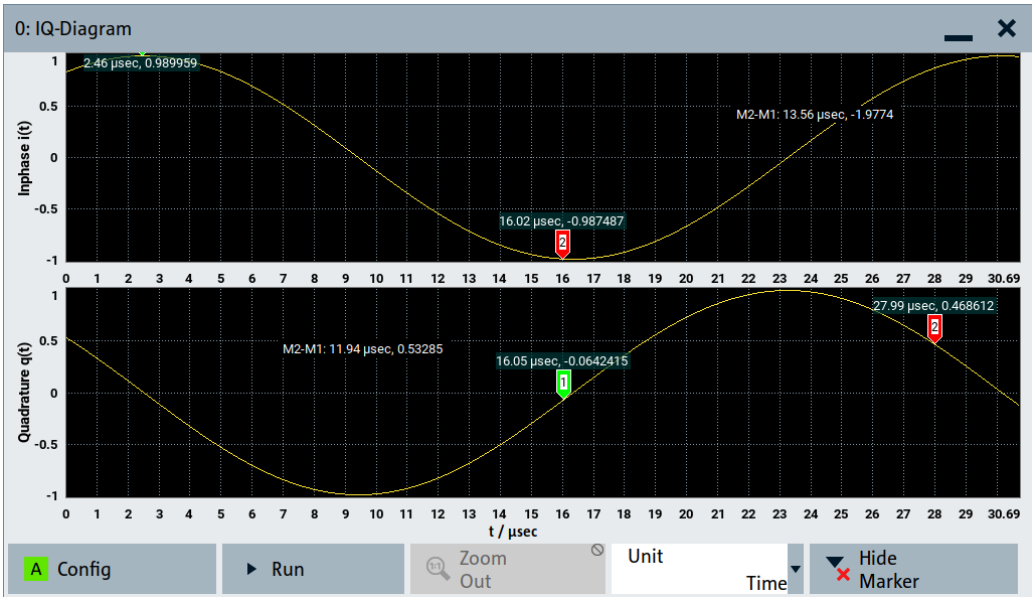


Figure 8-1: I/Q diagram with markers

= window with two separate coordinate systems with identical x-axis and y-axis
x-axis = time in units number of symbols, chips, samples or seconds depending on the signal
y-axis = amplitude, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

Application: To analyze impairments, added noise and signals (e.g. from external baseband input) in the time domain. This mode shows the signal like an oscilloscope.

Signal acquisition points: See Table 8-2.

8.2.1.2 Vector diagram

The vector diagram displays the Q component over the I component. All points in the complex domain are connected by lines.

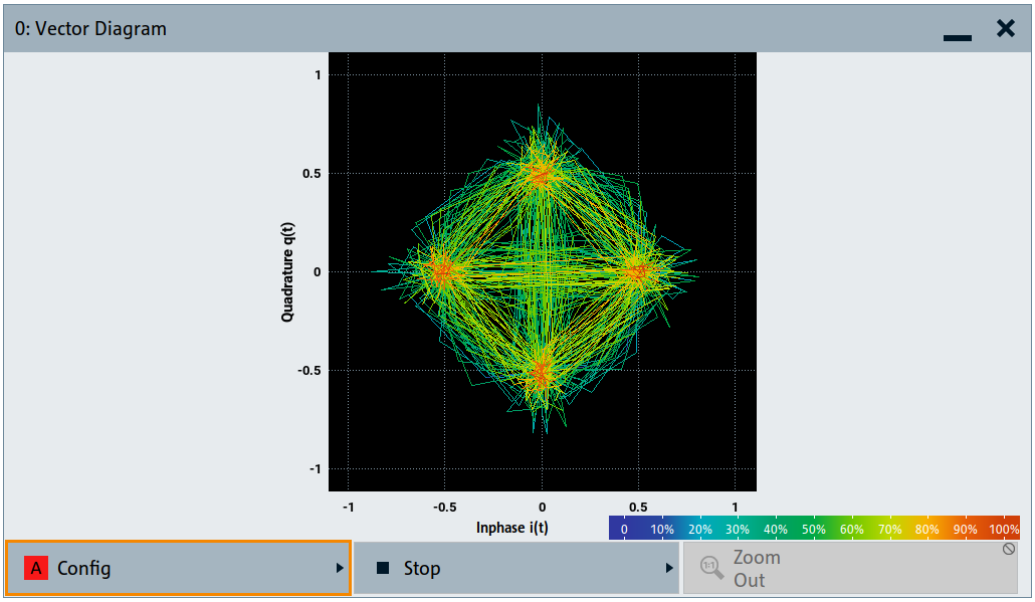


Figure 8-2: Vector diagram (QPSK 45° offset)

x-axis = In phase component I(t) of the signal is scaled to the peak envelope power, range -1 to 1
y-axis = Quadrature phase component Q(t) of the signal scaled to the peak envelope power, range -1 to 1

Application: To analyze the transition between the various states of modulation mapping, especially with linear modulations like MSK, QPSK or QAM. This mode shows the signal like an oscilloscope (X/Y-mode).

Signal acquisition points: See Table 8-2.

8.2.1.3 Constellation diagram

Constellation diagrams display the modulation symbols as discrete points in the I/Q plane. Unlike the vector diagram, the constellation diagram displays only one sample per symbol. This sample represents the symbol.

Constellation diagrams are helpful when generating signals using the "Custom Digital Modulation" settings. Compare the displayed constellation diagram with the diagram displayed in the "Modulation" tab of the "Custom Digital Modulation" dialog.

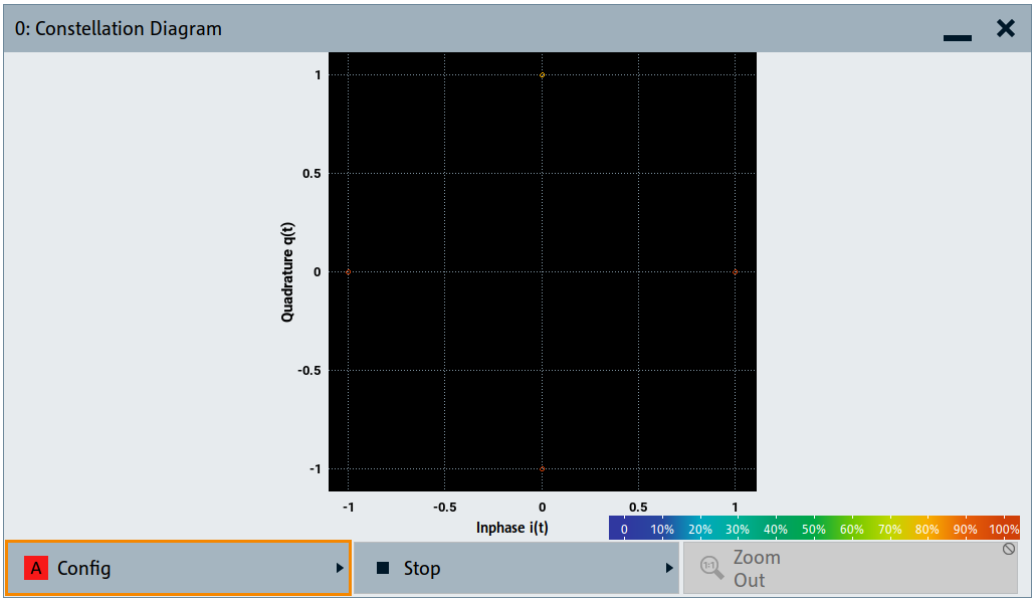


Figure 8-3: Constellation diagram (QPSK 45° offset)

x-axis = In phase component I(t) of the signal is scaled to the peak envelope power, range -1 to 1
y-axis = Quadrature phase component Q(t) of the signal scaled to the peak envelope power, range -1 to 1

Application: To classify modulation.

Signal acquisition points: See Table 8-2.

8.2.1.4 Eye diagram

The eye diagram displays synchronized and superimposed sections of either the in-phase or the quadrature components of the signal.

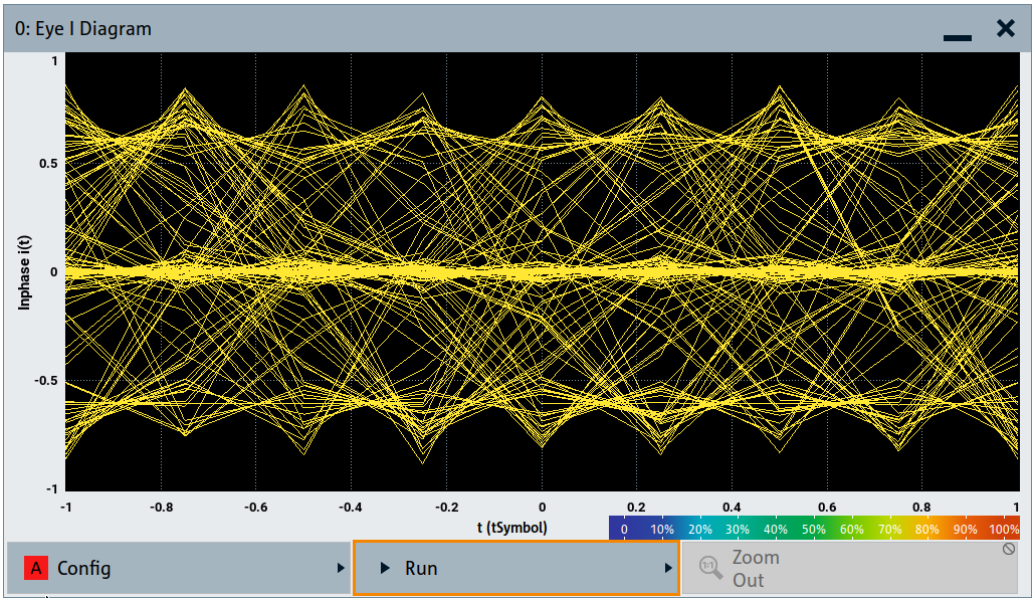


Figure 8-4: Eye diagram with partially closed eye (QPSK 45° offset)

x-axis = time in the range of -/+ 1 symbol
y-axis = amplitude, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

The display width is normalized for 2 symbols. It uses one-symbol eye opening in the center of the display and 1/2-symbols to the left and right of the center eye for capturing time transitions. Several hundred curve segments are superimposed. The beginning of the recording is synchronous to the symbol and chip clock pulse.

Application: To analyze amplitude and time distortion elements (e.g. jitter) at high-speed digital data systems. A high quality, unimpaired signal shows a clearly open eye (horizontally and vertically).

Signal acquisition points: See Table 8-2.

8.2.1.5 CCDF display

The complementary cumulative distribution function (CCDF) displays the probability with which the output signal exceeds the average power.

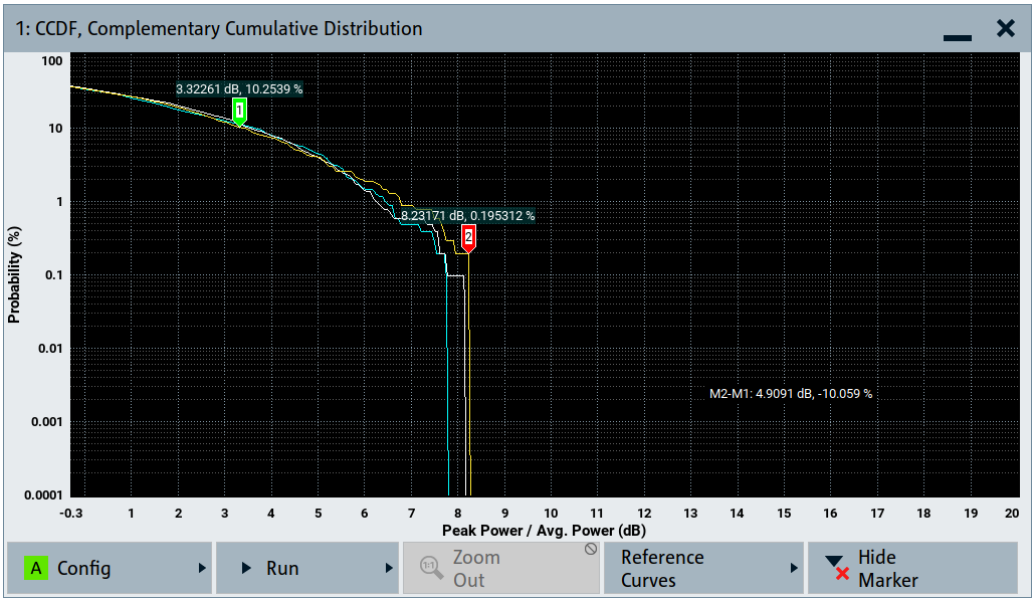


Figure 8-5: CCDF diagram of a 5 MHz LTE signal (Level -30 dBm) and two reference curves

x-axis = Level over the average signal power, where the average power (RMS) corresponds to the origin
y-axis = Probability of exceeding the average power that is the percentage of time the signal spends at or above the power level specified by the X-axis
Marker 1 = Interpolation: About 10.3 % of the samples exceed 3.3 dB above average; 1% of the samples exceed 7.5 dB above average (not shown with a marker)
Marker 2 = The point where the trace crosses the x-axis; indicates the highest peak that is found in the sample block and is 9.6 dB higher than average.

The CCDF diagram is calculated over 8 ksample and corresponds to a signal with the following characteristics:

- "Baseband" > "LTE" and "Test Model" > "E-TM1_1__5 MHz"
- In the status bar, set "Level" = "-30 dBm" and "PEP" = "-18.43 dBm"
  The difference between the level and the PEP results in the peak to average ratio. If the measurement is long enough, the displayed highest peak corresponds to the calculated crest factor.
  The PEP value does not indicate how often the peak level is reached. The CCDF shows the probability for reaching a dedicated instantaneous power.

Signal acquisition points: See Table 8-2.

8.2.1.6 Power spectrum

The power spectrum displays the signal spectrum which is calculated from the I/Q signal with fast Fourier transform (FFT). The power density over frequency is displayed.

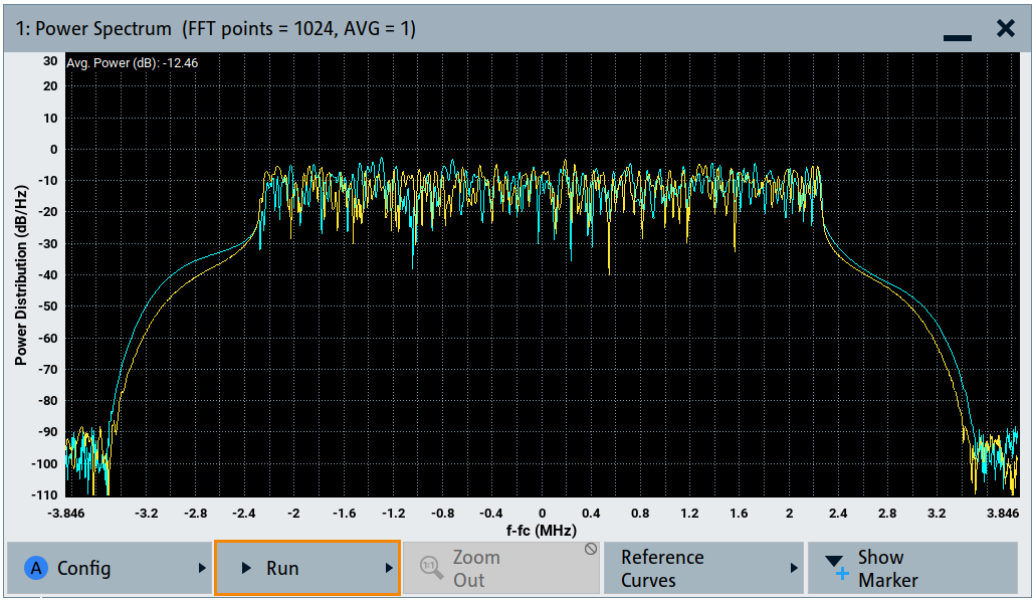


Figure 8-6: Power spectrum diagram of a 5 MHz LTE signal with enabled reference curve (blue)

"FFT points" = indicates the number of I/Q value pairs that are used for calculating a (part-)FFT
"AVG" = indicates the number of subspectra used for averaging
x-axis = frequency plotted symmetrically (- Sampling Rate/2 to +Sampling Rate/2)
y-axis = power density

Signal acquisition points: See Table 8-2.

8.2.2 Signal acquisition points

Signal characteristics can be displayed using different methods and different acquisition points, also at the same time. Table 8-2 shows which signal acquisition point is suitable for which kind of graphics mode. Also, it provides associated graphics sources and the designation of the access points in the block diagram.

Table 8-2: Signal acquisition points, modes and sources

Signal acquisition points	Graphics modes	Graphics source	Designation
Baseband signals	Constellation diagram, eye diagram	"Baseband" "BB Input"	A A*
Input streams	I/Q diagram, vector diagram, CCDF diagram, power spectrum diagram	"Stream"	A
Analog outputs	I/Q diagram, vector diagram, CCDF diagram, power spectrum diagram	"IQ Out" "RF"	1 A
Digital output streams	I/Q diagram, vector diagram, CCDF diagram, power spectrum diagram	"IQ Digital"	1

Figure 8-7 shows an example for locations of signal acquisition points.

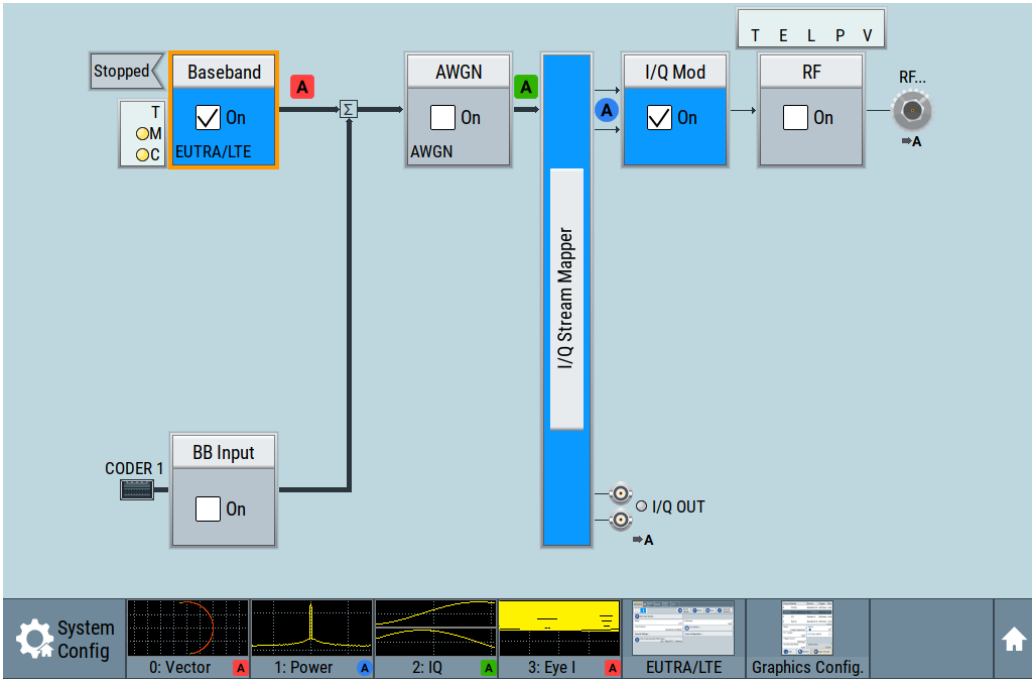


Figure 8-7: Block diagram with graphical signal display and signal acquisition points

8.2.3 Display functions

The graphical display provides general display functions known from other measurement instruments and offers zoom and markers.

Zooming

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.

Zooming is merely a visual tool, it does not change the number of samples used for the calculation. You can increase the number of samples before zooming.

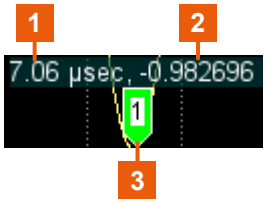
See also "To zoom into a diagram" on page 472.

Using markers

Markers are tools for numerical readout of measured data in diagrams. They help you analyze the displayed signal characteristics by determining particular values in the diagram.

Often you can use markers to measure the frequency distance of two peaks or to measure the power decrease of an oscillator at a given frequency offset, dBc value. Note that markers in the diagram are not related to the markers in the digital standards.

In the graphical display, the markers and their values (for example time or frequency) are displayed as usual.

Single marker indication	Delta marker indication
 • 1 = marker position on the x-axis in the current units • 2 = marker value on the y-axis • 3 = marker number	 • 1 = delta marker • 2 = result of the marker function, i.e. the delta values in the current units

See also "To enable markers to read-out measured data" on page 472.

Persistence and color maps

In addition to the standard representation, the vector, the constellation, and the power spectrum diagrams use a color map.

The color encodes the relative amplitude (in percent) of the probability distribution of the data points in the diagram. A detailed breakdown of the colors is below diagrams the colors are relevant for. Data points in areas with high probability are marked in red, data points in areas with low probability in blue. Thus, for example, you can observe not only the "level versus frequency" trace but also a third dimension, the probability of the power level.

Reference trace

Reference traces help you analyze a displayed characteristic, as do the markers. Reference traces are used to define amplitude curves or spectral distribution boundaries in the result diagram which are not to be exceeded. They indicate, for example, the upper power limits which are allowed from a device under test (DUT).

The R&S SMM100A supports up to five reference traces. You can load reference traces and activate them simultaneously.

8.3 Graphics configuration settings

This section focuses on the graphics configuration dialog, which determines the number and kind of the graphical signal displays.

Access:

1. Select the sine wave icon.

   The "Graphics Configuration" dialog opens.

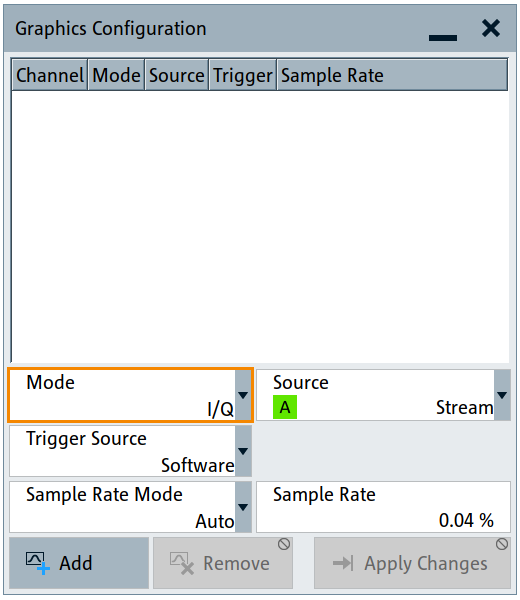


Figure 8-8: Graphics configuration dialog

2. To display a certain characteristic of the signal, use the parameter "Mode".
3. To select suitable signal acquisition points, use the parameter "Source".
4. To enable the graphical signal display, select "Add".

   A thumbnail of the graphical signal display is shown in the taskbar.

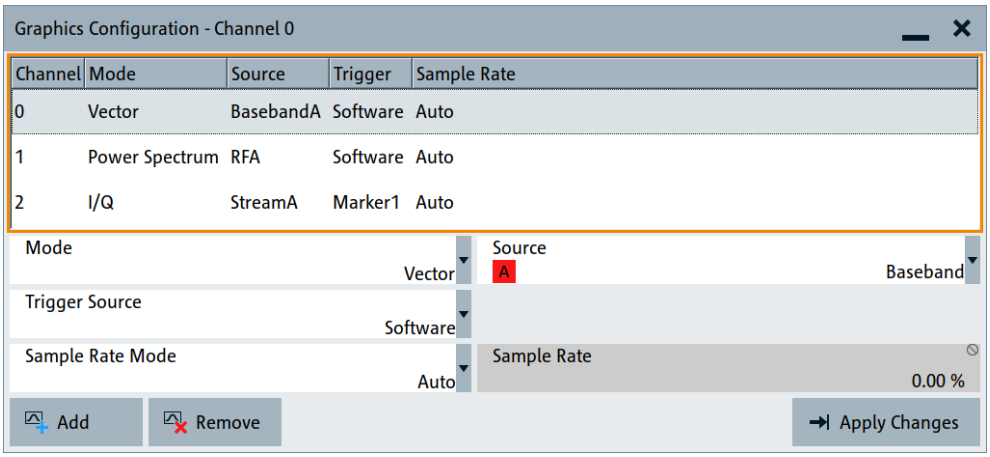


Figure 8-9: Graphics configuration dialog with active graphical signal displays

5. To enlarge the thumbnail, select it.

Settings:

Graphical Diagrams Table....464
Mode....464
Source....464
FFT Length....464

Full Scale (dBFS)....464
Trigger Source....464
Sample Rate Mode....465
Sample Rate....465
Add....465
Apply Changes....465
Remove....465

Graphical Diagrams Table
The active graphical signal displays are listed in the table at the top of the dialog.

Mode
Sets the graphics mode, see Section 8, "Monitoring baseband signal characteristics", on page 454.

Remote command:
`[:SOURce<hw>]:BB:GRAPhics:MODE` on page 950

Source
Sets the source for the signal acquisition point.

See Section 8.2.2, "Signal acquisition points", on page 460.

Remote command:
`[:SOURce]:BB:GRAPhics:SOURce` on page 951

FFT Length
Requires "Mode" > "Power Spectrum".

Selects the number of samples to be included in the graph of the power spectrum.

Remote command:
`[:SOURce]:BB:GRAPhics:FFTLen` on page 952

Full Scale (dBFS)
Requires "Mode" > "Power Spectrum".

Sets the normalization of the power values in the diagram. Observe the change in the units on the y-axis.

"On" The maximal digital power |I|=|Q|=max is mapped to 0 dB in the power spectrum diagram.
The y-axis shows the normalized power in dBFS.

"Off" The frequency average of the displayed power (frequency domain) agrees with the average power in the time domain.
The y-axis shows the power distribution in dB/Hz.

Remote command:
`[:SOURce]:BB:GRAPhics:FFTFscale` on page 952

Trigger Source
Sets the trigger source for signal recording.

"Software" Recording of signals starts automatically in predefined intervals. This asynchronous method is suitable if a representative display of the complete signal is required.

"Marker 1" The starting point for recording of signals is determined by the marker 1 setting of the activated digital standard ("Trigger/Marker" dialog). This synchronous method is suitable if specific signal segments are to be shown in greater detail. With periodic signals, a static image is obtained by selecting a period length of marker 1 that is equal to the signal period.
The displayed signal segment can be shifted by entering a marker delay in the "Trigger/Marker" dialog of the activated digital standard.

Remote command:
`[:SOURce<hw>]:BB:GRAPhics:TRIGger:SOURce` on page 952

Sample Rate Mode
Sets how the time resolution of the signal is determined. Maximum resolution corresponds to a display covering the entire signal bandwidth. The higher the resolution, the shorter the length of the displayed signal segment.

"Auto" The resolution is set to an optimum value in terms of signal and display type.

"Full Bandwidth" The resolution is set so that the display covers the entire signal bandwidth.

"User" Activates the "Sample Rate" input field, where you can manually set the resolution.

Remote command:
`[:SOURce<hw>]:BB:GRAPhics:SRATe:MODE` on page 950

Sample Rate
Displays the sample rate and depend on the sample rate mode as follows:

- If "Sample Rate Mode" = "Auto" or "Full Bandwidth", the sample rate displays the percentage of the entire signal bandwidth which is used for the graphical signal display.
- If "Sample Rate Mode" = "User", the sample equals the input for the percentage of signal bandwidth which is used for the graphical signal display.

Remote command:
`[:SOURce<hw>]:BB:GRAPhics:SRATe:USER` on page 951

Add
Adds a graphical signal display to the taskbar and graphical diagrams table.

Remote command:
`[:SOURce]:BB:GRAPhics:ADD` on page 951

Apply Changes
Enables the current settings for the selected graphical signal display.

Remove
Removes the selected graphical signal display from the taskbar/graphical diagrams table.

Remote command:
[:SOURce]:BB:GRAPhics:CLOSe on page 951.
The command closes all graphical signal displays.

8.4 Graphical signal display settings

Access:

1. In the taskbar, select "System Config" > "Graphics" > "Add".
2. Double-click the thumbnail in the taskbar.

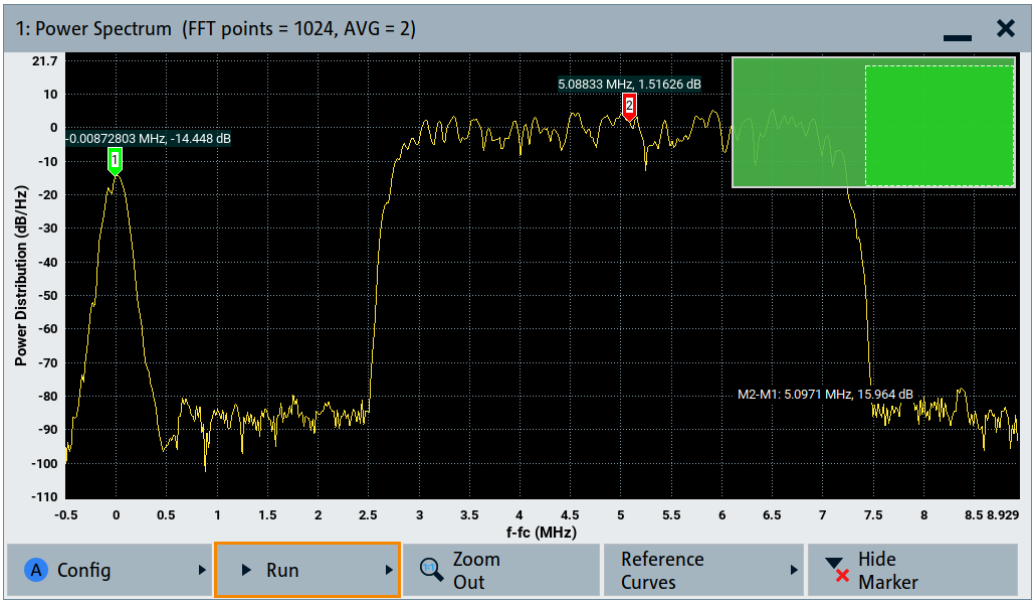


Figure 8-10: Graphical signal display of a power spectrum with markers

This section focuses on the functions of the enlarged graphical signal displays.

Settings:

Configure....466
Stop/Run....467
Zoom Out....467
Reference Curves....467
Display Units....467
Show Marker/Hide Marker....467
Reference Curves....467

Configure
Opens the "Graphics Configuration" dialog, see Section 8.3, "Graphics configuration settings", on page 462.

Note: This function is available for enlarged graphical signal displays and in the context menus of the thumbnails.

Stop/Run
Stops the processing of the displayed signal and freezes it.

"Run" continues a stopped displayed signal.

Zoom Out
Resets a previous zoom, see also "To zoom into a diagram" on page 472.

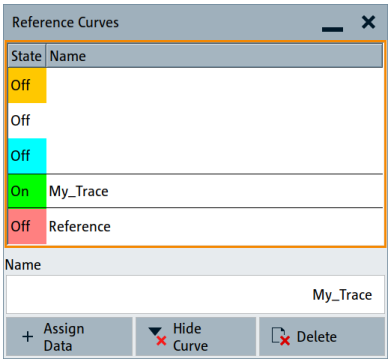
Reference Curves
Opens the dialog for defining reference curves, see "Reference Curves" on page 467.

Display Units
Changes the units of the X-axis. The available values depend on the generated signal.

Show Marker/Hide Marker
Shows two markers on the curve of the displayed signal or hides them.

See also:
- "Using markers" on page 461
- "To enable markers to read-out measured data" on page 472

Reference Curves
Enable the indication of up to five configurable reference curves (traces).



See "Reference trace" on page 462.

Reference curves table
Lists the configured reference curves and their current state.
To change a curve, select it.

"Name" Enters the name of a new reference curve.

"Assign Data" Opens the standard "File Select" function to load a file describing a reference curve.

"Show Curve" Shows or hides the selected curve.

"Delete" Removes the curve.

8.5 Checking the generated signal graphically

This section shows you how to use the different graphic modes to visualize the signal characteristics of the generated signal. It also shows how to observe the effect of standard settings, like an applied filter, an enabled fading or AWGN. The examples use a simple custom digital modulated signal.

To generate a simple WCDMA-3GPP (QPSK 45° offset) signal

► Use the custom digital modulation. Enable a predefined WCDMA-3GPP signal. For more information, see Section 3.3.2, "Generating a digitally modulated signal", on page 50.

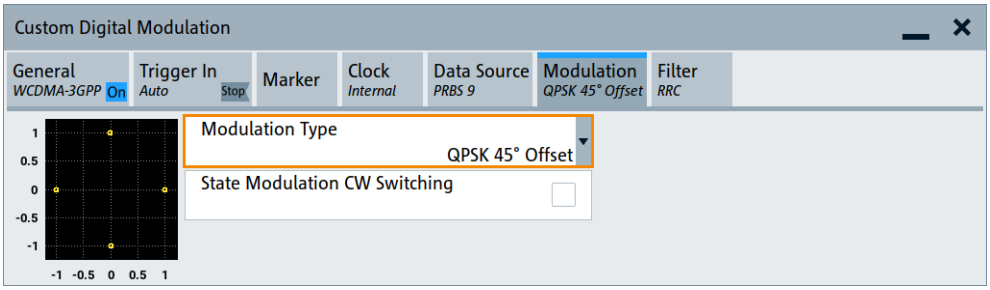
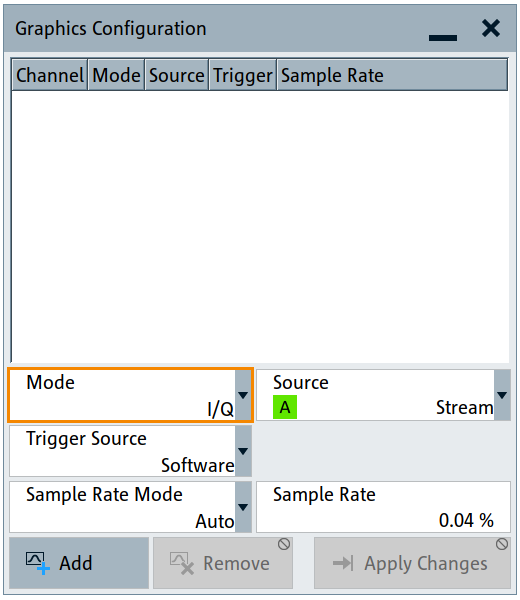


Figure 8-11: Used modulation type

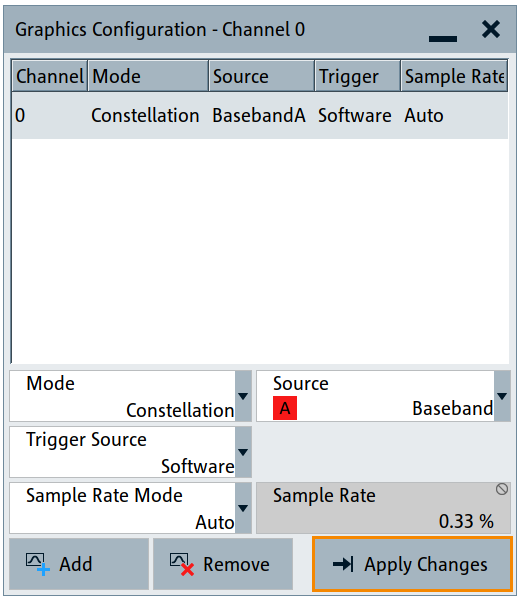
Configure the graphical signal display

1. In the taskbar, select the graphics icon:

The "Graphics Configuration" dialog opens.



2. Select "Mode" > "Constellation".
3. Select "Source" > "Baseband".
4. To view the signal, select "Add".



A new thumbnail (minimized view) indicating the constellation diagram appears in the taskbar.

5. To enlarge the constellation diagram, select it.

   The displayed constellation diagram confirms the QPSK offset modulation.

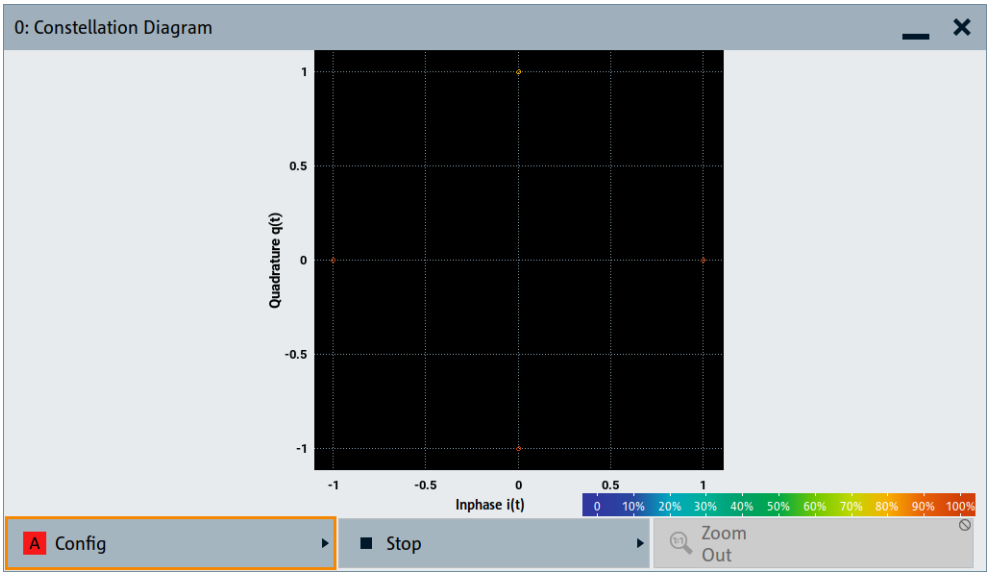


Figure 8-12: Constellation diagram of a WCDMA-3GPP (QPSK 45° offset) signal

To set and verify a baseband frequency offset

1. Select "Baseband" > "Baseband Offsets".
2. In the "Baseband Offsets" dialog, set "Baseband" > "Frequency Offset" = "1 Hz".
3. In the "Constellation Diagram", select "Configure".
   The "Graphics Configuration" dialog opens.
4. Add a vector diagram with signal acquisition point "Stream"
5. Enlarge the vector diagram.
   The vector diagram rotates with 1 Hz.

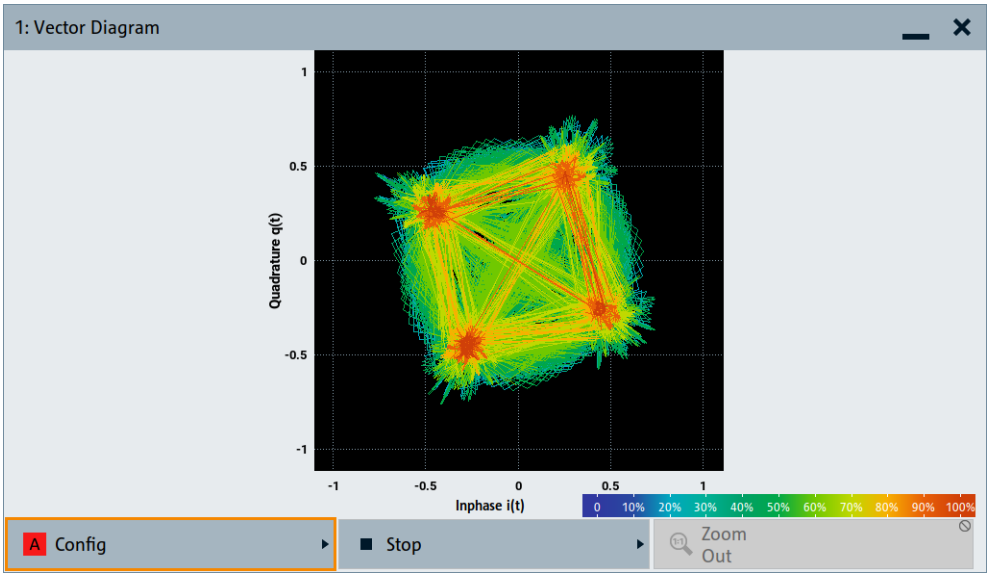


Figure 8-13: Rotating vector diagram

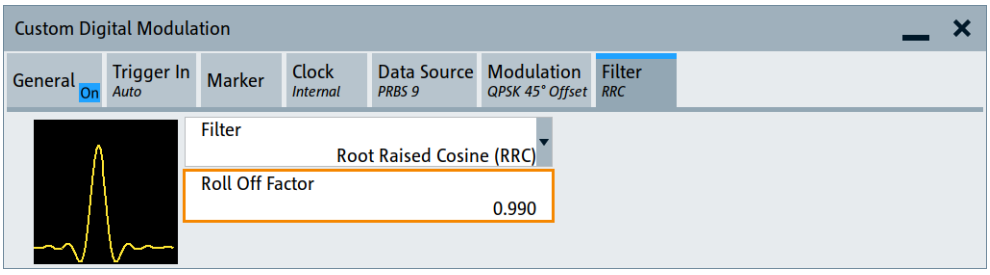
6. Reset the baseband frequency offset to 0 Hz.

   The vector diagram does not rotate anymore.

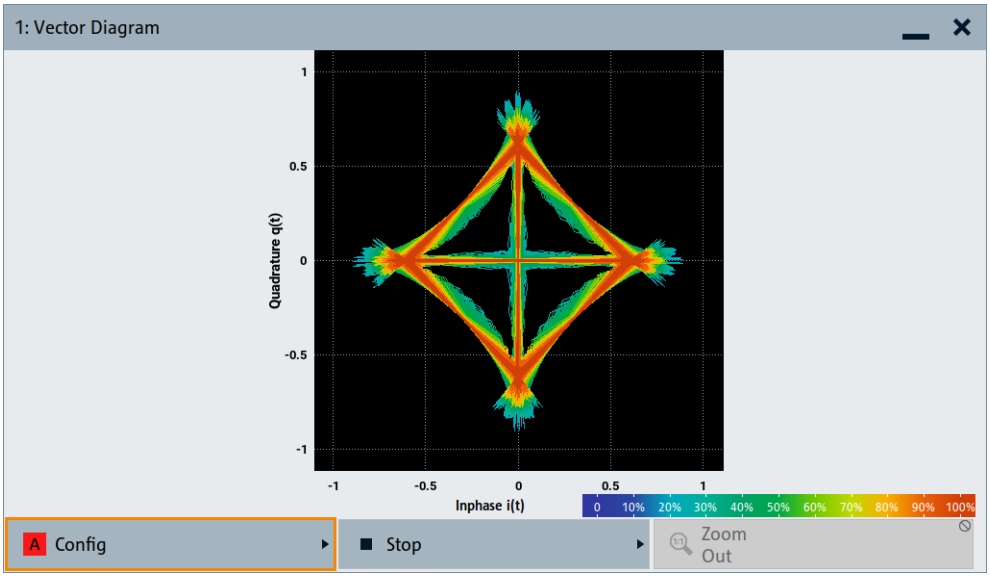
To filter the generated signal

This step-by-step instruction provides information on how to apply roll off filtering on the generated signal with a root raised cosine filter.

1. Select "Baseband" > "Custom Digital Mod".
2. Select "Filter" > "Roll Off Factor" = "0.99".



The vector diagram changes.



3. Preset the rolloff factor.

To zoom into a diagram

In an enlarged diagram:

1. Use the one-finger zoom to zoom with a fixed zoom factor.
2. Use the two-finger zoom to do a custom zoom.
   This zoom works like the two-finger pinching for magnifying images on your mobile phone.

   If the diagram is zoomed, an overview window appears.
3. Move the visible area in the graphics or in the overview window.
4. For the reverse operation, select "Zoom out".

To enable markers to read-out measured data

In an enlarged diagram:

1. Select "Show Marker".

   Two markers appear, one over the other.
2. To position the markers, select and shift them.

   "M2-M1" indicates the distance of marker 1 and marker 2 on the x-axis (left value) and on the y-axis (right value).

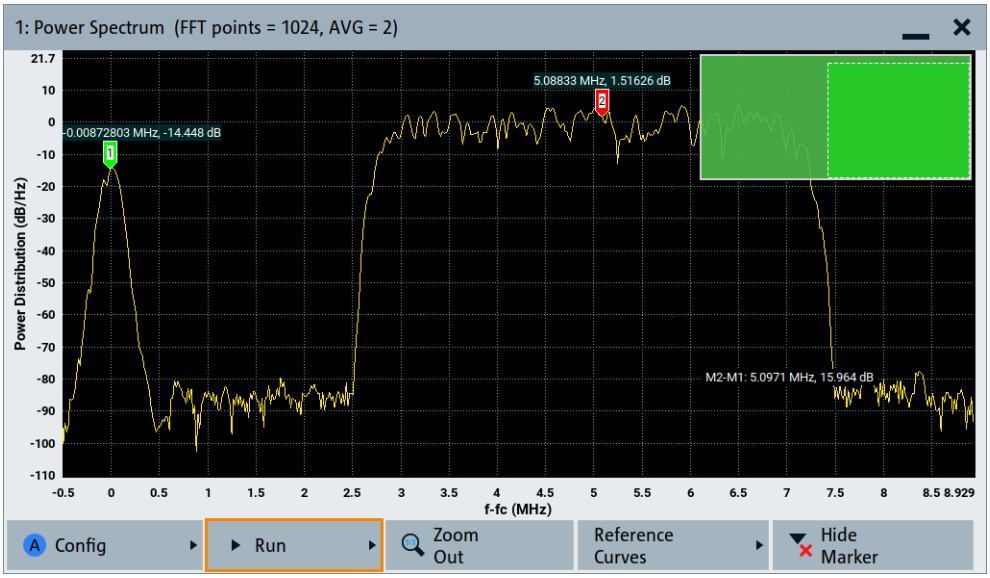
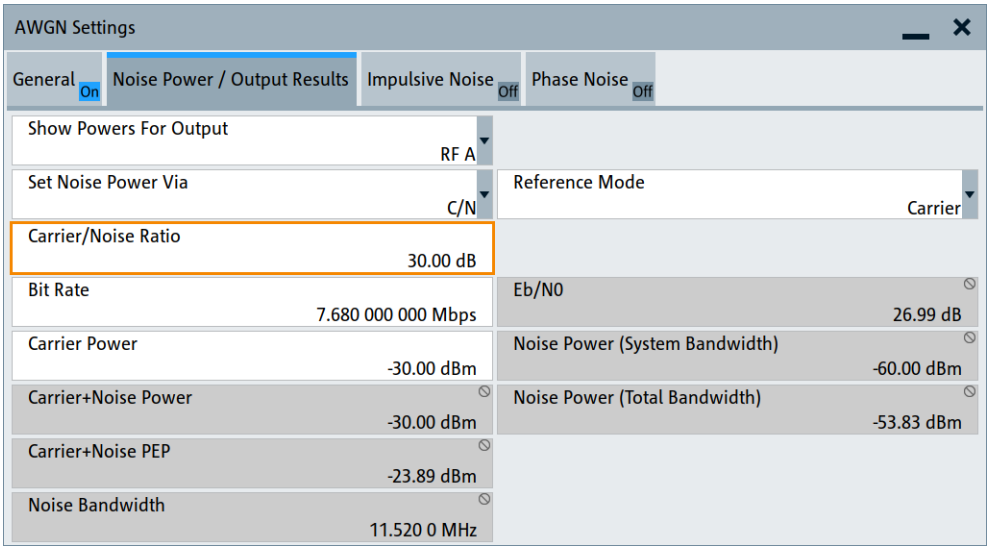


Figure 8-14: Power spectrum with GSM and WCDMA signals and markers

3. To hide the markers, select "Hide Marker".

To observe the effect of enabled additive noise (AWGN)

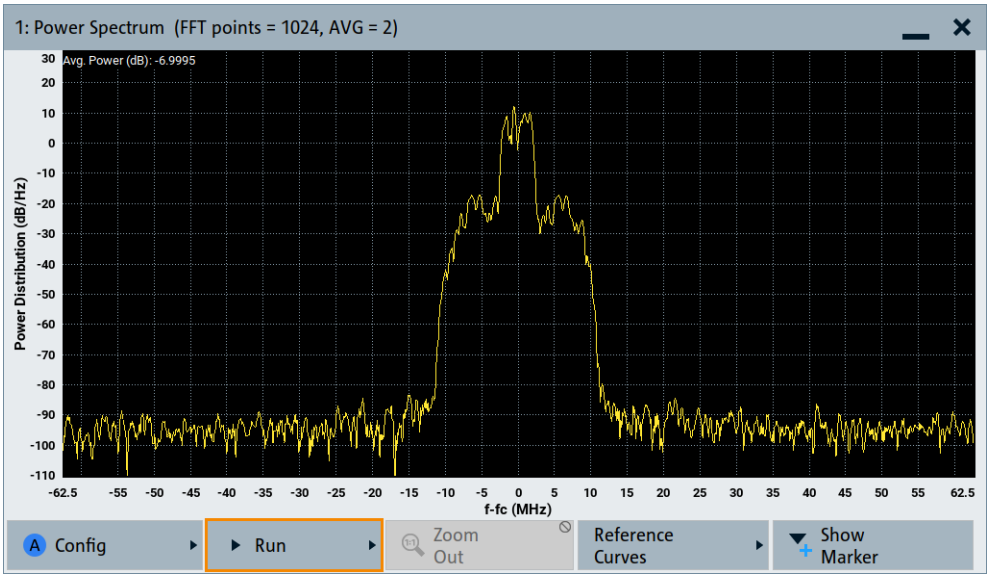
1. Select "AWGN" > "General".
2. Select "Mode" > "Additive Noise".
3. Select "Min Noise/System Bandwidth Ratio" = "3".
4. Select the tab "Noise Power / Output Results".
5. Select "Carrier/Noise Ratio" = "30 dB".



6. Select "AWGN" > "On"

7. Observe the power spectrum display.

   The power spectrum shows a noise floor with constant level. Also, the power spectrum shows the digitally modulated signal over the whole bandwidth. In this case, the WCDMA signal has a bandwidth of 3.84 MHz.



To print the current power spectrum

1. Press HCOPY.
2. Use the default settings.
3. Select "Save".

   The instrument creates a screenshot of the current screen and stores it in a file with a predefined filename in the default user directory `/var/user/`.
   See Section 10.11, "Creating screenshots of current settings", on page 552.
4. Use on of the standard file transfer methods to access the user directory of the instrument. Transfer the file to a PC.
   See Section 10.10, "Transferring files from and to the instrument", on page 546.
5. Print the file content.

9 Multi-instrument setups

R&S SMM100A is rarely used as a standalone instrument. Usually, the instrument is connected to a device under test (DUT) or other measurement equipment.

Test setups have different requirements, for example:

- Test setups comprising two or more instruments often require a common reference frequency.
- Generation of beamforming signals requires phase coherent signals.
- Some test setups also require control of the signal generation start and an exact generation start time, for example determined by a defined trigger event.
- In other cases, you need time-aligned simultaneous signals between multiple instruments.
- etc.

R&S SMM100A provides several settings that help fulfilling these requirements. This section explains the main principles and gives an overview of the related settings and step-by-step instructions.

- Synchronizing instruments 475
- Generating time-aligned baseband signals 475
- Generating high precision marker signals 482
- Control and operation of external instruments 484
- System configuration settings 491
- Digital baseband input settings 506
- I/Q analog output settings 511

9.1 Synchronizing instruments

For information on the possible scenarios concerning the distribution of reference frequency, test setups and the related settings:

See Section 7.8, "Reference oscillator", on page 321.

9.2 Generating time-aligned baseband signals

In test setups that combine the signal of two or more instruments it is often required that:

- The signal generation starts at a defined moment
- The signal generation starts simultaneously (or with an exactly defined delay) in all involved instruments.

One possible way to achieve quasi-simultaneous signal start is to trigger the instruments by the same trigger event, for example from a **common trigger source**.

Because of the trigger signal propagation time and the signal processing time, however, this method does not achieve precise time-aligned signals.

To generated **synchronous and time aligned signals** with multiple instruments, use the primary-secondary instrument mode.

This section explains how to use the provided settings to define the signal generation start in the basebands of **multiple instruments**.

- Connecting multiple instruments in primary-secondary instrument mode.....476
- Triggering several instruments with a common trigger signal.....481

9.2.1 Connecting multiple instruments in primary-secondary instrument mode

About the primary-secondary instrument mode

When connected in primary-secondary instrument mode, two or more R&S SMM100A or one R&S SMM100A and several other signal generators such as R&S SGT or R&S SMBV can generate synchronous and time-aligned signals.

In this mode, the primary instrument generates and outputs a dedicated synchronization signal (Sync Out), that has to be fed into the secondary instrument. The secondary instrument detects and demodulates the signal, and retrieves both the baseband clock and the trigger signal from it. Secondary instruments can forward the received synchronization signal (Sync In) and output it to trigger further secondary instruments.

Synchronization signal

The synchronization signal is a 50 MHz signal that carries the trigger pulse modulated on it. Hence, it provides **joint triggering** and **baseband clock synchronization** at the same time.

Final time alignment can require adding I/Q or trigger delay. However, once synchronization is achieved, the primary-secondary instrument mode ensures reproducible triggering, if the used waveform, sample rate and cabling are not changed.

Test setup

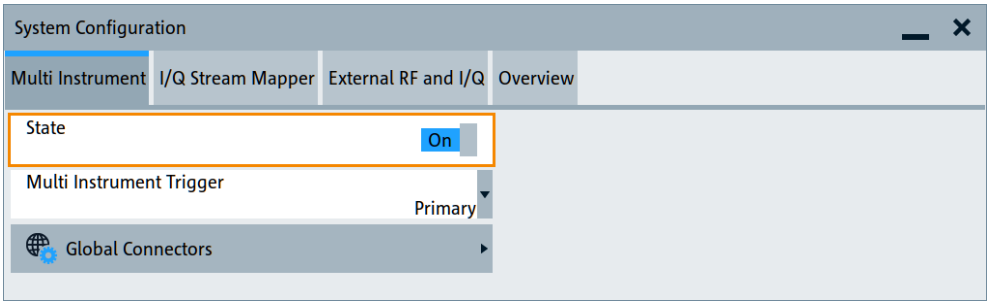
Regarding the **synchronization signal**, the instruments can be connected (cascaded) in a daisy chain (see Figure 9-1).

Also, all instruments in the setup have to use the **same reference frequency**. You can distribute the internal reference frequency of one of the instruments. Distribution is independent for primary or secondary instruments. Alternatively, supply all instruments with an external reference frequency source.

9.2.1.1 Multi-instrument settings

Access:

► Select "Taskbar" > "System Config" > "System Configuration" > "Multi Instrument".



For a step-by-step description, see Section 9.2.1.2, "Connecting and configuring primary-secondary instruments", on page 478.

Settings:

State 477
Multi Instrument Trigger 477
Synchronisation State 477
Global Connector Settings 478

State
Activates the configuration.

With "State" = "Off", the instrument works in a standalone mode.

Remote command:
`:SCONfiguration:MULTiinstrument:STATe` on page 783

Multi Instrument Trigger
Sets the mode in that the instrument works.

To activate the mode, set "Multi Instrument" > "State" = "On".

"Primary" Provides its trigger signal to the secondary instruments.

"Secondary" Synchronizes to the supplied trigger signal from the primary instrument.
Observe the "Synchronisation State" indication for information if the synchronization signal is found and synchronization is achieved.

Remote command:
`:SCONfiguration:MULTiinstrument:MODE` on page 782

Synchronisation State
If "Multi Instrument Trigger" = "Secondary", indicates if synchronization is achieved.

"Sync" Instrument is in sync.
It receives and decodes the synchronization and the trigger signal from the primary instrument.

"No Sync" Synchronization is not achieved, because:

- The baseband generators in the secondary instruments or in the primary instruments are not activated, see "To start signal generation" on page 480.
- There is no physical connection (the synchronization signal is not connected as required).
  For details, see Section 9.2.1.2, "Connecting and configuring primary-secondary instruments", on page 478.
- The secondary instrument does not detect the synchronization signal.

Remote command:
`:SCONfiguration:MULTiinstrument:TRIGger:SYNChronization?`
on page 783

Global Connector Settings
Provides a quick access to the related global connector settings.

With "State" = "On", the synchronization signal is assigned per default as follows:

- "Multi Instrument Trigger" > "Primary"
  "Connector" = "User 6": "Direction" = "Output", "Signal" = "Baseband Sync Out"
- "Multi Instrument Trigger" > "Secondary"
  "Connector" = "User 6": "Direction" = "Output", "Signal" = "Baseband Sync Out"
  "Connector" = "User 5": "Direction" = "Input", "Signal" = "Baseband Sync In"

See also:

- Section 9.2.1.2, "Connecting and configuring primary-secondary instruments", on page 478.

See also Section 11.2, "Configuring local and global connectors", on page 563.

9.2.1.2 Connecting and configuring primary-secondary instruments

To connect the instruments and route signals

1. With the default connector settings of the R&S SMM100A, connect the instruments in a daisy chain:

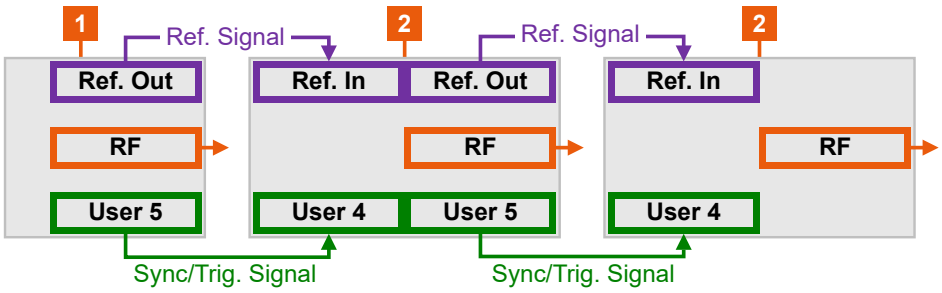


*Figure 9-1: Example: Daisy chain connection for distributing the synchronization signal (simplified)**

*	= I/Q, LAN etc. connections are not shown
1	= Primary instrument acting as a synchronization and trigger signal source
2	= Secondary instruments: One or more cascaded instruments, receiving (and forwarding) the synchronization and trigger signal
Ref Out, Ref In	= Reference frequency connectors
User x	= Synchronization and trigger signal connectors
RF	= RF signal output connector

- Connect **User 6** connector of the primary instrument R&S SMM100A to **User 5** connector of the first secondary instrument.
- Connect User 6 connector of the first secondary instrument to the User 5 connector of the second secondary instrument, etc.

Note: Avoid unnecessary cable length and branching points.
Use cables of the same length and type for all connections between the primary instrument and the secondary instruments and between secondary instruments.

2. To distribute the internal reference signal of one of the instruments (in this example the primary instrument), connect the instruments in a daisy chain **concerning the reference frequency**.
   Connect Ref Out of the primary instrument R&S SMM100A to the Ref In of the first of the secondary instrument group, etc.
   See Section 7.8, "Reference oscillator", on page 321.

To configure the primary instrument (R&S SMM100A)

1. Select "RF" > "Reference Frequency" > "Source" > "Internal".
2. Select "System Config" > "Multi Instruments".
3. Select "Multi Instrument Trigger" > "Primary".
4. Select "State" > "On".
5. In the "Global Connector Settings" dialog, and observe the current signal assignment.

   Per default, the synchronization signal ("Baseband Sync Out") is output at the User 6.
6. Configure the baseband signal as required for the particular test setup.
   Configure the trigger signal, for example, as follows:

   a) Select "Baseband" > "EUTRA/LTE" > "Trigger In"
   b) Select "Mode" > "Armed Retrigger" and "Source" > "Internal"
   c) Set "Sync. Out to Trigger" > "On".

   The trigger parameters of all basebands are coupled. Once the basebands are activated, they use a common trigger signal.
   See also "Starting the signal generation with the first sample" on page 97.

To configure the secondary instrument (R&S SMM100A)

1. Select "RF" > "Reference Frequency" > "Source" > "External".

Use the default reference frequency settings.

2. Select "System Config" > "Multi Instruments" > "Multi Instrument Trigger" > "Secondary".
3. Select "State" > "On".
4. Observe the current synchronization status.

   The parameter indicates that the instruments are not synchronized.
   Synchronization is achieved at the moment the basebands in the secondary instruments and in the primary instrument are activated.
5. Configure the baseband signal.

   a) Select the same trigger mode as in the primary instrument.
   b) Set "Sync. Out to Trigger" > "On".
   c) Observe the automatic trigger source selection "Source" = "Baseband Sync In"

   Once the baseband is activated, the secondary instruments are triggered by the synchronization signal.
   If the secondary instrument is R&S SMM100A, the trigger parameters of all basebands are coupled and all basebands use a common trigger signal.

To start signal generation

1. In the secondary instruments, start signal generation.
   That is, activate the baseband generator.
2. In the primary instrument, activate the baseband generator.
3. In the secondary instruments, observe the value of the parameter "System Config" > "Multi Instruments" > "Synchronization State"

   The instruments are synchronized if the following applies:
   - The physical connection is established.
   - The synchronization signal is routed property.
   - The baseband generators in all generators are active.

To compensate signal mis-alignment:

1. Connect an oscilloscopes or network analyzer.
   Observe the generated signals.
2. Compare the signal start in the instruments.
3. To compensate signal delay, select "I/Q Modulator" > "I/Q Digital Impairments".
4. Vary the value of the parameter "I/Q Delay" to achieve time-aligned signals.
5. If the value range is insufficient, enable also or alternatively a trigger delay.
   Select "Baseband" > "<Dig Standard>" > "Trigger In" > "Delay".
6. Vary the values until the signals align in time.

9.2.1.3 Further information

See:

- Trigger settings of the used baseband source, for example Section 4.4.2.1, "Trigger settings", on page 106.

See also Section 11.2, "Configuring local and global connectors", on page 563.

9.2.2 Triggering several instruments with a common trigger signal

Using the same trigger event on several instruments is useful to synchronize the transmitted and received signals. Some test cases also require that you control the signal generation start and determine the exact generation start time by a defined trigger event. The signal generation start can be controlled, for example, by triggering the instrument internally or externally from the DUT.

To share a common trigger signal:

- Let one R&S SMM100A generate a dedicated signal that triggers all R&S SMM100A instruments.
  See Example "Triggering several R&S SMM100A instruments simultaneously" on page 481.
- Connect all instruments to a common external trigger source.

See also Section 3.3.4, "Working with marker signals", on page 56.

Example: Triggering several R&S SMM100A instruments simultaneously

This example shows you how to connect several R&S SMM100A, distribute the trigger signal generated by the first one (R&S SMM100A#1) and trigger the instruments simultaneously.

Required cabling and connections:

- Connect the instruments in a star network, concerning the trigger signal.
  That is, connect the User 6 output of the R&S SMM100A#1 to the User 3 input of all other R&S SMM100A and the R&S SMM100A#1 itself.
- Always use cables of the same length.
  Use as short as possible cables.

Required configurations:

- In **all** R&S SMM100A:
  - Use the default settings "User 3" > "Direction" = "Input" and "Signal" = "Global Trigger 1".
  - Select "Baseband" > "<Dig Standard>" > "Trigger In" > "Source" > "Ext. Global Trigger 1".
- In R&S SMM100A#1, set "System Config" > "Setup" > "Global Connectors" > "User 6" > "Direction" = "Output".
  Set "User 6" > "Signal" = "Manual Trigger".

To trigger the signal generation form R&S SMM100A#1, select "Global Connectors" > "Execute Trigger".

Alternatively, send the remote control command `:OUTPut:USER<ch>:TRIGger[:IMMediate]`.

R&S SMM100A#1 generates a short high signal and outputs it at the User connector. The signal acts as a common external trigger signal for all R&S SMM100A and all basebands.

9.3 Generating high precision marker signals

This section provides information on how to generate high precision marker signals. It covers the following topics:

- "Required options" on page 482
- "About high precision marker signals" on page 482
- "To connect for high precision marker output" on page 482
- "To generate high precision marker signals" on page 483

Required options

Generating high precision signals requires a base unit instrument.

About high precision marker signals

High precision signals are narrow pulse analog I/Q signals. You can output two of these marker signals. One marker signal is for the I component and one marker signal is for the Q component.

With enabled high precision marker, you can also output the baseband marker signals via the "TMC" connectors or the "User x" connectors. Make sure to also enable the RF output within the signal path of the high precission marker. With disabled RF output, you cannot output the baseband marker signals at the "User x" connectors.

For more information, refer to the specifications document.

To connect for high precision marker output

1. Connect the DUT to the I/Q connectors of the R&S SMM100A.
2. Connect the DUT to the RF connector of the R&S SMM100A.

   The table Table 9-1 provides an overview of the relevant connections and the figure Figure 9-2 illustrates a test setup.

Table 9-1: Connections of a high precision marker setup

Signal	R&S SMM100A	DUT
RF out	"RF"	RF in
I out	"I" (marker 1)	I in
Q out	"Q" (marker 2)	Q in

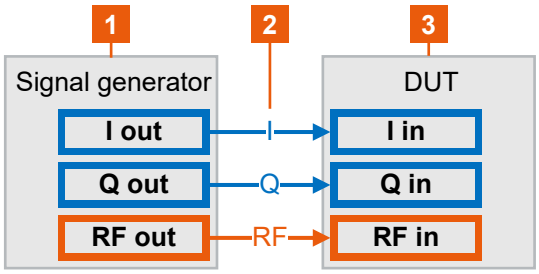
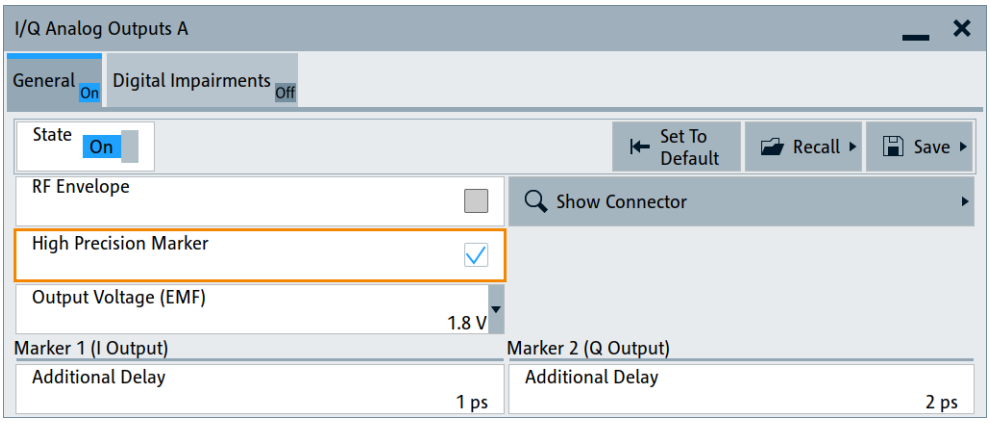


Figure 9-2: Test setup: High precision marker signal

1 = R&S SMM100A
2 = Signals: two HP marker signals and one RF signal
3 = DUT with marker input connectors (I/Q analog) and RF input

To generate high precision marker signals

1. In the block diagram, select the symbol "I/Q OUT" to unfold the "I/Q Analog" block.
2. Select "I/Q Analog" > "I/Q Analog Outputs".
3. Configure the high precision marker signals:
   a) Select "High Precision Marker" > "On".
   b) Set the output level of both marker signals. For example, set "Output Voltage (EMF)" > "1.8 V".
   c) Delay the marker signals individually. For example, set "Additional Delay" = "1 ps" for marker 1 and "Additional Delay" = "2 ps" for marker 2.
4. Set "State" > "On", to enable the I/Q analog output.



The R&S SMM100A outputs the I component (marker 1) at the "I" connector and the Q component (marker 2) at the "Q" connector.

9.4 Control and operation of external instruments

In test scenarios that require more than one RF signal, the I/Q analog signal can be routed to and processed by external instruments. Typically, the generated I/Q streams are further processed by R&S SGS.

Other applications like the radar echo generation or the generation of WLAN 802.11ad signals at 58.3 GHz require connected R&S FSW or R&S SZU.

The R&S SMM100A provides all settings required to configure the output connectors, to establish the connections to the connected RF instruments and to control them. The settings are grouped in the "System configuration" > External RF and I/Q dialog. In this dialog, you find an overview of all available I/Q input and output connectors and configure the connection to the external instruments.

Once the connection is established, the R&S SMM100A acts as a **primary instrument** and controls the **setup-related parameters** of any connected further processing external instrument. Control applies to connected instruments, for example., R&S SGS (also in combination with R&S SGU), R&S SZU, R&S FSW.

9.4.1 Prerequisites for control of external instruments from the R&S SMM100A

Required are the following connections between the R&S SMM100A and the external instruments:

- **Physical remote control connection** over LAN or USB
  The remote control connection to the external instruments must be in status **connected**.
  See Section 9.5.2, "External RF and I/Q settings", on page 492.
- **Physical signal connection** for the digital or analog I/Q signal
- For the most test setups, the instruments must use a **common reference frequency signal**.
  Suitable reference frequency signal sources are:
  – An external common reference source
  – The distributed reference frequency of the R&S SMM100A.

9.4.2 Test setups

The test setup depends on the external instrument and the used I/Q output signal (digital, analog single-ended or analog differential).

9.4.3 Control of connected R&S SZU

If a is connected to the R&S SMM100A, the R&S SMM100A block diagram changes and resembles the signal routing. The analog I/Q output signal is firmly routed to the

R&S SZU. The I/Q modulator block visualizes the I/Q modulator of the R&S SZU. The routing is fixed.

The R&S SMM100A controls the R&S SZU as it is its embedded unit. You access the R&S SZU settings directly from the R&S SMM100A block diagram. The access is identical to the access of the R&S SMM100A RF settings but the list shows only the supported settings.

For example:

- To access the R&S SZU RF settings, select the R&S SZU icon.
- To access the I/Q modulator settings of the R&S SZU, select the "I/Q Mod" block.

The R&S SMM100A **RF settings are dedicated to the R&S SZU**. The corresponding RF output cannot be used for other application, for example, LO coupling.

As with other downstream instruments, the frequency and level indications in the R&S SMM100A **status bar show the R&S SZU values.** Parameters like the frequency and level offset, level limits, delta phase or RF output state affect the RF output of the R&S SZU.

The remote commands required to define the R&S SZU settings are the same as the R&S SMM100A commands, so that you can reuse your SCPI scripts. Note the changes in the value ranges and the commands usage listed in section "Remote Control" in the description SZU100A Getting Started.

9.4.4 Overview of the input and output signals and interfaces

Designed as a signal generator with various application fields, the R&S SMM100A uses a hardware concept that enables you to define and customize some of the input and output signals and interfaces. Depending on the configuration, digital interfaces can be used as input or output connectors. The different logical settings of the same physical interface are grouped in different dialogs.

Logical signals, streams and channels at the interfaces

This section provides background information and an introduction to the topics. For an overview of the interfaces and their characteristics, refer to:

- Section 9.4.4.1, "Overview of the baseband signal sources", on page 485
- Section 9.4.4.2, "Overview of the baseband and RF output signals", on page 486
- Section 9.4.4.4, "Important signal parameters and interface characteristics", on page 487

9.4.4.1 Overview of the baseband signal sources

The Table 9-2 gives an overview of the possible input signals and the connectors that they are supplied at. Any one of the specified input signals can be processed by the I/Q modulator and output at the RF outputs.

Table 9-2: Physical input signals

Input Signal	Input connector	GUI element	Related descriptions
Internal digital baseband	-	"Baseband"	Section 4, "Configuring the internal baseband source", on page 80
External digital	Dig I/Q HS Dig I/Q	"BB Input"	Section 9.6, "Digital baseband input settings", on page 506
External analog wideband	I/Q	"I/Q Mod"	Section 6, "Applying I/Q vector modulation", on page 289

Input interface for the external digital baseband signal

Two digital interfaces HS Dig I/Q can be used as input for digital signals but not at the same time. They provide direct communication with other Rohde & Schwarz instruments, like:

- Signal generators
- R&S FSW signal and spectrum analyzer

Application examples of the external digital baseband signal

Provided the instrument is equipped with the required options, the externally applied signals can be used for and further processed as follows:

- Used as a standalone baseband source and processed separately, e.g. detuned, or loaded with noise or directly applied to the I/Q modulator
- Used as a user-specific signal instead of the internally generated signal

Input interface for the external analog signal

The R&S SMM100A provides also an input interface for an external wideband analog I/Q signal. The external signal is fed directly to the I/Q modulator. For a description of the related connectors and settings, see Section 6, "Applying I/Q vector modulation", on page 289 and Table 6-1.

9.4.4.2 Overview of the baseband and RF output signals

Usually, the generated baseband signal is modulated on the RF frequency and output at the RF connector. As shown in Table 9-3, the R&S SMM100A outputs the digitally modulated signal converted to an analog I/Q baseband output signal. The analog baseband signal can be output single-ended or differential (non-inverted). Also, you can generate an RF envelope signal.

The Table 9-3 shows the possible output connectors with the corresponding kind of signal.

Table 9-3: Physical output signals

Output Signal	Output connector	GUI element	Related descriptions
RF	RF	"RF"	Section 7, "Configuring the RF signal", on page 308
Analog I/Q • Single-ended • Differential • RF Envelope	• I/Q • I/Q Bar • I/I Bar	"I/Q Analog"	Section 9.7, "I/Q analog output settings", on page 511

9.4.4.3 Interdependencies

The following functions cannot be activated simultaneously. They deactivate each other.

- The internal baseband generator ("Baseband" block) and the external digital baseband input ("BB Input")
- The output of analog ("I/Q Analog") and digital ("I/Q Digital") signals

9.4.4.4 Important signal parameters and interface characteristics

Correct signal processing of the externally supplied input signals in the instrument and correct processing of the output signal in the next connected instrument require information of signal parameters. These signal parameters are sampling rate, crest factor and signal level, expressed as peak or as RMS level value.

Sample rate

The sample rate of the digital input and output signal can be defined manually or automatically retrieved from the input and estimated for the output signal. The bandwidth and thus the sample rate of the digital input signal is not limited by the installed sample rate options.

For more information, refer to the specifications document.

Crest factor

According to its definition, the crest factor gives the difference in level between the peak level and RMS level value in dB (see Figure 9-3).

The R&S SMM100A uses the crest factor to calculate the power levels that is the instrument compensates the RMS levels of the externally supplied signal by the crest factor. For example, the crest factor of the external signal is important for the calculation of the RF output power.

Figure 9-3: Relation between the level settings

Test setups often involve an upconverter connected to the I/Q connectors of the generator or feeding of external signal to the digital input of the R&S SMM100A. As a rule, whenever an I/Q signal is transferred between two instruments, *the crest factor and the peak levels of the two involved instruments have to be coordinated*.

To ensure proper signal settings and correct results, check if the peak level values and crest factor values are equal. Equal values hold for the I/Q outputs of the R&S SMM100A and the I/Q inputs of the upconverter are equal.

In the R&S SMM100A, level values are represented as relative to full-scale values (see Figure 9-3).

Where to find the necessary values

- Dialog "BB Input"

Avoiding overflow of the input signal and output signal

The R&S SMM100A constantly monitors the input and output digital signal and indicates an overflow status.

- Overflow of the **input signal** (crest factor and peak level) is indicated if the entered "Peak Level" (in dBFS) value does not correspond to the real value
  Tip: The overflow status is indicated as long as the signal level is not reduced and the peak level value corrected. Trigger "Auto Level Set" to collect the required values and adjusts the settings automatically.
- Overflow of the **output signal** is indicated if the digital signal is clipped, i.e. if the level of the output signal, or the noise level (AWGN) are too high.

Specifics of the digital I/Q interfaces

Mapping digital channels to the baseband signal path

The external digital signals supplied at the Dig I/Q interfaces of the instrument can contain more than one, possibly even multiplexed, digital channels. The R&S SMM100A processes each of these digital channels as a separate signal.

The external digital signals supplied at the HS Dig I/Q interfaces of the instrument can contain more than one, possibly even multiplexed, digital channels. The R&S SMM100A processes each of these digital channels as a separate signal.

Signal processing prerequisites for external baseband signals

This section focuses on the way that these requirements are fulfilled and explains how the instrument deals with signals deviating from the expected values:

- **Crest factor peak level and RMS level**

  These values can be adjusted in one of the following ways:

  – Adjusted manually
  If you have knowledge about these values, enter them directly.

  – Estimated automatically by the internal measurement function
  Use the function Auto Level Set to trigger the R&S SMM100A to measure the input signal, estimate the peak level and RMS level and calculate the crest factor out of them.
  Tip: For a correct signal leveling:
  1) Enable an appropriate measurement time.
  2) Execute one measurement for each baseband source.
  3) Set the measurement period to a time value that is long enough to capture several periods of the input signal.

  – Determined automatically
  The R&S SMM100A can receive the values from the connected transmitter.
  If the external digital signal source is a second Rohde & Schwarz instrument, it signals the peak level and the RMS level of the signal over the digital input interface. To enable the R&S SMM100A to receive these values, enable the parameter "DIG IQ Auto Setting" on page 511.

  In the second automatic way, the R&S SMM100A adjusts the corresponding input fields with the measured/received values. The internal gain control mechanism uses these received values to adjust the input signal gain to achieve an optimal dynamic range.

- **Sample rate**
  External input signals with sample rates different than the system clock are resampled, as illustrated on Figure 9-4.

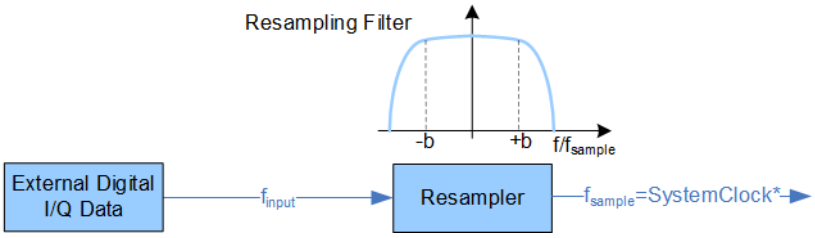


Figure 9-4: Resampling principle of external digital baseband signals

* = Max. sample rate depends on connected device
f_{input} = Max. sample rate

- **Maximum modulation bandwidth**
  A baseband signal with a sample rate $f_{smaple} < f_{smaple, max}$ (i.e. smaller than the used system clock) is interpolated, see Figure 9-4. The resulting modulation bandwidth is calculated as *sample rate * 0.8*.

Estimating or defining the sample rate

The sample rate of the signal at the digital interface can be determined with one of the following methods:

- **Estimated sample rate**
  Enable the instrument to evaluate the received I/Q data clock
- **User-defined sample rate**
  Provide both the external signal source and the receiving instrument with a common external reference signal and set the sample rate value.

Specifics of the analog I/Q interfaces

The R&S SMM100A outputs the digitally modulated signal not only directly but also converted to an analog I/Q baseband output signal. The R&S SMM100A outputs the analog baseband signal single-ended or differential (non-inverted); an RF envelope signal can be generated, too.

Differential output signal

The differential output provides symmetrical signals for differential inputs of DUTs without the need of an additional external electric network. To achieve an optimal and balanced operating point of these inputs, ensure the correct adjustment of the used DC voltage ("Bias") and the offset ("Offset") between inverting and non-inverting output.

See also "Bias (EMF)" on page 516 and "Offset (EMF)" on page 517.

Maximum overall output voltage

The voltage of the analog output signals is defined as a combination of the output voltage of the I and Q signal components and an optional bias voltage. If you use the differential output, you can also set an offset.

The values of these parameters are interdependent so that the sum of output voltage and bias voltage has an upper limit V_{max} as follows:

- Single-ended signal: $V_p + V_{bias} \leq 4$ V
- Differential signal: $0.5*V_p + |V_{bias}| + 0.5*V_{offset} \leq 4$ V

Where:

- V_p is the output voltage, see "I/Q Level Vp (EMF)" on page 516.
- V_{bias} is the bias voltage, see "Bias (EMF)" on page 516.
- V_{offset} is the offset between inverting and non-inverting output, see "Offset (EMF)" on page 517.

9.4.5 Further information

For description of the settings related to connection establishment, see:

- Section 9.5.2, "External RF and I/Q settings", on page 492
- Section 9.5.1, "I/Q stream mapper settings", on page 491

For information on the **manual and remote control operation** of the external instruments, see the documentation of the particular instrument:

- For R&S SZU, see the SZU100A Getting Started
- For R&S SGT, see the SGT100A User Manual

9.5 System configuration settings

The settings in this dialog comprise the I/Q mapping and the processing of the generated I/Q streams. Form this dialog, you can control and configure the connections to instruments connected to the RF and I/Q connectors.

Required options

The equipment layout includes:

- Base unit
- Option differential analog I/Q outputs R&S SMM-K17
- Optional, option frequency R&S SMM-B1006

For description of the "Multi-Instrument" settings, see Section 9.2.1.1, "Multi-instrument settings", on page 477.

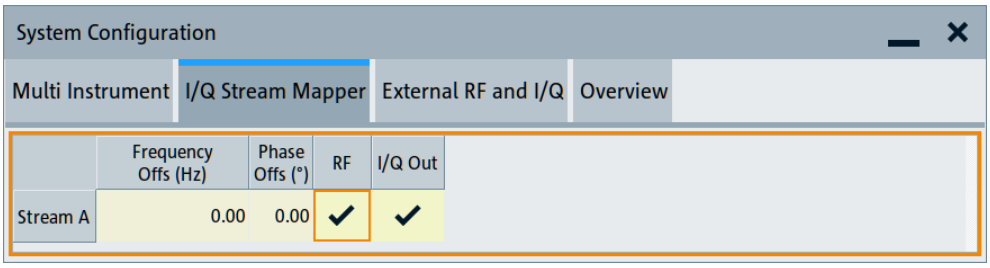
This section described the following settings:

- I/Q stream mapper settings....491
- External RF and I/Q settings....492
- External instrument configuration settings....497
- Overview....505

9.5.1 I/Q stream mapper settings

Access:

► In the block diagram, select "I/Q Stream Mapper".



The dialog provides the settings for routing of the signal streams to the available output connectors.

Settings:

Frequency Offset....492
Phase Offset....492
Map Stream X to Connector....492

Frequency Offset
Sets an absolute frequency offset f_{offset}.

Tip: Use this parameter to shift the used frequency band in the RF frequency section without modifying the RF settings.

Remote command:
`:SCONfiguration:OUTPut:MAPPing:STReam<st>:FOFFset` on page 784

Phase Offset
Sets the phase offset of the corresponding stream.

Remote command:
`:SCONfiguration:OUTPut:MAPPing:STReam<st>:POFFset` on page 784

Map Stream X to Connector
The mapping of the generated stream to the output connectors is represented as a stream matrix. A blue circle at a matrix element routes the stream to the selected connector.

Remote command:
`:SCONfiguration:OUTPut:MAPPing:RF<ch>:STReam<st>:STATe` on page 783
`:SCONfiguration:OUTPut:MAPPing:IQOutput<ch>:STReam<st>:STATe` on page 783

9.5.2 External RF and I/Q settings

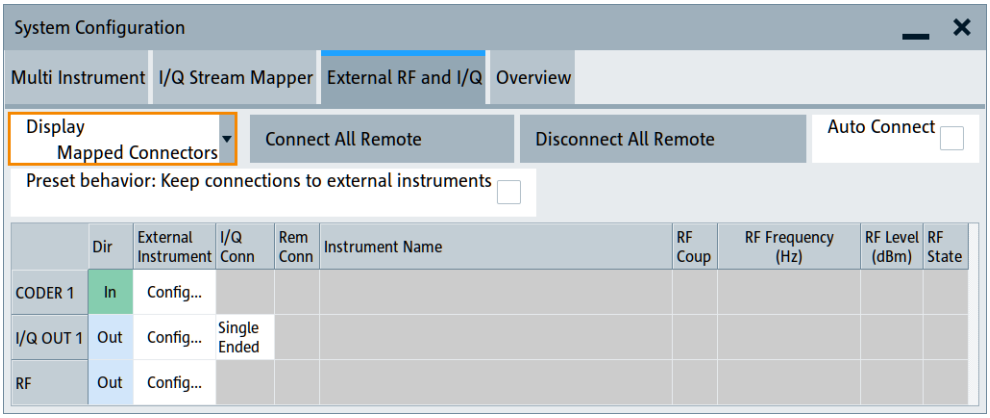
Prerequisites for connections to external instruments

Connecting external instruments to the R&S SMM100A requires the following signals and connections.

Signal	Interface	Remark
Control	LAN or USB	The control connection is enabled.
Input Output	Analog I/Q or digital I/Q Analog I/Q, digital I/Q or RF	The physical input signal or output signal is present at the interface.
Reference	Reference input or output	The external instrument and the R&S SMM100A have a common reference frequency signal.

Accessing the external RF and I/Q settings

► On the taskbar, select "System Config" > "System Configuration" > "External RF and I/Q".



The dialog provides an overview of all available I/Q input and output connectors and comprises the settings necessary to establish the connection to the external instruments. Displayed is an overview of the currently connected external instruments together with relevant information like the connection status and the RF level and frequency that these external instruments use.
The dialog provides access to some additional short information on each of the connected instruments. It also provides a show connector function for an easy localization of the selected connector on the instrument front or rear panel.

Settings:

Display 493
Auto Connect 494
Connect All Remote/Disconnect All Remote 494
Preset behavior: Keep connections to external instruments 494
Connector Name 495
Direction 495
External Instrument 495
I/Q Conn 495
Remote Connection Status 496
Instrument Name 496
RF Couple 497
(Delta) RF Frequency/ RF Level 497
RF State 497

Display
Filters the displayed connectors upon one of the following criteria:

"All Connectors"
No filter is applied.

"Mapped Connectors"
Displayed are only the connectors to which a stream is mapped.

Note: To prevent faults, use this filter before you further configure the external instruments.

"Input Connectors"/"Output Connectors"
Filters the display according to the connector direction.

Remote command:
`:SCONfiguration:EXTernal:DISPlay` on page 786

Auto Connect
If enabled, the instrument automatically detects connected external instruments and establishes the required connection.

If the "Auto Connect" > "Off", however, after a R&S SMM100A startup you have to revise the test setup and perform the following:

- Check whether the necessary connections between the R&S SMM100A and the external instruments are still existing.
- Prove that the remote control of the particular instruments is required.
- Select "Connect All Remote" or "Disconnect All Remote".

Remote command:
`:SCONfiguration:EXTernal:ACONnect` on page 786

Connect All Remote/Disconnect All Remote
Triggers the instrument to:

- Establish the remote connections to all configured external instruments.
- Terminate all existing remote connections.
  The external instruments are not removed from the list of external instruments. Only the remote connection status changes.

You can toggle the remote connection status with the parameter "Rem Conn".

Note:
External instruments connected to the R&S SMM100A are preset (`:DEVice:PRESet`) whenever:

- The connection to the external instrument is established or terminated ("Connect/ Disconnect All Remote" or "Rem. Conn > On/Off")
- The R&S SMM100A is preset ([Preset]).

To ensure that the remote connections to the external instruments will be automatically established after the startup of the instrument or a reboot, enable "Auto Connect > On".

Remote command:
`:SCONfiguration:EXTernal:REMote:CONNect[:ALL]` on page 786
`:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]` on page 786

Preset behavior: Keep connections to external instruments
Sets the effect of R&S SMM100A preset ([Preset] or `*RST`) on the following:

- The connection status between the instrument and the connected external instruments.
- The R&S SMM100A itself and the preset values.
- The connected instruments.

"Preset behavior..."	Off	On
R&S SMM100A and preset values	Standard R&S SMM100A preset See Table 10-1.	Excluded from preset: • "I/Q Output Type" See also
Connection status	Terminated ("Disconnect All Remote")	Unchanged
Connected instruments	External instrument preset (`:DEVice:PRESet`)	External instrument preset

Remote command:
`:SCONfiguration:EXTernal:PBEHaviour` on page 787

Connector Name
Displays the connector name.

Remote command:
Via keyword in the SCPI syntax, e.g. `IQOutput`

Direction
Displays the connector direction. Also the signal type (analog or digital) is color coded.

The availability of the connector depends on the connector state in the "I/Q Stream Mapper" dialog.

Remote command:
`:SCONfiguration:EXTernal:CODer<ch>:DIRection?` on page 787
`:SCONfiguration:EXTernal:IQOutput<ch>:DIRection?` on page 787
`:SCONfiguration:EXTernal:RF<ch>:DIRection?` on page 787

External Instrument
Opens a dialog with settings to establish the connection to the external instrument for the selected signal path.

See Section 9.5.3, "External instrument configuration settings", on page 497.

See also "Prerequisites for connections to external instruments" on page 492.

I/Q Conn
Selects the I/Q output signal type or indicates the I/Q connection status.

Depends on the interface type:
- Analog I/Q interfaces:
  Selects the I/Q output signal type.
- Digital I/Q interfaces:
  The column indicates the status of the I/Q connection of the digital interfaces.
  The indication includes a status LED and an icon, where the icon depends on the connector (Dig I/Q or HS Dig I/Q) used.

Indication	Designation
green LED and an icon	The Dig I/Q/HS Dig I/Q interface is used as an **input** connector
yellow LED and an icon	The Dig I/Q/HS Dig I/Q interface is used as an **output** connector
icon without an LED	An external instrument is connected to the Dig I/Q interface, but no direction is specified

Indication	Designation
No icon displayed	No connection
"Single Ended"/"Differential"	Selects the type of the I/Q output signal at the I/Q output connector Works like the parameter "I/Q Output Type" on page 515.

Remote command:
:SCONfiguration:EXTernal:CODer<ch>:IQConnection:STATe? on page 788

Remote Connection Status
The column indicates the status of the remote connection. Click the status indicator to toggle the remote connection status.

Note:
External instruments connected to the R&S SMM100A are preset (:DEVice:PRESet) whenever:

- The connection to the external instrument is established or terminated ("Connect/ Disconnect All Remote" or "Rem. Conn > On/Off")
- The R&S SMM100A is preset ([Preset]).

Note: An active "Rem. Conn." and an "RF State" > "On" do not mean that an I/Q stream is mapped to this connector.
Use the "System Configuration > External Rf and I/Q > Display > Mapped Connectors" filter to list only the connectors with a mapped I/Q stream.

Remote command:
:SCONfiguration:EXTernal:CODer<ch>:RCONnection:STATe? on page 788
:SCONfiguration:EXTernal:CODer<ch>:REMote:DISConnect on page 794
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:IQOutput<ch>:RCONnection:STATe?
on page 788
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:DISConnect
on page 794
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:RF<ch>:RCONnection:STATe? on page 788
:SCONfiguration:EXTernal:RF<ch>:REMote:DISConnect on page 794
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794

Instrument Name
The column displays useful information on the connected external instrument, like the instrument designation and the RF path the RF settings are coupled to.

Remote command:
:SCONfiguration:EXTernal:CODer<ch>:INAMe? on page 788
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:IQOutput<ch>:INAMe? on page 788
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:RF<ch>:INAMe? on page 788
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794

RF Couple
If enabled, this parameter couples all major RF settings (like the "RF Frequency", the "RF Level" and the "RF State") of the external instrument to the R&S SMM100A.

The R&S SMM100A acts as a primary instrument. Connected external instruments synchronize their settings and the RF output state to the R&S SMM100A. You can apply delta frequency and level offset to the signal.

Remote command:
:SCONfiguration:EXTernal:IQOutput<ch>:RF:COUPling on page 789
:SCONfiguration:EXTernal:RF<ch>:RF:COUPling on page 789

(Delta) RF Frequency/ RF Level
In uncoupled mode, sets the RF frequency and RF level of the external instrument.

With enabled "RF Coupled" parameter, applies a frequency and level offset. The RF frequency of the external instrument is calculated as follows:

$RF_{ExtInstr} = RF_{Instrument} + Delta_{Freq}$

Both the RF frequency and the RF frequency offset are applied at the external instrument.

Remote command:
:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency on page 789
:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency:OFFSet on page 789
:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer on page 790
:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer:OFFSet on page 790
:SCONfiguration:EXTernal:RF<ch>:RF:FREQuency on page 789
:SCONfiguration:EXTernal:RF<ch>:RF:FREQuency:OFFSet on page 789
:SCONfiguration:EXTernal:RF<ch>:RF:POWer on page 790
:SCONfiguration:EXTernal:RF<ch>:RF:POWer:OFFSet on page 790

RF State
With enabled "RF Coupled" parameter, displays the RF output state of the connected external instrument. The parameter is coupled to the state of the RF output of the R&S SMM100A.

In uncoupled mode, enables/disables the RF output in the external instrument.

Remote command:
:SCONfiguration:EXTernal:IQOutput<ch>:RF:STATe on page 791
:SCONfiguration:EXTernal:RF<ch>:RF:STATe on page 791

9.5.3 External instrument configuration settings

Access:

1. On the taskbar, select "System Config" > "System Configuration".

2. Select "External RF and I/Q" > "External Instrument" > "Config...".

   The dialog provides settings to configure the connection to the external instrument and to control to the external instrument. Also you can find out the related connector at the R&S SMM100A.

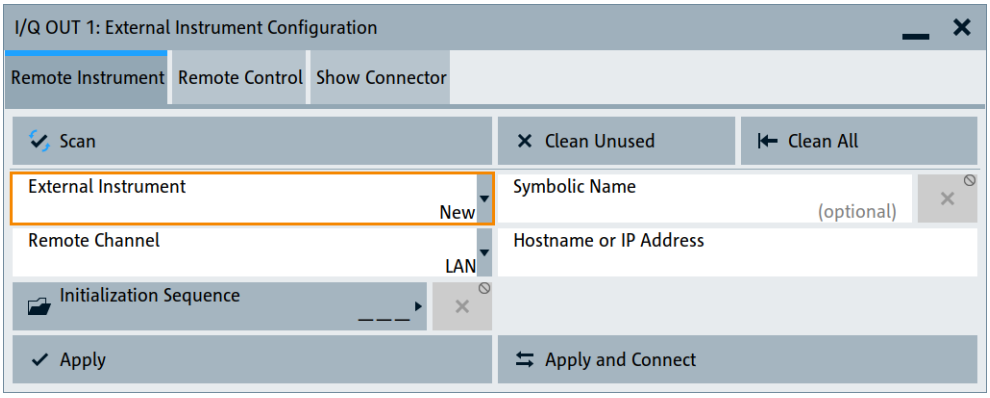
Settings:

- Remote instrument settings 498
- Remote control settings 503
- Show connector 504

9.5.3.1 Remote instrument settings

Access:

1. Select "External RF and I/Q" > "External Instrument" > "Config...".
2. Select "Remote Instrument".



The tab provides settings to configure the connection settings of the remote instrument.

Settings:

Detect 499
Scan 499
Clean Unused/Clean All 499
External Instrument 500
Set Symbolic Name 500
Remote Channel 500
Remote Channel 501
Hostname or IP Address 501
Device ID 501
RF Path 501
Frontend Configuration 501
Initialization Sequence 502

Remove Initialization Sequence....502
Apply....502
Apply and Connect....502

Detect
To use this function, connect an external instrument to the digital I/Q interface of the R&S SMM100A.

Searches for these external instruments via the LAN or USB control interface. If detected, the "External Instrument" selection lists the external instrument including its configuration for the remote control connection.

Note: The first initialization of a connection to an external instrument can last several minutes. During the initialization procedure, you cannot search for the external instrument.

Remote command:
`:SCONfiguration:EXTernal:CODer<ch>:REMote:DETect?` on page 793

Scan
Searches for external instruments via the remote control interface, for example, via the LAN interface. If detected, the "External Instrument" selection lists the external instrument including its configuration for the remote control connection.

The R&S SMM100A can search, for example, the following instruments:

R&S SMW, R&S SMM100A, R&S SMBV100B, R&S SMCV100B, R&S SGS, R&S SGT or external frontends

Note: The scan function searches throughout the entire network and can last several minutes.
The first initialization of a connection to an external instrument can last several minutes. During the initialization procedure, you cannot search for the external instrument.

Remote command:
`:SCONfiguration:EXTernal:REMote:SCAN` on page 791
`:SCONfiguration:EXTernal:REMote:SCAN:STATe?` on page 791

Clean Unused/Clean All
Removes partly or fully the configuration of external instruments the R&S SMM100A controls via the LAN interface.

This function does not affect USB control connections.

"Clean Unused"
Removes external instrument configurations from unused LAN connections. The configurations for used LAN connections remain. These connections are the enabled and configured control connections. Also, this function allows you to update the external instruments list for a new pool of valid instruments.

Remote command:
`:SCONfiguration:EXTernal:REMote:PURGe` on page 795

"Clean All" Disconnects and removes all connections of configured external instruments. Also, this function removes all instruments from the list of external instruments.

Remote command:
:SCONfiguration:EXTernal:REMote:CLEan on page 796

External Instrument
Lists all available instruments found by the Scan function.

To connect an external instrument, use one of the following:
- Enable "Select Instrument > New" and configure the settings manually.
- Select "Select Instrument", navigate trough the pool of available instruments, and select the required. The required settings are retrieved and updated automatically.

Select "None" to disable the connection.

Execute "Apply" to confirm the settings.

Remote command:
:SCONfiguration:EXTernal:REMote:LIST? on page 792
:SCONfiguration:EXTernal:REMote:ADD on page 792
:SCONfiguration:EXTernal:CODer<ch>:REMote:ISELect on page 793
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ISELect on page 793
:SCONfiguration:EXTernal:RF<ch>:REMote:ISELect on page 793

Set Symbolic Name
Sets the alias name of the instrument.

Remote command:
:SCONfiguration:EXTernal:REMote:ADD on page 792
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794

Remote Channel
Displays or selects the remote or hardware channel for control of the external instrument.

"LAN" Control via the LAN interface.

"USB" Control via the USB interface.

"Frontend Connection"
Fixed remote channel for control of external frontends via the LAN interface.

Remote command:
:SCONfiguration:EXTernal:REMote:ADD on page 792
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794

Remote Channel
Displays or selects the remote or hardware channel for control of the external instrument.

"LAN" Control via the LAN interface.

"USB" Control via the USB interface.

"Frontend Connection"
Fixed remote channel for control of external frontends via the LAN interface.

Remote command:
:SCONfiguration:EXTernal:REMote:ADD on page 792
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794

Hostname or IP Address
Displays or sets the host name or IP address of the connected external instrument.

See also "Prerequisites for connections to external instruments" on page 492.

Remote command:
:SCONfiguration:EXTernal:REMote:ADD on page 792
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794

Device ID
Sets/displays the device identifier that is a unique string with the following structure:

<frontend type>-<serial number>

For a defined "External Instrument", the information is read out automatically.

Remote command:
:SCONfiguration:EXTernal:REMote:ADD on page 792
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794

RF Path
In a two-path instrument, determines the RF output to be used.

Remote command:
:SCONfiguration:EXTernal:REMote:ADD on page 792
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 794
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO? on page 794

Frontend Configuration
Requires R&S SMM-K553 or R&S SMM-K554.

Accesses the "RF Frontend" dialog to configure settings of the connected external frontend.

For R&S SMM-K553:

For more information, see the document "R&S SMM-K553 Frontend Control User Manual".

For R&S SMM-K554:

See Section 7.13, "Multiplying RF output frequencies", on page 439.

Initialization Sequence
Accesses the standard "File Select" dialog for loading an existing initialization file (extension `*.iec`).

When you establish the connection to an external instrument ("Rem Conn" is active), the R&S SMM100A performs the following:

- Sends the command `:DEVice:PRESet`.
- Sends the content of the initialization sequence file to reconfigure the external instrument.

If necessary, perform further settings and configuration of the external instruments.

Remote command:
`:SCONfiguration:EXTernal:REMote:INITialization:CATalog?` on page 795
`:SCONfiguration:EXTernal:CODer<ch>:REMote:INITialization:FILE` on page 795
`:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:FILE` on page 795
`:SCONfiguration:EXTernal:RF<ch>:REMote:INITialization:FILE` on page 795

Remove Initialization Sequence
Deletes the loaded sequence.

Apply
Confirms the settings and displays the external instrument in the "External RF and I/Q" dialog.

Remote command:
`:SCONfiguration:EXTernal:CODer<ch>:REMote:ISELect` on page 793
`:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ISELect` on page 793
`:SCONfiguration:EXTernal:RF<ch>:REMote:ISELect` on page 793

Apply and Connect
Confirms the settings and triggers the connection establishment. In the connected instruments, the status of this active remote connection is displayed by the "Remote" indication.

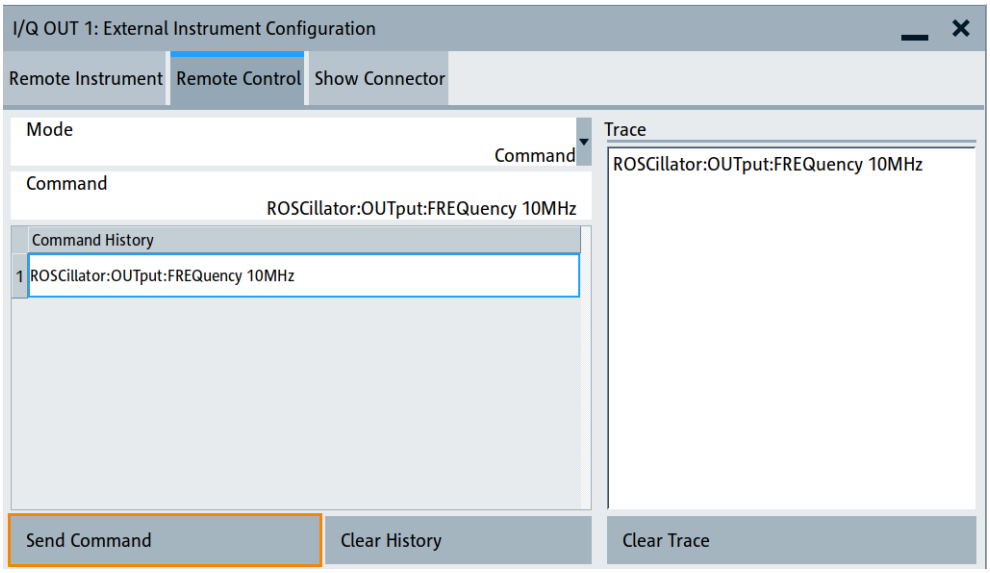
Remote command:
`:SCONfiguration:EXTernal:CODer<ch>:REMote:ISELect` on page 793
`:SCONfiguration:EXTernal:CODer<ch>:REMote:CONNect` on page 793
`:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ISELect` on page 793

:SCONfiguration:EXTernal:IQOutput<ch>:REMote:CONNect on page 793
:SCONfiguration:EXTernal:RF<ch>:REMote:ISELect on page 793
:SCONfiguration:EXTernal:RF<ch>:REMote:CONNect on page 793

9.5.3.2 Remote control settings

Access:

1. Select "External RF and I/Q" > "External Instrument" > "Config...".
2. Select "Remote Control".



In this dialog, you can send individual SCPI commands or a sequence of SCPI commands to the connected instruments.

These commands and their results are displayed in the "Command Trace" field, as long as the trace is not deleted "Clear Trace". The sent commands are also listed in the "History" list. As long as this history list is not deleted ("Clear History"), you can select a command from the list and send it again.

Settings:

Mode....503
Command/Send Command....504
File/Command Sequence/Send Sequence....504
Command History/Clear History....504
Trace/Clear Trace....504

Mode
You can send a single command ("Command") or a command sequence ("Sequence") to the connected instrument.

Command/Send Command
Entry field for the SCPI commands.

You can enter a new command or select a previously sent command from the "History".

If the remote connection is active, select "Send Command" to execute the command.

Remote command:
`:SCONfiguration:EXTernal:CODer<ch>:REMote:SEND` on page 796
`:SCONfiguration:EXTernal:IQOutput<ch>:REMote:SEND` on page 796
`:SCONfiguration:EXTernal:RF<ch>:REMote:SEND` on page 796

File/Command Sequence/Send Sequence
Opens the standard "File Select" dialog for loading of user-defined files with extension `*.iec`.

The provided navigation possibilities in the dialog are self-explanatory.

When a file is selected, its name and content are displayed, and the first command is selected. You can send the commands one by one ("Send Command") or send the entire sequence at once ("Send Sequence").

After a command is sent, the next command form the sequence is selected.

See also:
- "Initialization Sequence" on page 502
- Section 10.6.1, "File select settings", on page 535.

Command History/Clear History
List of the sent commands.

As long as this history list is not cleared ("Clear History"), you can select a command from the list and send it again.

Trace/Clear Trace
List of the sent commands and their results, where the results are displayed in blue color.

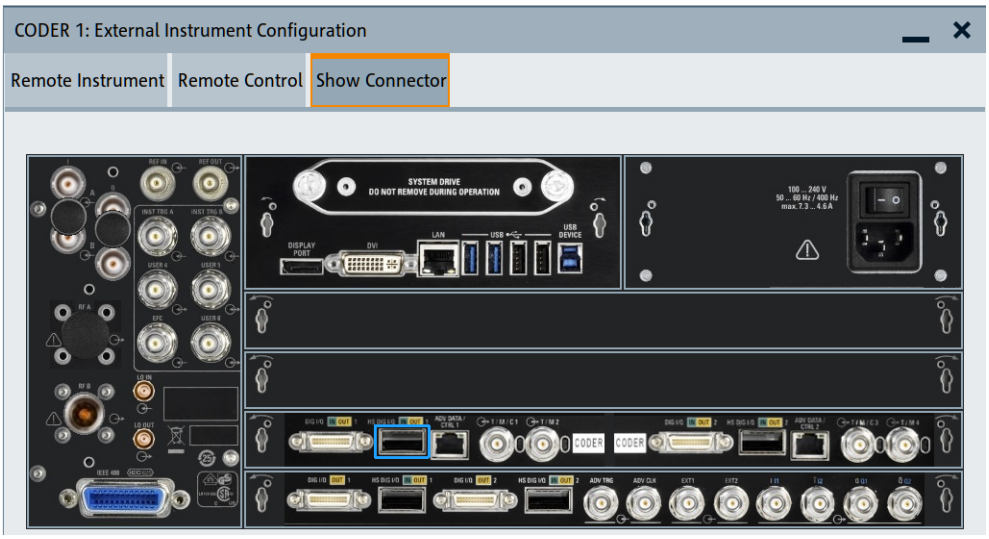
To delete the trace, select "Clear Trace".

9.5.3.3 Show connector

Access:

1. Select "Taskbar > System Config > System Configuration > External RF and I/Q".
2. Navigate to the required connector.
   Select "External Instruments > Config ...".

3. In the "<Dig. Conn. Name>: External Instrument Configuration" dialog, select "Show Connector".



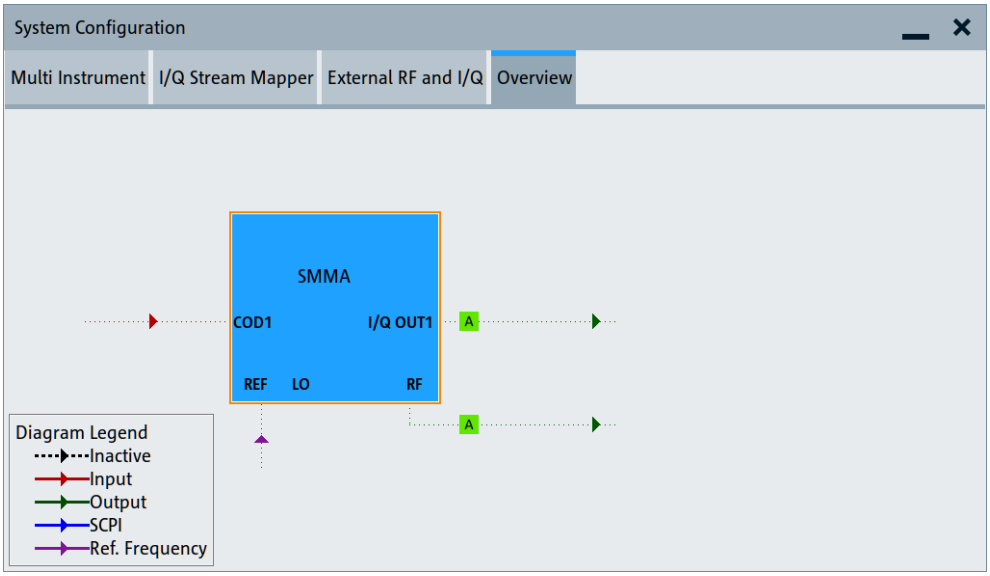
The dialog displays the location of the selected connector.
The "Show Connector" function triggers the instrument to identify the connector on the rear panel. The LED next to the selected connector blinks.

9.5.4 Overview

You can check current connections, interfaces, input signals and output signals of the R&S SMM100A in the "Overview" tab.

Access:

► Select "System Configuration" > "Overview".



The overview tab shows information on the following:

- Input signals and output signals: Type (RF, reference, HS Dig IQ, I/Q, User x) and state (active, inactive)
- Input and output interfaces
- Current stream mapping to the output interfaces
  See Section 9.5.1, "I/Q stream mapper settings", on page 491.
- Connected controller ("System Controller") and connection ("SCPI").
  See Section 9.5.2, "External RF and I/Q settings", on page 492.
- Connections for remote control of connected external devices

Hotspots for fast access to the required settings

Several of the displayed elements are hotspots. Select an element to access the related dialog.

9.6 Digital baseband input settings

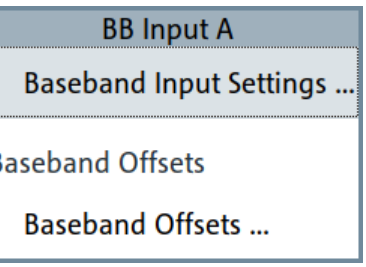
The R&S SMM100A provides interfaces to feed an **external digital baseband signal** into the signal path.

Required options

The equipment layout for applying an external baseband signal includes:

- Base unit
- Option frequency R&S SMM-B1006

For more information, refer to the specifications document.



To access and configure the "Baseband Input" settings

The **"BB Input"** block provides access to the settings for frequency offset and path gain, and to the available configuration parameters of the external signal.

The digital baseband input interface **Dig I/Q** are located on the R&S SMM100A rear panel, see Section 9.4.4, "Overview of the input and output signals and interfaces", on page 485.

In the default instrument state, the block diagram displays the connector in an unfolded state. The digital input interface is inactive.

1. To display the **"BB Input"** block if the connectors are folded, select the connector symbol "Coder 1".

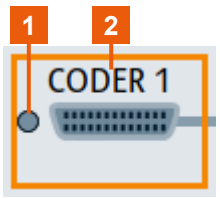


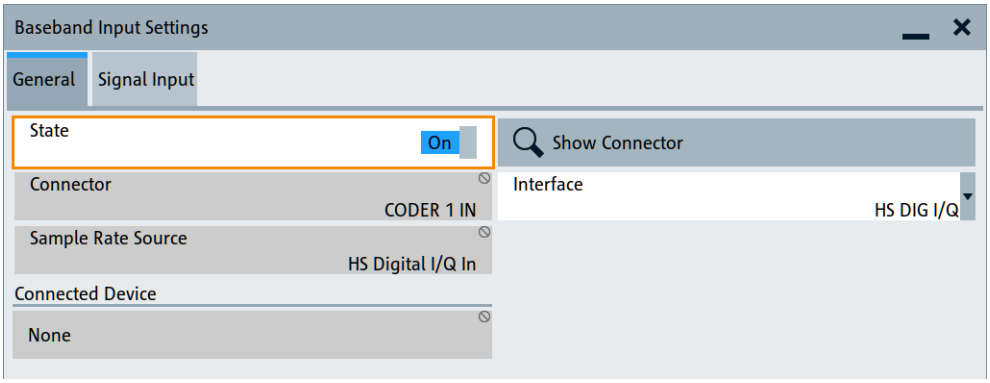
Figure 9-5: Representation of the digital baseband input interface HS Dig I/Q

1 = Digital input interface state: gray = inactive; blue = active
2 = Connector name

2. To access the frequency offset settings, select "BB Input > Baseband Offsets". See Section 4.12, "Shifting the baseband signal", on page 261.

3. To access the dialog box for configuring the external signal input, select "BB Input > Digital I/Q In > Baseband Input Settings".

   The "Baseband Input Settings" dialog provides settings necessary to define the used connector, and to adjust the signal parameters, like the sample rate and the baseband input level.



   In this dialog, you access the **settings of the Dig I/Q connector**. You recognize the type of connector that is active by the used **connector icon**.

4. To set the input connector, select "BB Input > General > Interface > HS Dig I/Q"

5. To enable the input signal:
   - Select "BB Input > On" or
   - Select "BB Input > Baseband Input Settings > State > On".

The remote commands required to define these settings are described in Section 13.17.3, "SOURce:BBIN subsystem", on page 814.

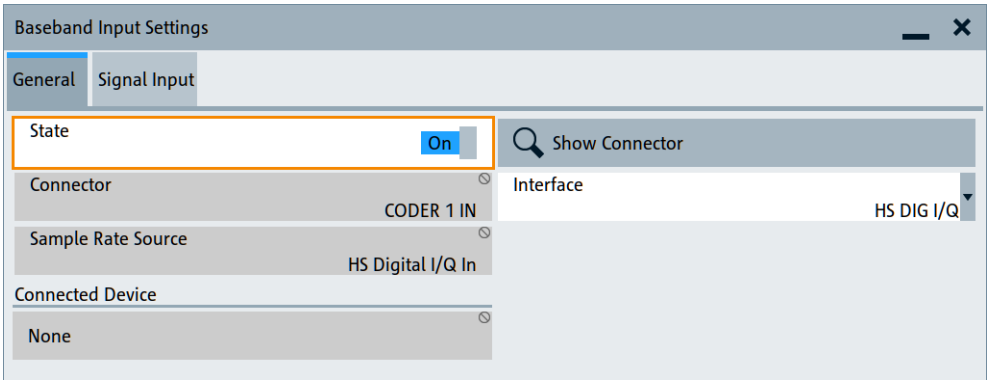
Settings:

- General settings 507
- Signal input settings 509

9.6.1 General settings

Access:

► Select "BB Input > Digital I/Q In > Baseband Input Settings".



Settings:

State....508
Connector....508
Interface....508
Sample Rate Source....508
Connected Device....509

State
Enables the feeding of the selected external digital signals into the baseband.

Remote command:
`[:SOURce<hw>]:BBIN:STATe` on page 816

Connector
Defines the connector used as an external signal source.

Available are all digital input connectors, as defined with "System Configuration" > "External RF and I/Q" > "Direction" > "Input". See "Direction" on page 495.

Remote command:
`[:SOURce<hw>]:BBIN:DIGital:SOURce` on page 816

Interface
Sets which of the digital interfaces is used, the Dig I/Q or the HS Dig I/Q.

Remote command:
`[:SOURce<hw>]:BBIN:DIGital:INTerface` on page 816

Sample Rate Source
Indicates the digital interface used to estimate the sample rate.

"HS Digital I/Q In"
Estimates the sample rate value based on the information transmitted by the transmitter.
Resulting value per channel is displayed by the parameter Sample Rate.

Remote command:
`[:SOURce<hw>]:BBIN:SRATe:SOURce` on page 819

Connected Device
If the connection to the external device is properly established and signal transmission is active, this parameter displays information on the instrument connected to the Dig I/Q interface:

- Name, serial number and port of the connected instrument
- The transmitter sample rate, if supported by the transmitter

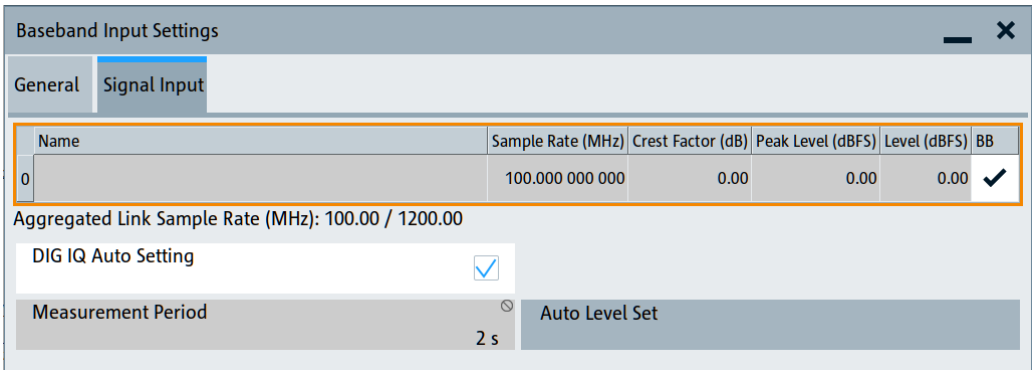
"None" indicates that no device is connected.

Remote command:
`[:SOURce<hw>]:BBIN:CDEVice?` on page 817

9.6.2 Signal input settings

Access:

1. Select "BB Input > Digital I/Q In > Baseband Input Settings > Interface = HS DIG I/Q".
2. Select "Signal Input".



Settings:

Channel Table 509
└ Number 510
└ Name 510
└ Sample Rate 510
└ Crest Factor 510
└ Peak Level 510
└ Level 510
└ BB 510
Aggregated Link Sample Rate 510
DIG IQ Auto Setting 511
Measurement Period 511
Auto Level Set 511

Channel Table
Displays information on the up to 8 digital channels per HS Dig I/Q interface:

Number ← Channel Table
Subsequent number.

Name ← Channel Table
Channel indication, set by the transmitter.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:NAME` on page 817

Sample Rate ← Channel Table
Displays the used sample rate per channel.

For information on the maximum sample rate and the aggregated link sample rate, see "Aggregated Link Sample Rate" on page 510.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:SRATe` on page 818

Crest Factor ← Channel Table
If DIG IQ Auto Setting > "Off", sets the crest factor per channel.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:CFACtor` on page 818

Peak Level ← Channel Table
If DIG IQ Auto Setting > "Off", sets the peak level per channel. The value is set as attenuation in digital baseband domain.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:PEAK` on page 818

Level ← Channel Table
Indicates the level, set automatically depending on the selected peak level and crest factor.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:RMS` on page 818

BB ← Channel Table
Activates the channel.

You can only activate one channel at a time. Toggle the state of the channel to test all channels one after another.

Remote command:
`[:SOURce<hw>]:BBIN:CHANnel<ch0>:BB:STATe` on page 817

Aggregated Link Sample Rate
Indicates the aggregated sample rate and the maximum sample rate, where:

- The aggregated sample rate is the sum of the sample rates of all active channels. It cannot exceed the maximum sample rate.
- The R&S SMM100A supports two standard max. sample rate values. This parameter indicates the currently selected one, where the max. sample rate is selected depending on the capabilities of the transmitter/receiver.

For more information, refer to the specifications document.

Remote command:
[:SOURce<hw>]:BBIN:SRATe:SUM? on page 819
[:SOURce<hw>]:BBIN:SRATe:MAX? on page 820

DIG IQ Auto Setting
Activates an automatic adjustment of the baseband input signal.

The R&S SMM100A receives peak level, level and crest factor values directly from the connected transmitter and recognizes changes automatically.

Remote command:
[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe on page 820

Measurement Period
Sets the recording duration for measuring the baseband input signal by "Auto Level Set".

Note: For accurate level measurements, set the measurement period to a time value that is long enough to capture several periods of the input signal.

Remote command:
[:SOURce<hw>]:BBIN:MPERiod on page 820

Auto Level Set
Starts measuring the input signal for estimating the crest factor, the peak level, and the Revel of the input signal.

See also "Signal processing prerequisites for external baseband signals" on page 489.

Remote command:
[:SOURce<hw>]:BBIN:ALEVel:EXECute on page 821

9.7 I/Q analog output settings

Required Options

The equipment layout for output of analog I/Q signal includes:

- Base unit
  Including output the baseband signal at the single-ended outputs
- Option differential analog I/Q outputs (R&S SMM-K17)

Location of the I/Q analog outputs

The analog output connectors I/Q are located on the R&S SMM100A rear panel, see Section 9.4.4.2, "Overview of the baseband and RF output signals", on page 486.

The block diagram displays the "I/Q OUT" connector in a folded state. The analog output connectors are inactive (gray LEDs).

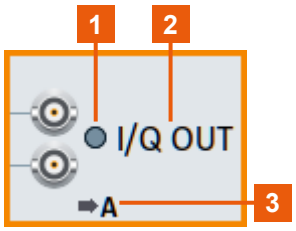
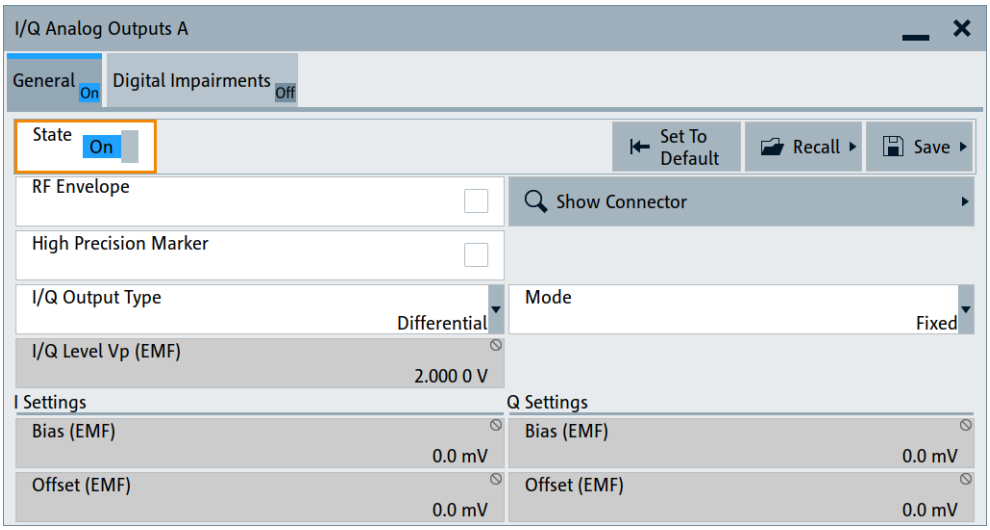


Figure 9-6: Representation of the analog output interface

1 = Analog output interface state: gray = inactive; blue = active
2 = Analog output connector name
3 = Mapped I/Q stream

To open the "I/Q Analog Output" settings

1. Select the "I/Q OUT" symbol to unfold the "I/Q Analog" block.
2. To route or reroute the signal to the analog outputs, select the "I/Q Stream Mapper" block.
3. To enable the baseband signal at the analog outputs, select "I/Q Analog" > "On".
4. To configure the analog output signal, select "I/Q Analog" > "I/Q Analog Outputs" > "General".



The dialog provides the settings for selecting the analog output signal type (single-ended or differential), enabling and generating an RF envelope signal, and adding digital impairments to the signal.
The parameters defining the voltage level of the output signal are interdependent.
See also "Maximum overall output voltage" on page 490.

Maximum overall output voltage

The voltage of the analog output signals is defined as a combination of the output voltage of the I and Q signal components and an optional bias voltage. If you use the differential output, you can also set an offset.

The values of these parameters are interdependent so that the sum of output voltage and bias voltage has an upper limit V_{max} as follows:

- Single-ended signal: $V_p + V_{bias} \leq 4$ V
- Differential signal: $0.5*V_p + |V_{bias}| + 0.5*V_{offset} \leq 4$ V

Where:

- V_p is the output voltage, see "I/Q Level Vp (EMF)" on page 516.
- V_{bias} is the bias voltage, see "Bias (EMF)" on page 516.
- V_{offset} is the offset between inverting and non-inverting output, see "Offset (EMF)" on page 517.

For more information, refer to the specifications document.

Related settings

- See Section 9.7.1, "General analog I/Q output settings", on page 513.
- See Section 5.2, "Impairing the signal", on page 280.

See the user manual R&S SMM-K540, R&S SMM-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

9.7.1 General analog I/Q output settings

Access:

► Select "I/Q Analog" > "I/Q Analog Outputs" > "General".

For impairments settings, see Section 5.2, "Impairing the signal", on page 280.

Settings:

State....513
Set To Default....514
Save/Recall....514
RF Envelope....514
Show/Show Connector....515
High Precision Marker....515
Output Voltage (EMF)....515
Additional Delay....515
I/Q Output Type....515
Mode....516
I/Q Level Vp (EMF)....516
Couple I/Q Bias....516
Bias (EMF)....516
Offset (EMF)....517

State
Enables the analog I/Q signal output at the "I/Q" or "I/Q Bar" connectors. By default, these output connectors are disabled.

Remote command:
[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe on page 987

Set To Default
Calls the default settings. The table below lists the default values of the main parameters.

Parameter	Value
"State"	Not affected by a preset
"RF Envelope"	Off
"I/Q Output Type"	Single Ended Not affected by a preset, if you have connected external instruments and "Preset behavior: Keep connections to external instruments" > "On".
"I/Q Level Vp (EMF)"	1 V
"Bias (EMF)"	0 mV

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet on page 987

Save/Recall
Opens the "Save/Recall" dialog that is the standard instrument function for saving and recalling the complete dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The settings are saved in a file with a predefined extension. You can define the filename and the directory, in that you want to save the file.

See also Section 10.5, "Saving and recalling settings", on page 529.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog? on page 987
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:STORe on page 987
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:LOAD on page 988
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:DELete on page 988

RF Envelope
Requires R&S SMM-K540.

Enables the output of a control signal that follows the RF envelope. This control signal is provided for power amplifiers envelope tracking testing. The signal is output at the I/I Bar connectors.

The envelope tracking (ET) is a method used by modern power amplifiers (PA) to improve their efficiency, especially when amplifying high crest factor RF signals. With envelope tracking, the PA estimates, i.e. "tracks", the RF signal and varies the supply voltage at the end-amplifying stage synchronous to the changes in the RF signal.

See the user manual R&S SMM-K540, R&S SMM-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:STATe

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

High Precision Marker
Enables the output of high precision marker signals at the analog I/Q output connectors "I/Q".

The high precision marker signals are narrow pulse signals. The pulse width depends on the clock rate of the internal I/Q signal. Use these marker signals for signal generation alignment in time-sensitive test setups.

How to: Section 9.3, "Generating high precision marker signals", on page 482

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker[:STATe]` on page 991

Output Voltage (EMF)
Requires "High Precision Marker" > "On".

Sets the output voltage of the high precision marker signals. The level applies for the I component and the Q component.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker:VOLTage` on page 991

Additional Delay
Requires "High Precision Marker" > "On".

Sets an additional delay for the I component (marker 1) or Q component (marker 2) of the high precision marker signals.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker:ADELay:I` on page 990
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker:ADELay:Q` on page 991

I/Q Output Type
Selects the type of output signal.

The parameters in the "I/Q Analog Outputs" dialog depend on the selected output mode.

"Single-Ended"
- If "RF Envelope" > "Off", uses a single-ended output at the I/Q connectors.
- If "RF Envelope" > "On", the envelope signal is output at the I connectors.

You can define a bias between the output signal and the ground.

"Differential" Option: R&S SMM-K17
- If "RF Envelope" > "Off", the analog I/Q signal components are output at the I/Q and I/Q Bar connectors.
- If "RF Envelope" > "On", the inverted envelope signal Ē is output at the I Bar connectors.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE` on page 988

Mode
Selects fixed mode or variable mode for the power levels at the I/Q outputs.

"Fixed" The power levels of the I/Q signal components are fixed, see table Table 9-4.

Table 9-4: Fixed mode I/Q output power levels

"I/Q Output Type"	"I/Q Level Vp (EMF)"	"Bias (EMF)"	"Offset (EMF)"
Single ended	1.0 V	I: 0.0 mV Q: 0.0 mV	-
Differential	2.0 V	I: 0.0 mV Q: 0.0 mV	I: 0.0 mV Q: 0.0 mV

"Variable" Requires R&S SMM-K17.
Enables individual power level settings of the I/Q signal components.

For more information, refer to the specifications document.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:MODE` on page 988

I/Q Level Vp (EMF)
Displays or sets the output voltage for the I and Q signal components. Setting requires "Mode" > "Variable".

To keep the I/Q analog output power levels below the maximum input power level at your DUT, see "Maximum overall output voltage" on page 490.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut:LEVel` on page 989

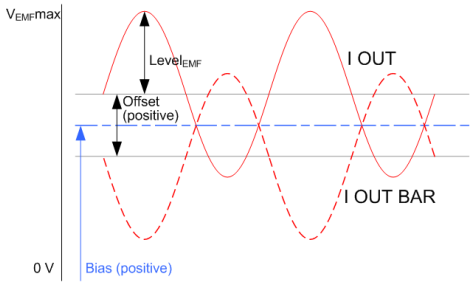
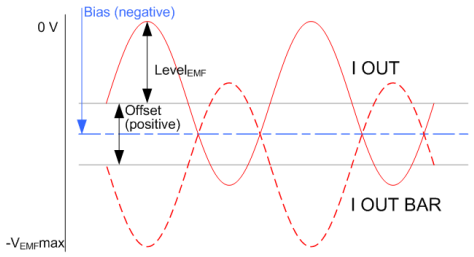
Couple I/Q Bias
Requires "Mode" > "Variable".

If enabled, couples the bias setting of the I signal and the Q signal component. The bias of the I signal component is configurable, the bias of the Q signal component updates automatically to the same value.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:COUPling[:STATe]`
on page 989

Bias (EMF)
Displays or sets the bias DC voltage. This bias is superimposed upon the I or Q signal.

Setting requires "Mode" > "Variable".

Effect of a positive bias	Effect of a negative bias
	

In "Single Ended" mode, this parameter is the bias between the I/Q output signal and the ground. Use this bias, for example, to define the operating point of a DUT.

To keep the I/Q analog output power levels below the maximum input power level at your DUT, see "Maximum overall output voltage" on page 490.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:I` on page 989
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:Q` on page 989

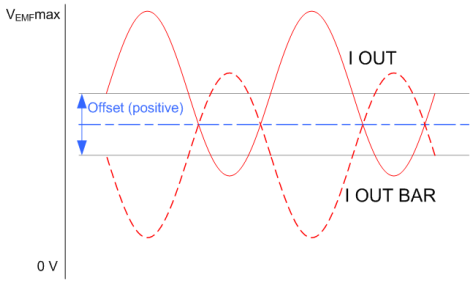
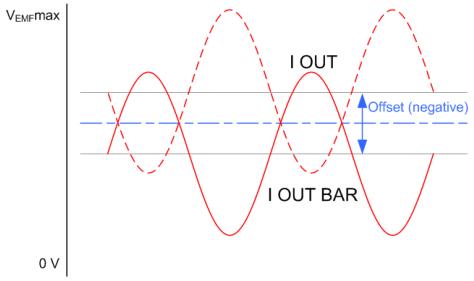
Offset (EMF)
Requires "I/Q Output Type" > "Differential".

Displays or sets the offset between the inverting and the non-inverting output. Setting requires "Mode" > "Variable".

Sets an offset between the inverting and the non-inverting output.

To keep the I/Q analog output power levels below the maximum input power level at your DUT, see "Maximum overall output voltage" on page 490.

The selected offset is set half in the positive and half in the negative direction.

Effect of a positive offset	Effect of a negative offset
	
A positive offset is set with half of the value in the positive direction at the non-inverting outputs, in the negative direction at the inverting outputs.	A negative offset is set with half of the value in the negative direction at the non-inverting outputs, in the positive direction at the inverting outputs.

Example: Effect of a positive offset on the I signal component

"I Offset" = 100.0 mV

The offsets applied on the two output connectors are as follows:

- +50.0 mV at the positive signal output
- -50.0 mV at the inverted signal output

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:I` on page 990

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:Q` on page 990

10 File and data management

The R&S SMM100A uses files to save all instrument data. The instrument allows you to save and to load instrument settings, and to import and to export user data for processing in another instrument or later. Finally, you can create a screenshot of the current settings displayed on the screen and save it as a file.

The main save and recall function for managing of the instrument settings is available via the Save/Rcl key. Dedicated save/recall functions are available in the settings dialogs of the digital standards or accessible whenever user files are used.

This section focuses on the functions provided for managing of user data files and covers the topics listed below.

For information on the related remote control commands, see Section 13.6, "MMEMory subsystem", on page 720.

For information on how to save the displayed setting in a file, see Section 10.11, "Creating screenshots of current settings", on page 552.

- Accessing, retrieving and handling data 519
- About the file system 520
- Restoring an instrument configuration 523
- Protecting data 528
- Saving and recalling settings 529
- Accessing files with user data 535
- Exporting and importing remote command lists 539
- Loading, importing and exporting lists 539
- Using the file manager 540
- Transferring files from and to the instrument 546
- Creating screenshots of current settings 552

10.1 Accessing, retrieving and handling data

Depending on the 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 generates 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 R&S SMM100A creates, such as user files that contain user-defined configurations or data, like instrument settings or measurement data. See also "Types of user data" on page 521.

You can access, retrieve and delete user files, see Section 10.9, "Using the file manager", on page 540.

Non-operational data (usage data)

The R&S SMM100A generates this data during and through its use. Such data is collected e.g. for troubleshooting, to help our customer support center find solutions quickly, or if you have purchased and activated the Health and Utilization Monitoring Service (HUMS).

The R&S SMM100A does not generate this data continuously and in real-time; this data is saved on the product. You can store the data on a remote server, for example via a network connection.

The R&S SMM100A generates the following data:

- User and authentication data
- Network and communication data
- Software and firmware update data
- Diagnostic and troubleshooting data
- Environmental conditions
- Hardware component metadata
- User behavior (HUMS only)

On demand, this data is stored in a ZIP file containing files in TXT format. The volume of the non-operational data depends on the usage of the product and typically amounts to about 30 Mbyte.

You can access, retrieve and delete this data, see:

- Network and communication data, see Section 10.5, "Saving and recalling settings", on page 529.
  The R&S SMM100A displays the network address data on the screen.
- Hardware component metadata, see Section 14.8.1, "Hardware configuration settings", on page 1108.
- User behavior, monitored by HUMS, see Section 12.5.8, "HUMS settings", on page 649.
  The R&S Health and Utilization Monitoring Service user manual is available on the Rohde & Schwarz internet.
- For all other data stored in the instrument, see Section 14.9, "Collecting information for technical support", on page 1111.

For additional information on the different memory types of your product and on how to protect sensitive data, see:

- Section 10.4, "Protecting data", on page 528.
- Instrument security procedures document.

10.2 About the file system

Depending on their content, this description distinguishes between system files and user files. System files and the system directory are protected and not accessible. User files contain user-defined configurations or data.

This section focuses on user files. It provides an overview of the R&S SMM100A file system and covers the following topics:

- "Types of user data" on page 521
- "File storage location" on page 521
- "File handling" on page 522
- "File naming conventions" on page 522
- "File extensions" on page 523
- "File contents" on page 523

Types of user data

The following data types contain user data:

- Settings or configuration files, for example, you save the current instrument settings and load these settings on another instrument.
  See Section 10.5, "Saving and recalling settings", on page 529.
- SCPI scripts that contain a series of commands. You can run the script to perform a task.
  See Section 10.7, "Exporting and importing remote command lists", on page 539.
- Externally generated waveforms. You can load the waveform files at the ARB application on the instrument.
  See Section 4.6, "Using the arbitrary waveform generator (ARB)", on page 149
- Externally or internally generated lists, for example, user correction lists. You can load these list files on the instrument.
  See Section 10.8, "Loading, importing and exporting lists", on page 539 and Section 10.6, "Accessing files with user data", on page 535.
- Externally or internally generated complex modulation data and control data. You can load these data files on the instrument.
  See Section 10.6, "Accessing files with user data", on page 535.

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 instrument is powered off and can be accessed and modified subsequently.
- *Temporary*, i.e. volatile data that the instrument retains while it is powered on.
  Volatile data is immediately lost when the R&S SMM100A is switched off.

File storage location

Without any additional measures, the R&S SMM100A stores user files on the internal memory or if connected, on a memory stick.

Both, the user directory `/var/user/` on the internal memory or the `/usb/` directory on the memory stick, can be used to **preserve** user-defined data. Any directory structure can be created.

The `/var/volatile` directory serves as a RAM drive and can be used to protect sensitive information. The data is available **temporarily**.

Default storage location

The R&S SMM100A stores user data in the user directory.

In the file system, user directory is always indicated as **/var/user/**.

In manual control, you access this directory via the "File Manager", see Section 10.9, "Using the file manager", on page 540. In remote control, you can query it with the command `:SYSTem:MMEMory:PATH:USER?`.

To query and change the default directory used for mass storage, use the command `:MMEMory:CDIRectory`.

File handling

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 10.9, "Using the file manager", on page 540.

To *transfer files* from and to the instruments or to exchange files, use one of the following alternatives:

- Connect a memory stick to one of the USB interfaces.
  The instrument automatically recognizes a connected memory stick and assigns the `/usb/` drive to it.
- Connect the instrument to a LAN.

  An instrument connected to a LAN supports two standard file transfer methods from a remote client:
  - FTP (file transfer protocol)
  - File sharing according to the SAMBA/SMB (server message block) protocol.

  Both file transfer methods open the folder `/user` that is the `/var/user/` folder on the instrument.
  For a step-by-step description, see Section 10.10, "Transferring files from and to the instrument", on page 546.
- Map a network folder or a computer to an instrument connected to a LAN.
  A mapped network folder is indicated as `/shares/<"Local Folder">`.
  For a step-by-step description, see Section 10.9.4, "Mapping a network folder", on page 544.

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 and *is case-sensitive*, i.e it is distinguished between uppercase and lowercase letters.
- All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the filename).
- Avoid using special characters.
- Do not use slashes "\" and "/". These symbols are used in file paths.

- Avoid using the following filenames: `CLOCK$`, `CON`, `COM1 to COM4`, `LPT1 to LPT3`, `NUL` or `PRN`
  They are reserved by the operating system.

File extensions

The R&S SMM100A distinguishes the files according to their extensions; each type of file is assigned a specific file content and also a specific file extension. The extension is usually of no consequence to you since access to the files occurs in the individual dialogs where only the relevant type of file is available. For example, files with user correction data can only be saved and loaded in the "UCOR" dialog.

See Section A, "Available user files and file extensions", on page 1135 for an overview of the supported file extensions.

File contents

To maintain the file size and to accelerate processing times, the instrument saves settings that deviate from their default values. Considered is also configuration data for the operating elements and lists with user data, e.g. dialog positions and a list of user correction data. However, if a list data is part of the instrument settings, a reference to this list is saved, not the list itself.

This approach ensures that the created files contain only relevant information and allows you to transfer instrument settings even between different equipped signal generators. During the recall process, the instrument interprets only the relevant settings; all non-referenced parameters are set to their preset values. Error messages indicate the settings which cannot be implemented, like referencing non-existing lists or the attempt to activate settings which are not supported by the instrument.

10.3 Restoring an instrument configuration

The R&S SMM100A has various options to set default settings. You can preset the R&S SMM100A to an initial state at any time as a known starting point for configurations. It is often useful as a first step during troubleshooting when unusual results arise.

The figure Figure 10-1 shows the impact of the particular reset functions.

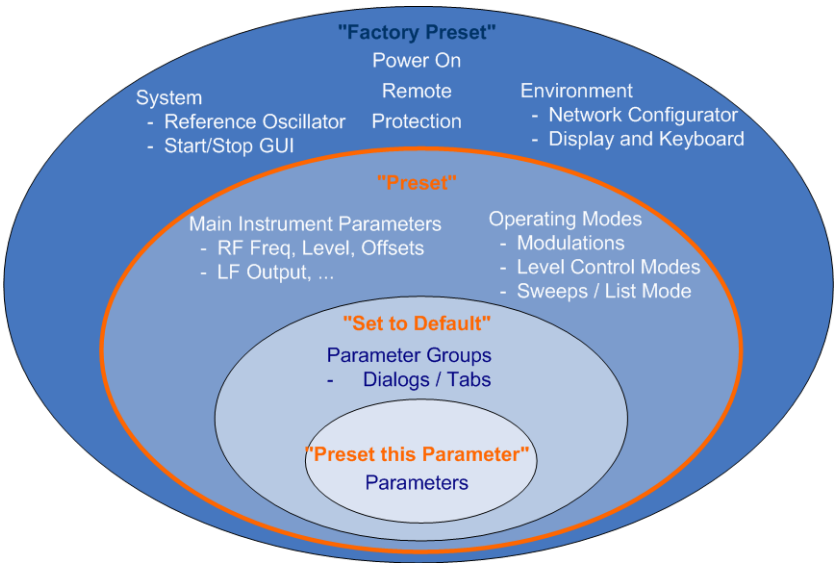


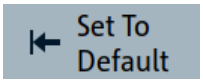
Figure 10-1: Preset functions for parameters and operating modes

Overview of the characteristics of the preset functions

Select the preset option that most fits to your particular application:

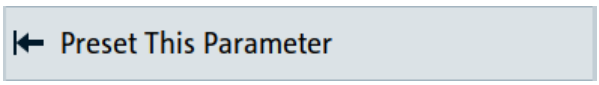
- [Preset]
  It is the most frequent function. A preset executes a defined instrument setup to provide an initial instrument state as a basis for a new configuration.
  It resets all parameters and switching states including the states of inactive operating modes. Also, it resets external instruments connected to the R&S SMM100A.
  A preset does not change network settings, remote access settings or system settings.

► To execute a preset, press the [Preset] key at the front panel.



- "Set to Default"
  This function relates to individual dialogs or tabs and resets the associated settings of the corresponding dialog. All other settings are retained.
  For example, you can use it to reset all digital modulation settings in the "Custom Digital Mod" dialog.

► To reset the settings, click "Set To Default".



- "Preset this parameter"
  Sets a single parameter to its default value.

1. To reset an individual parameter, open its context-sensitive menu.
2. Select "Preset This Parameter".

- "Factory Preset"
  A factory preset is the most profound preset function that resets almost all instrument settings, including reference oscillator, network and remote access settings.

  A factory preset does not change the following settings:
  - Security, password, and settings protected by these passwords
  - User-defined data, like setups or data lists
  - Settings that relate to an integration of the instrument in a measurement setup.

► **NOTICE!** Execute a "Factory Preset" only if it is necessary. After a "Factory Preset", the network connection to the instrument no longer exists.

To restore the factory defaults, select "System Config" > "Setup" > "Settings" > "Factory Preset".

Presetting the instrument to a user-defined state

The reset functions set the parameters and operating modes to default values predefined by the factory. Alternatively to the instrument default settings, you can preset the instrument to a user-defined state:

- Save and reload user-defined settings as preset, see Section 10.3.3, "Presetting the instrument to a user-defined state", on page 527.
- Save and reload user-defined instrument states, see Section 10.5.2, "Saving and recalling instrument settings", on page 533.

Marking parameters with non-default values

To check the current state of the settings concerning default values, the R&S SMM100A offers a feature that visually identifies deviations from the default values.

For more information, see Section 10.3.2, "Identifying parameters with non-default values", on page 526.

10.3.1 Preset, set to default and factory preset settings

Preset....525
Set To Default....526
Preset this Parameter....526
Execute Factory Preset....526

Preset
Resets all parameters and switching states, and closes all opened dialogs.

Note:
In contrast to the [Preset] key, the SCPI commands `*RST` and `:SYSTem:PRESet` do not close open dialogs in the GUI.

Consider also the following possibilities:

- You can define the settings that are restored when you preset the instrument (see Section 10.3.3, "Presetting the instrument to a user-defined state", on page 527)
- You can reset the instrument to the factory state (see "Execute Factory Preset" on page 526)

See also Table 10-1 that contains the key parameters that are reset by the corresponding preset functions.

Remote command:
`*RST` on page 713

Set To Default
Resets the associated settings of the corresponding dialog or tab.

Remote command:
For example, `[:SOURce<hw>]:BB:<Digital Standard>:PRESet`

Preset this Parameter
Restores the default value of a single parameter.

Execute Factory Preset
Resets the instrument to its factory settings.

Note: "Factory Preset" retains all security settings and does not delete any user files like setups or user data.
See also Table 10-1 that contains the key parameters that are reset by the corresponding preset functions.

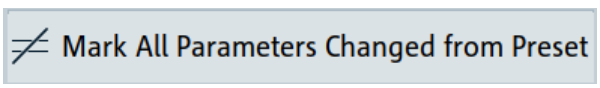
Remote command:
`:SYSTem:FPReset` on page 719

10.3.2 Identifying parameters with non-default values

To recognize the current state of the settings related to their default values at the first glance, enable a function that visually identifies parameters in states different than preset.

To enable this display:

1. To open the context-sensitive menu, touch and hold the screen anywhere in the GUI of the R&S SMM100A.
2. Select "Mark All Parameters Changed from Preset".



If enabled, marks the parameters that deviate from their default values.

Example:

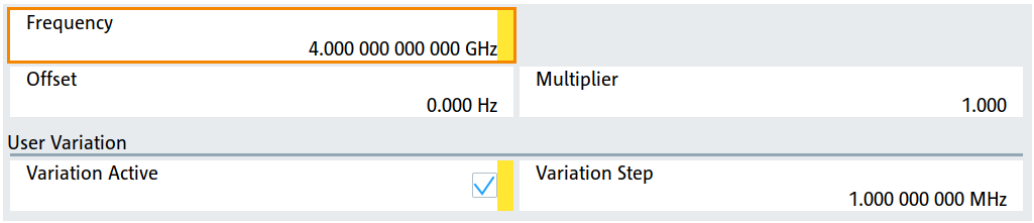


Figure 10-2: Marked parameters show that the value deviates from its default

Frequency = changed (default = 1 GHz)
Offset = changed (default = 0 kHz)
Multiplier = unchanged
Variation active = changed (default = disabled)
Variation step = unchanged

10.3.3 Presetting the instrument to a user-defined state

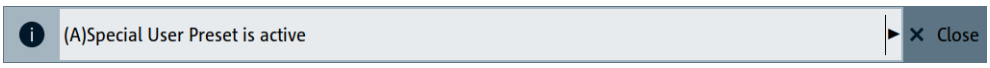
You can define the settings that are restored when you preset the instrument.

Note: The preset of the instrument to a user-defined state does not include all modified settings. For information, see the corresponding description of the settings.

1. Configure the settings as required.
2. Save them as described in Section 10.5.2, "Saving and recalling instrument settings", on page 533:
   a) Save the settings as a file with the predefined filename `UserPreset` without file extension.
   The save function assigns the file extension `.savrcltxt` automatically.
   b) Save this file in the directory **`/var/user/`**.

   The filename `UserPreset` and the directory `/var/user/` are mandatory.
3. Press the [Preset] key.
   When operating the instrument remotely, send the `*RST` command.

   The instrument restores the user-defined settings. An "Info" message appears and confirms loading of a file with user-defined preset settings.



10.3.4 Reference

See Table 10-1 for an overview of the main generator settings that are affected by the corresponding preset functions. While the regular [Preset] key primarily resets the signal relevant parameters of the instrument, the "Factory Preset" affects almost all instrument settings.

For information on the default values of further parameters, see the description of the corresponding remote commands.

Table 10-1: Key parameters affected by preset and factory preset

Parameter	Preset value	Preset	Factory Preset
RF frequency	1 GHz	x	x
RF level (RF output)	off	x	x
RF level limit	30 dBm	-	x
Offsets	0	x	x
Modulation state	off	x	x
LF output state	off	x	x
Sweep state	off	x	x
List mode state	off	x	x
Reference frequency settings	-	-	x
Network settings	-	-	x
Hostname	-	-	x
GPIB address	-	-	x
Start or stop display update	-	-	x
Display and keyboard settings	-	-	x
Preset behavior: Keep connections to external instruments	off	-	x
Password and password-protected settings	-	-	-
Security settings	-	-	-
User files (setups, user correction, etc.)	-	-	-
HUMS	off	-	x

10.4 Protecting data

During operation, the R&S SMM100A saves user data permanently in the user directory, see "File storage location" on page 521.

To protect any classified data and to avoid saving any sensitive data on the R&S SMM100A permanently, you have the following options:

- Activate the **volatile mode**. This mode redirects user data to the volatile memory, see "Volatile Mode" on page 608.
  The internal memory is write-protected.
  Once you power off the instrument for at least five minutes, all volatile memory modules lose their contents.

To avoid loosing this data, connect an **external memory device**, for example, a USB flash drive.

See also:

– "Default storage location" on page 522
– "Volatile Mode" on page 608
– Section 10.10.4, "Using a USB storage device for file transfer", on page 550

- Save user files **temporarily in the `/var/volatile` directory**, which remains available only until the instrument is turned off.
  You can access data in the volatile memory just as data that is saved permanently in the `/var/user/`.
  See also Section 10.9.3, "Displaying all saved files", on page 544.

To remove the system drive

1. **NOTICE!** You can damage the instrument and loose data, when removing the system drive during operation.
   Switch off the R&S SMM100A.
   See "To shut down the product" on page 34.
2. Remove the system drive from the instrument.

For detailed information on how to protect the instrument and to protect sensitive data from unauthorized access, refer to the document Instrument Security Procedures.

10.5 Saving and recalling settings

You can save and recall instrument settings, user settings and other related data for the following use cases:

- Reload or repeat a specific signal generation task on the instrument.
- Transfer a specific configuration of your instrument to another instrument, for example in multi-intrument setups.
- Save or load complete instrument settings to or from a file.
- Save or load settings of a particular digital standard or a firmware option.

Save or recall the complete instrument settings

Two different methods are available for managing *complete instrument settings*:

- Quick (immediate) Save/Recall
  A defined set of instrument settings are saved or recalled quickly in just one step, without defining a filename or storage location. This function enables a fast switching between different instrument settings.
- Save/Recall in files with user-defined names
  The defined set of instrument settings are saved to a definable storage location. The file extension is `*.savrcltxt`.
  Settings files created in this way are visible in the file system and accessible with the supported methods for file handling.

In the general case, a recall process replaces the instruments settings with the saved values. An exception is the frequency and level settings. During recall of the instrument settings, it is possible to retain the current settings or to overwrite them with the saved values.

Save/Recall the settings belonging to a firmware option

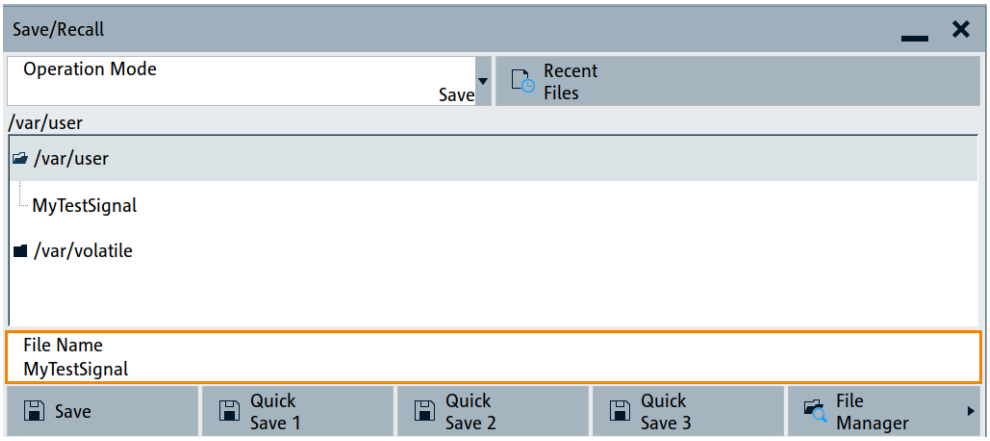
Each of the firmware option provides a special "Save/Recall" function to manage directly the settings associated to the corresponding digital standard, e.g. all settings in the "3GPP FDD" dialog.

The "Save/Recall" function creates files with user-defined names, predefined file extension and on a definable storage location. The files are accessible with the supported methods for file handling.

10.5.1 Save/Recall settings

Access:

1. Press the [Save/Rcl] key.
2. Select "Operation Mode" > "Save" or "Recall" to open the corresponding settings.

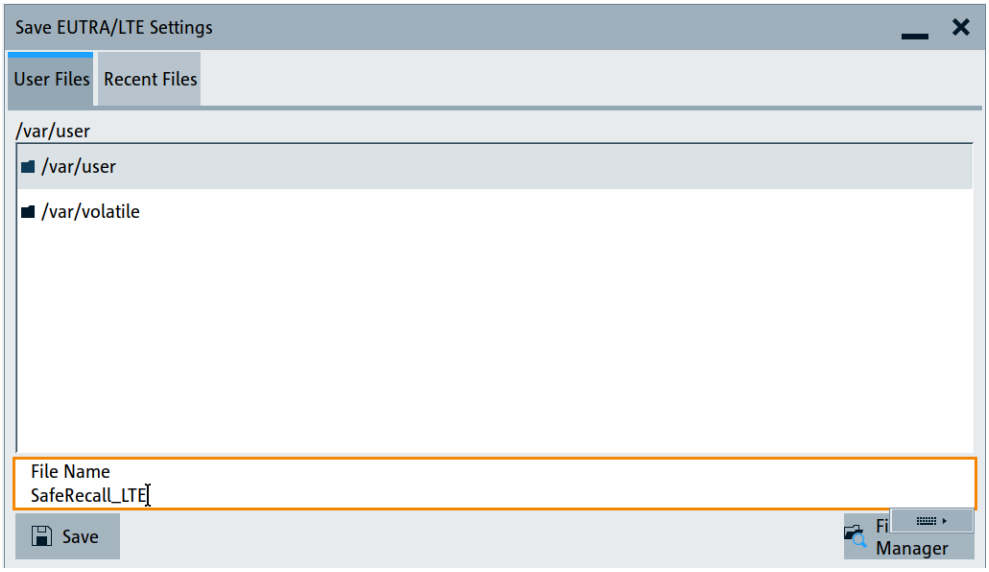


The settings for both operation modes are similar and related.

To access save or recall settings of a firmware option

► In the general dialog of the corresponding digital standard, select the "Save" or "Recall" function.
For example, select "Baseband" > "EUTRA/LTE" > "General" > "Save".

The name of the dialog is context-sensitive and differs depending on the particular digital standard. The provided functions are similar.



Settings:

Operation Mode 531
Directory, File List and Filename 531
Recent files 532
Show SCPI List 532
SCPI List 532
Save 532
Quick Save x 532
Exclude Frequency 533
Exclude Level 533
Recall 533
Quick Recall x 533
File Manager 533

Operation Mode
Accesses the settings for storing ("Save") and loading ("Recall") of the instrument settings. Also, you can import SCPI-Files ("SCPI-Import") or export SCPI files ("SCPI-Export").

See Section 10.7, "Exporting and importing remote command lists", on page 539.

Directory, File List and Filename
Note:
You access this generic standard function each time you perform one of the following:
- Save or load (settings) files
- Define a folder in that these files are saved
- Navigate through the file system.

The dialog name changes depending on the context. The provided functions are self-explanatory and similar.

Use the settings for example as follows:
- To navigate through the file system, use the directory tree.

- To create a file, load and save files, use the dedicated functions "New", "Select", Save, and Recent files.
- To access the general data table editor, use the "Edit" button
- To perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Section 10.9, "Using the file manager", on page 540).

Remote command:
To list all files in a directory:
`:MMEMory:CDIRectory` on page 726
`:MMEMory:CATalog?` on page 725
Refer to the description of firmware options for the syntax of the corresponding SCPI command:
`[:SOURce<hw>]:BB:<Digital Standard>:SETTing:CATalog`
`[:SOURce]:CORRection:CSET:CATalog?` on page 959
To list files with user data:
`[:SOURce<hw>]:BB:DM:DLISt:CATalog?` on page 867
`[:SOURce<hw>]:BB:DM:CLISt:CATalog?` on page 867

Recent files
Displays the files last used.

Show SCPI List
Opens the "SCPI List", which lists the current settings of the R&S SMM100A as SCPI commands.

The R&S SMM100A provides this function for Operation Mode > SCPI-Export.

SCPI List
Provides a list of all SCPI commands corresponding to the current instrument settings.

Save
Saves the current instrument settings or the settings belonging to a digital standard under the defined filename.

Remote command:
`:MMEMory:STORe:STATe` on page 732
Refer to the descriptions of the firmware options for the correct syntax of the corresponding SCPI commands:
`[:SOURce<hw>]:BB:<Digital Standard>:SETTing:STORe`
`[:SOURce<hw>]:BB:<Digital Standard>:SETTing:DELete`

Quick Save x
Stores the current instrument setting in one of the intermediate memories.

These instrument settings are retained until a different instrument setting is stored in the intermediate memory. When the instrument is switched off, the contents of the intermediate memories are retained.

Remote command:
`*SAV` on page 714

Exclude Frequency
The current frequency is retained when a stored instrument setting is loaded.

Remote command:
[:SOURce<hw>]:FREQuency[:CW|FIXed]:RCL on page 977

Exclude Level
The current level is retained when a stored instrument setting is loaded.

Remote command:
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:RCL on page 1038

Recall
Restores the selected configuration.

During recall, the instrument considers all related settings, for example sweeps in active state or lists. An error message indicates the settings which cannot be implemented.

Remote command:
:MMEMory:LOAD:STATe on page 730
Refer to the descriptions of the firmware options for the correct syntax of the corresponding SCPI command:
[:SOURce<hw>]:BB:<Digital Standard>:SETTing:LOAD

Quick Recall x
Loads the selected configuration from one of the intermediate memories. A message appears if no instrument configuration is stored in this memory.

Remote command:
*RCL on page 713

File Manager
Accesses the "File Manager" dialog, see Section 10.9, "Using the file manager", on page 540.

10.5.2 Saving and recalling instrument settings

Instrument settings can be saved to a file and loaded again later, so that you can repeat the tests with the same settings.

To access and recall instrument setups quickly

► Assign the appropriate action to the [★ (User)] key.
See Section 11.4.2, "How to assign actions to the [★ (User)] key", on page 583.

To save and recall instrument settings

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "Operation Mode" > "Save".
2. Select "Quick Save 1".

The instrument saves its settings in the intermediate memory 1. The filename and the storage location cannot be changed.

3. Adapt the instrument settings as required. Select "Quick Save 2"
4. To restore the settings, select the "Operation Mode > Recall"
5. Select "Quick Recall 1"

   The instrument is restored to the previous state.
6. Select "Quick Recall 2" to switch to the settings saved in the second file.

To save complete instrument settings

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "Operation Mode" > "Save".
2. In the file selection dialog, select a filename and storage location for the settings file.
3. Select "Save".

   A file with the defined name and path and the extension `*.savrcltxt` is created.

To restore an instrument configuration

Save the configuration as described in "To save complete instrument settings" on page 534.

1. To restore settings, select "System Config" > "Setup" > "Settings" > "Save / Recall" > "Operation Mode > Recall".
2. To retain the current frequency settings, enable "Save"/"Recall" > "Exclude Frequency",
3. To retain the current level settings, enable "Save"/"Recall" > "Exclude Level",
4. In the file select dialog, select the filename and storage location of the settings file.

   The settings are restored, but the frequency and level settings are retained. You can repeat the signal generation with the same settings.
   See also Section 10.3.3, "Presetting the instrument to a user-defined state", on page 527.

10.5.3 Recalling firmware option settings

Some test setups, e.g. for MIMO tests, require that two or more instruments generate baseband signal with similar settings. One easy way to speed up the configuration is to use the dedicated save/recall function to transfer the configuration data from one instrument to the other.

To transfer settings of a digital standard to another instrument

1. In the first instrument, select for example "Baseband" > "3GPP FDD".

Adjust the settings as required.

2. In the "General" tab, select "Save".
   In the file selection dialog, select a filename and storage location for the settings file.

   A file with the defined name and path and a predefined extension (`*.3g`) is created.

3. Connect both instrument to a LAN.
   Alternatively, use a USB flash drive to transfer the created `*.3g` file to the second instrument.

4. In the second instrument, select "Baseband > 3GPP FDD > General > Recall" to load the saved file.

5. Navigate in the file selection dialog. Select the filename and storage location of the settings file.

   The settings are loaded in the second instrument. If the corresponding settings are left unchanged, the second instrument generates a signal with identical baseband settings.

10.6 Accessing files with user data

When calculating signals according to the different digital standards or when generating custom digitally modulated signals, the R&S SMM100A uses the data from different data sources (see also Section 4.4.1.1, "About data signals", on page 86). To simulate the signal of one UE for instance, the instrument modulates and codes the provided data for each channel. It further processes the signal as described in the corresponding standard.

Whenever a data list file is enabled as a data source, the instrument provides direct access to the standard "File Select" function. This function enables you to select, create and edit the data list files.

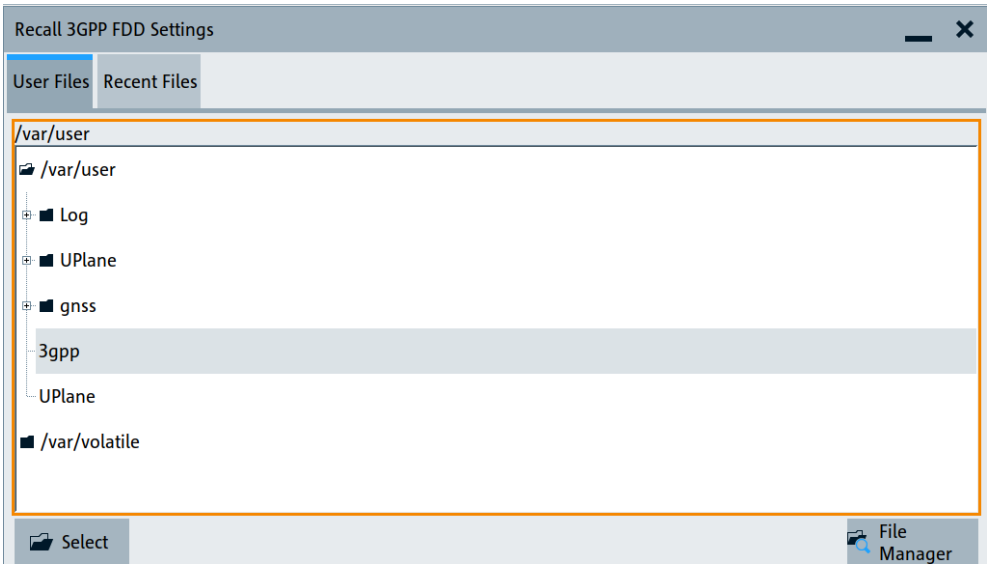
10.6.1 File select settings

The "File Select" dialog opens automatically each time you select a data list file as data source or you select a control list.

To access a loadable data list file

1. Select the "Data List Name" in the individual dialog.
   For "Baseband > 3GPP FDD > Base Stations > BS1 > Channel Table > P-CCPCH > Data = Data List", for example, select "DList Patt = None".

   A file select dialog for loading, creating and modifying a file opens.



Tip: The name of the dialog is context-sensitive and differs depending on the particular function this dialog is from. However, the provided functions are similar.

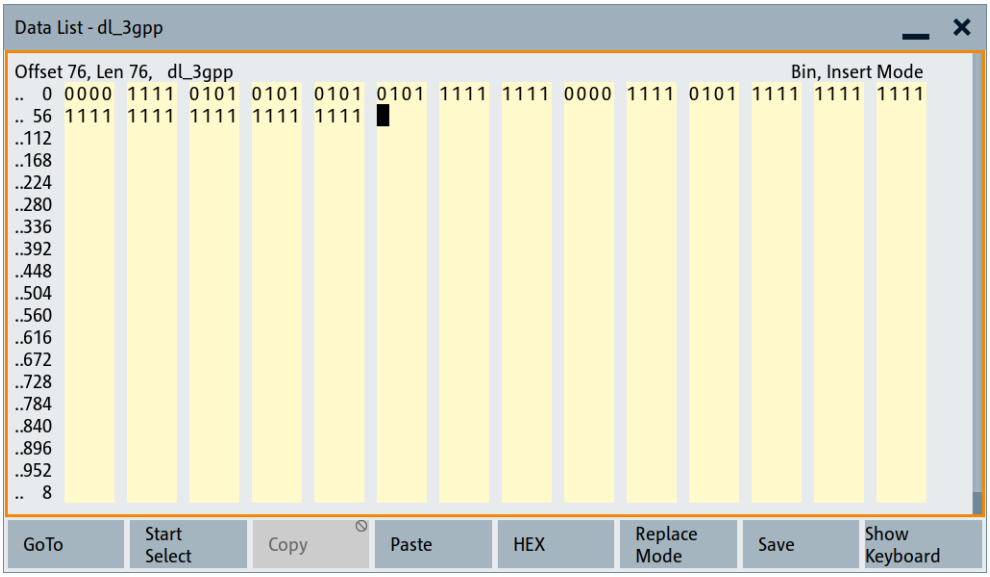
2. To load an existing file:
   Navigate through the file system.
   Select the file and confirm with "Select".

3. To create a file, for example if there is no data list file specified:
   Navigate through the file system.
   Select "New" and specify the filename.

   A new empty file is created and saved in the selected folder.

4. To edit an existing or newly created file:
   Navigate through the file system.
   Select the file and select "Edit".

   The standard "Data List Editor" dialog opens.
   See Section 4.5.3.7, "Data list editor", on page 130.



5. Edit the file content.
   Confirm with "Save".

Settings:

Directory, File List and Filename....537
Functions for handling of data lists....538
Functions for handling of control lists....538
Recent files....538
File Manager....538

Directory, File List and Filename
Note:
You access this generic standard function each time you perform one of the following:

- Save or load (settings) files
- Define a folder in that these files are saved
- Navigate through the file system.

The dialog name changes depending on the context. The provided functions are self-explanatory and similar.

Use the settings for example as follows:

- To navigate through the file system, use the directory tree.
- To create a file, load and save files, use the dedicated functions "New", "Select", Save, and Recent files.
- To access the general data table editor, use the "Edit" button
- To perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Section 10.9, "Using the file manager", on page 540).

Remote command:
To list all files in a directory:
`:MMEMory:CDIRectory` on page 726
`:MMEMory:CATalog?` on page 725

Refer to the description of firmware options for the syntax of the corresponding SCPI command:
`[:SOURce<hw>]:BB:<Digital Standard>:SETTing:CATalog`
`[:SOURce]:CORRection:CSET:CATalog?` on page 959
To list files with user data:
`[:SOURce<hw>]:BB:DM:DLISt:CATalog?` on page 867
`[:SOURce<hw>]:BB:DM:CLISt:CATalog?` on page 867

Functions for handling of data lists
Provided are the following standard functions for file handling:

"Select" Select and load the file.

Remote command:
`[:SOURce<hw>]:BB:DM:DLISt:SELect` on page 868
Refer to the descriptions of the firmware options for the correct syntax of the corresponding SCPI command:
`[:SOURce<hw>]:BB:<Digital Standard>:...:DATA DLISt`
`[:SOURce<hw>]:BB:<Digital Standard>:...:DSELect`

"New" Creates file with the specified "Filename".
To confirm, select "OK"; use "Cancel" to undo the operation.
To edit the file content, select "File Select > Edit".

"Edit" Accesses the "Data List Editor" and loads the selected file for editing
See Section 4.5.3.7, "Data list editor", on page 130.

Functions for handling of control lists
Provided are the following standard functions for file handling:

"Select" Select and load the file.

Remote command:
`[:SOURce<hw>]:BB:DM:CLISt:SELect` on page 868

"New" Creates file with the specified name. To edit the file content, select "File Select > Edit".

"Edit" Access the "Control List Editor" and loads the selected file for editing, see Control and marker lists editor.

Recent files
Displays the files last used.

File Manager
Accesses the "File Manager" dialog, see Section 10.9, "Using the file manager", on page 540.

10.6.2 Creating data lists and control lists

The general principle for accessing files with user data is described in "To access a loadable data list file" on page 535. Detailed and further information on how to create

and access files with user data like data lists and control lists is provided in the following sections:

- Section 4.5.4.2, "How to create and assign a data list", on page 137
  Overview of the possible ways and a detailed description on how to create data lists.
- Section 4.5.4.1, "How to create and assign a control list", on page 136
  Overview of the possible ways and detailed description on how to create control lists.
- Section 13.6.2, "Handling files in the default or in a specified directory", on page 721
  Information on accessing files in a remote environment

10.7 Exporting and importing remote command lists

To set specific instrument settings or perform tasks automatically, you can create scripts or import scripts that contain the settings in the form of remote control command sequences.

The R&S SMM100A also offers a SCPI macro recorder with code generator to record manual settings and create an executable script.

Completed scripts are saved in files and possibly converted to different formats, depending on the language of the source code.

The R&S SMM100A supports the following commonly used languages:

- Plain SCPI: `*.txt`
- MATLAB: `*.m`
- NICVI: `*.c`
- Python: `*.py`

It is also possible to convert the SCPI command list to a user-specific language.

How to: Section 12.10, "Using remote command scripts", on page 689

10.8 Loading, importing and exporting lists

The R&S SMM100A provides built-in editors for creating list files, for example for the list mode or lists with user correction data. You can also create or evaluate them with an external application. The instrument provides interfaces with the following functionality:

- Import and export list files in a standard ASCII format file
- Load files with modulation and control information
- Load an internally or an externally generated waveform file

Lists are saved and loaded in the corresponding dialogs. For example, the user correction data list is created and saved in the "User Correction" dialog.

Waveform files are created with the signal generation software R&S WinIQSIM2 or in the dialogs of some of the digital standards.

For more information, see the following sections:

- Section 10.6.2, "Creating data lists and control lists", on page 538
- Section 7.12.3.4, "Import/export list files", on page 416

10.9 Using the file manager

The "File Manager" is a tool similar to a standard Windows Explorer. It helps you manage mass storage media and files saved on the R&S SMM100A.

You can perform the following tasks:

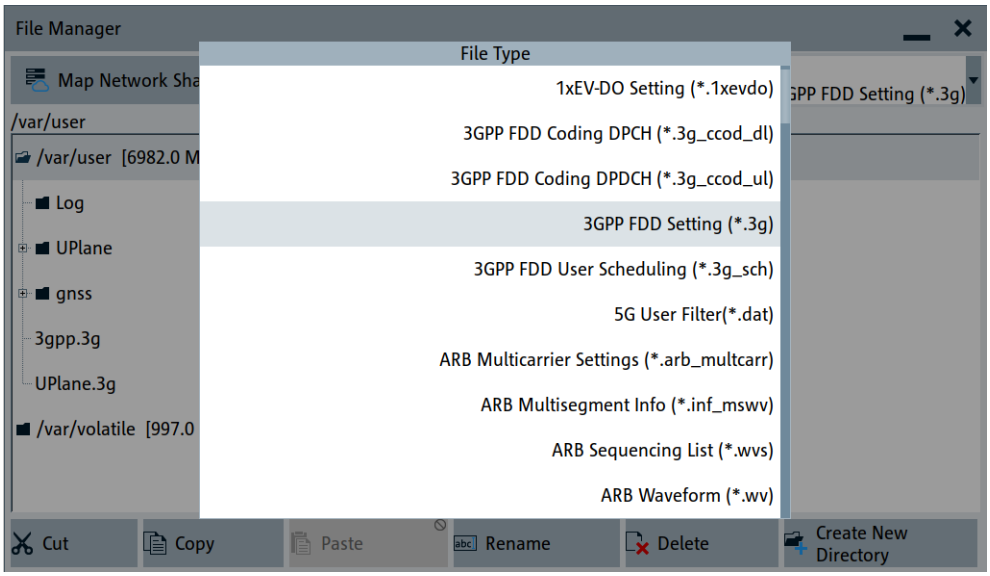
- Copying multiple files from disk to other media
  See Section 10.10, "Transferring files from and to the instrument", on page 546
- Copying files into another directory
  See Cut, Copy&Paste and Delete
- Renaming and deleting files
- Creating directories
  See Create New Directory
- Mapping shared network folders
  See Section 10.9.4, "Mapping a network folder", on page 544
- Displaying saved files
  See Section 10.9.3, "Displaying all saved files", on page 544

10.9.1 File manager settings

Access:

► Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager".

Tip: Each "Save/Recall" dialog and each "File Select" dialog provides a quick access to the "File Manger".



The "File Manager" dialog provides all standard functions required for file management. It displays the contents of the selected folder on the R&S SMM100A and provides functions to rename, delete, copy, or move individual files.

Settings:

Map Network Share..... 541
File Type..... 541
Directory and Filename..... 541
Cut, Copy&Paste and Delete..... 542
Rename..... 542
Create New Directory..... 542

Map Network Share
Opens a dialog where you can map one or more network folders. See Section 10.9.2, "Map network share settings", on page 542.

See also Section 10.9.4, "Mapping a network folder", on page 544.

File Type
Selects the file type to be listed. If a file type with a specific file extension is selected, only files with this extension are listed.

See Section A, "Available user files and file extensions", on page 1135 for an overview of the supported file extensions.

Directory and Filename
Selects the directory in which the file to be deleted or copied is located. The dialog lists all files in this directory. Selected files are highlighted. The path is indicated above the directory tree.

Unlike the "Save/Recall" and "File Select" dialogs, the "File Manager" displays the full filenames including extensions.

Remote command:
:MMEMory:CDIRectory on page 726

Cut, Copy&Paste and Delete
Standard file management functions.

Before a file is deleted, you have to confirm the delete operation.

Remote command:
:MMEMory:DELete on page 730
:MMEMory:COPY on page 726

Rename
Renames the selected file or directory.

Remote command:
:MMEMory:MOVE on page 730

Create New Directory
Creates a folder and opens an edit dialog box to enter name and path (absolute or relative to the current directory) of the new folder.

Remote command:
:MMEMory:MDIRectory on page 730

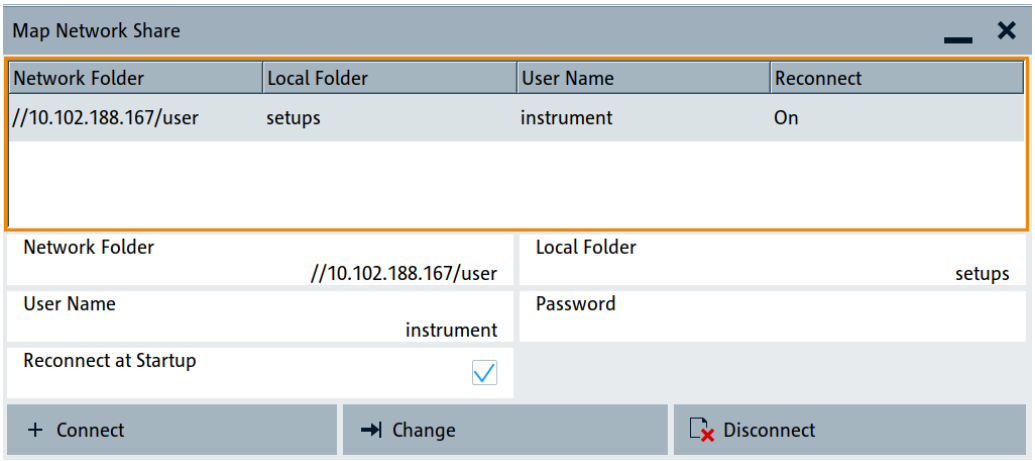
10.9.2 Map network share settings

Access:

► Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager" > "Map Network Share".

The "Map Network Share" dialog provides settings that are similar to the standard Windows Explorer function "Map network drive". These settings help you to create up to 10 "shortcuts" to shared folders or computers in the network.

The dialog displays a list of current mapped network folders. The directory tree of the "File Manager", "Save/Recall", and "File Select" dialogs indicate a mapped network folder as `/shares/<"Local Folder">`.



See also Section 10.9.4, "Mapping a network folder", on page 544.

Settings:

Network Folder....543
Local Folder....543
User Name....543
Password....543
Reconnect at Startup....543
Connect....543
Change....544
Disconnect....544

Network Folder
Enter the path of the folder or computer, e.g. `//<IP Address>/user` or `//<server name>/user`.

Local Folder
Enter a letter or an alias name to describe the folder.

In the directory tree, a mapped network folder is indicated as `/shares/<"Local Folder">`.

User Name
Enter a user name of a user that has the permission to access the selected network folder.

Password
Enter the user password of the selected user.

Reconnect at Startup
Enables reconnecting every time you start up the instrument.

Connect
Triggers the instrument to prove the credential and to map (i.e. connect) the selected network folder or computer to the instrument.

You can map up to 10 network folders.

Change
Applies the changes.

Disconnect
Disconnects the network drive.

10.9.3 Displaying all saved files

To display all files on the internal memory

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager".
2. Navigate to `/var/user/`.

To display all files on a connected USB flash drive

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager".
2. Navigate to `/usb/`.

To display all files in the volatile memory

1. Select "System Config" > "Setup" > "Settings" > "Save / Recall" > "File Manager".
2. Navigate to `/var/volatile/`.

10.9.4 Mapping a network folder

Possibly you would like to transfer instrument or user settings to another R&S SMM100A, distribute waveform files to several instruments or you have to access frequently the same network drive. In these cases, on a R&S SMM100A connected to a LAN you can create a shortcut to this network folder or this computer.

How to: Section 3.1.7, "Connecting to LAN", on page 29

To map a network folder, proceed as follows:

1. On the computer or the network folder you want to map, enable remote access. You can specify a list of users allowed for remote access.

   Note: The remote access settings depend on the operating system the remote computer is using. For step-by-step instructions, refer to the documentation of the particular operating system.

2. On the R&S SMM100A, enable file transfer via SMB (samba).
3. Select "System Config" > "Setup" > "Remote Access" > "Network" to configure the following network settings:

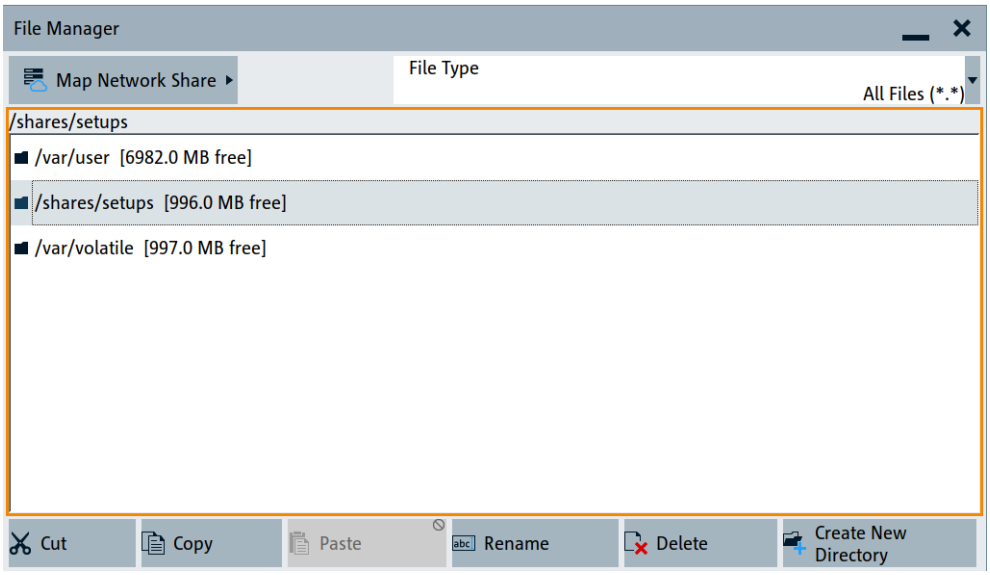
   a) Select "Address Mode" > "Auto (DHCP)".

b) Check that the "DNS Suffix" and "DNS Server" are correct.

4. Press the [Save/Rcl] key.
5. In the "Save/Recall" dialog, select "File Manager" > "Map Network Share".
6. In the "Map Network Share" dialog, select:
   a) In the "Network Folder" field, enter `//<IP Address>/user` or `//<Server Name>/user`.
   For example, enter *//10.100.1.100/user*.
   b) In the "Local Folder" field, enter an alias name, e.g. *setups*.
   c) Enter the "User Name" and "Password" of a user with a remote access permission to the selected network folder.
   d) If necessary, enable "Reconnect at Startup".
   e) Select "Connect".

   The selected network folder is mapped to your instrument. The list of mapped network folders is updated.
7. Close the "Map Network Share" dialog.

   The navigation tree in the "File Manager" dialog displays the mapped network folder as `/shares/Setups`.



If the connection does not succeed, consider to check the following:

- Is the network folder or computer you try to map turned on?
- Is the network folder or computer enabled for remote access?
- Does the selected user name have the necessary permissions?

See also Section 10.10.5, "Using a file server for test files exchange", on page 551.

10.10 Transferring files from and to the instrument

As explained in "File handling" on page 522, you access the file system of the R&S SMM100A via one of the following ways:

- Via the built-in "File Manager"
  See Section 10.9, "Using the file manager", on page 540.
- On an instrument connected to a LAN:
  - Via one of the standard functions FTP or SMB (samba)
    See Section 10.10.2, "Accessing the file system using FTP", on page 547 and Section 10.10.3, "Accessing the R&S SMM100A file system using SMB (Samba)", on page 549
  - Via mapped network drives
    See Section 10.9.4, "Mapping a network folder", on page 544.
- Via a connected USB storage device
  See Section 10.10.4, "Using a USB storage device for file transfer", on page 550

Mainly because of security reasons, the access to the file system of your R&S SMM100A can be denied, because one or all these access methods are deliberately disabled. Access to the file system via LAN and/or USB requires that the corresponding service is enabled and a write access to the file system is enabled. Refer to Section 10.10.1, "Removing file system protection", on page 546 for description of the required steps.

This section provides an introduction to the topic. For comprehensive information, refer to the application note 1GP72: Connectivity of Rohde&Schwarz Signal Generators.

- Removing file system protection 546
- Accessing the file system using FTP 547
- Accessing the R&S SMM100A file system using SMB (Samba) 549
- Using a USB storage device for file transfer 550
- Using a file server for test files exchange 551

10.10.1 Removing file system protection

Before you try to access the file system via FTP, SMB (samba) or USB, fulfill the following:

- Disable write protection on the file system
- Enable the corresponding service or interface

To enable write permission on the file system

1. Select "System Config" > "Setup" > "Security" > "Security".
2. Select "General" > "Disk & Memory".
3. Enable "Volatile Mode".
4. Enter the "Security Password".
   The default password is *123456*. For more information, see Section 11.6, "Using the security settings", on page 605.

The R&S SMM100A requests a reboot.

5. Confirm the request.

   The system reboots. The enabled settings are active.

To enable file transfer over FTP

1. Select "System Config" > "Setup" > "Security" > "Security".
2. Select "LAN Services" > "Common Services" > "LAN" > "On".
3. Enable "FTP"
4. Enter the "Security Password".
   The default password is *123456*. For more information, refer to Section 11.6, "Using the security settings", on page 605.
5. Select "Accept".

To enable file transfer over SMB (samba)

1. Select "System Config > Setup > Security > Security > LAN Services"
2. Enable "LAN Interface"
3. Select "Samba Services".
4. Enable the "SMB 1.0/2.0 Client".
5. Enable the "SMB 1.0/2.0 Server".
6. Enter the "Security Password".
   The default password is *123456*. For more information, see Section 11.6, "Using the security settings", on page 605.
7. Select "Accept".

To enable file transfer over USB

1. Select "System Config > Setup > Security > Security > General"
2. Select "Disk & Memory".
3. Enable "USB Storage"
4. Enter the "Security Password".
   The default password is *123456*. For more information, see Section 11.6, "Using the security settings", on page 605.
5. Select "Accept".

10.10.2 Accessing the file system using FTP

If the R&S SMM100A is connected to a LAN, you can use file transfer protocol (FTP) to access the file system and to transfer files from and to the instrument.

How to: Section 3.1.7, "Connecting to LAN", on page 29

To access the file system over FTP

We assume that the instrument and the remote PC are connected to a LAN.

1. Enable file transfer via FTP
2. Enable write permission on the file system
3. On the remote PC, start the Windows Explorer.
4. In the address field, enter `ftp://<"IP Address" of the Instrument>`, e.g. *ftp://10.124.0.166*.
   Tip: The R&S SMM100A indicates its IP address on the block diagram.

   A log-on dialog opens and requests a password.

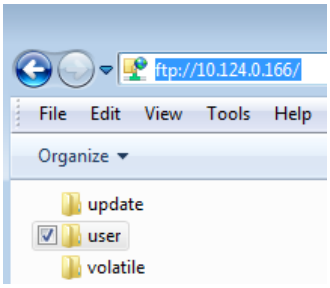
   The default user name and password is *instrument*.

   Tip:
   Default password

   The FTP and SAMBA file access use the user "instrument" with default password "instrument".

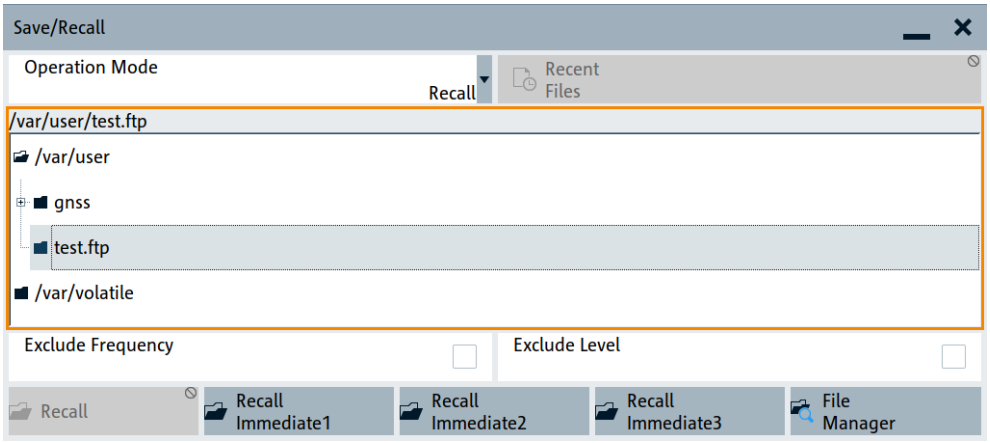
   We recommend that you change this password in the "Setup > Security > Password Management > Change User Password" dialog before connecting the instrument to the network.

   See Section 11.6.5, "Password management", on page 615.
5. Enter the password to access the `user` directory.
   The `user` directory corresponds to the `/var/user/` directory of the instrument.

   There, you can perform standard functions like creating directory, or saving files.
6. In the `user` directory, create a directory, e.g. `test ftp`.
7. Select "System Config" > "Setup" > "Settings" > "Save / Recall".
   Open the `/var/user/` directory.

   The dialog displays the `/var/user/test ftp` directory.



10.10.3 Accessing the R&S SMM100A file system using SMB (Samba)

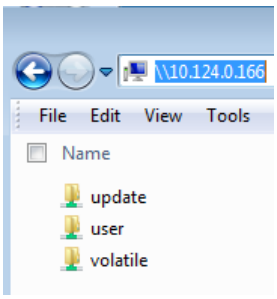
The SMB (Samba) protocol is an alternative way to access the file system of the instrument from a remote PC. This protocol works if both the instrument and the PC are connected to a LAN.

How to: Section 3.1.7, "Connecting to LAN", on page 29

To access the file system over SMB

We assume that the instrument and the remote PC are connected to a LAN.

1. Enable file transfer via FTP
2. Enable write permission on the file system
3. On the remote PC, start the Windows Explorer.
4. In the address field, enter `//<"IP Address" of the Instrument>`, e.g. *ftp://10.124.0.166*.
   Tip: The R&S SMM100A indicates its IP address on the block diagram.



The `user` directory corresponds to the `/var/user/` directory of the instrument; the `volatile` directory - to the `/var/volatile` directory.

To map the R&S SMM100A as a network drive to the remote PC

We assume that the instrument and the remote PC are connected to a LAN.

1. Enable file transfer via SMB (Samba)
2. Enable write permission on the file system
3. On the remote PC, start the Windows Explorer.
   Open the "Map Network Drive" dialog.
   a) Select a valid "Drive", e.g. *W*.
   b) In the "Folder" field, enter `//<"IP Address" of the Instrument>/user`
   or `//<"Hostname" of the Instrument>/user`
   For example: *//10.124.0.166/user* or *//SMM100A-102030/user*.
   Tip: The R&S SMM100A indicates its IP address on the screen.
   c) Select "Finish".

   A log-on dialog opens and requests a user name and a password.

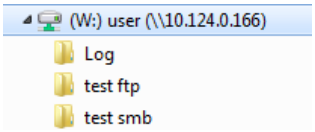
   Tip:
   Default password

   The FTP and SAMBA file access use the user "instrument" with default password "instrument".

   We recommend that you change this password in the "Setup > Security > Password Management > Change User Password" dialog before connecting the instrument to the network.

   See Section 11.6.5, "Password management", on page 615.
4. Enter the user name and the password of your instrument.

   The `/var/user/` directory of the instrument is mapped to and displayed as a network drive of the remote PC.



   You can access the files in the `/var/user/` directory, perform standard function like creating directory, or saving files.

10.10.4 Using a USB storage device for file transfer

Alternatively to the file transfer possibility via LAN, you can use a USB storage device for direct file transfer from and to the instrument.

We recommend that you transfer files with user data (like lists or instrument setup files) to the instrument, rather than load and play them from a connected USB storage device.

To transfer a file with user data to the instrument

1. Connect a USB storage device, for example a USB memory stick to one of the USB interfaces of the instrument.

   The R&S SMM100A recognizes the connected USB storage device automatically.

2. Enable file transfer via USB
3. Enable write permission on the file system
4. Select "System Config" > "Setup" > "Settings" > "Save / Recall".

   The dialog displays the `/var/user/` directory and the `/usb/` drive.

5. In the "Save/Recall" dialog, select "File Manager".
6. In the directory tree, navigate to the `/usb/` drive.
   Select the required file with user data.
7. Select "Copy".
8. In the directory tree, navigate to the `/var/user/` directory.
   Select "Paste".

   The file with user data is transferred to the instrument.

10.10.5 Using a file server for test files exchange

You can use a central file storage location like a file server in your company network to save setup files, SCPI scripts, application programs, or waveform files on it. Usually, you would like to distribute the files to several instruments. If the R&S SMM100As are connected to a LAN, you can create a shortcut on the instruments to the file server.

To access the file server

1. On each R&S SMM100A, map the required directory of the file server to the instrument.
   Perform the steps described in Section 10.9.4, "Mapping a network folder", on page 544.
2. On each R&S SMM100A, use the same alias name for the directory of the file server, i.e. enter the same "Local Folder" (in this example `Setups`).

   On any of the R&S SMM100A, you access the file server directly from the "File Manager" and under the same name, e.g. `/shares/Setups`.
   An extra advantage in remote control is that the same application program would control the instruments.
   For example, use the remote control command `MMEMory:CDIRectory "/shares/Setups"` to set the default directory for mass storage.

10.11 Creating screenshots of current settings

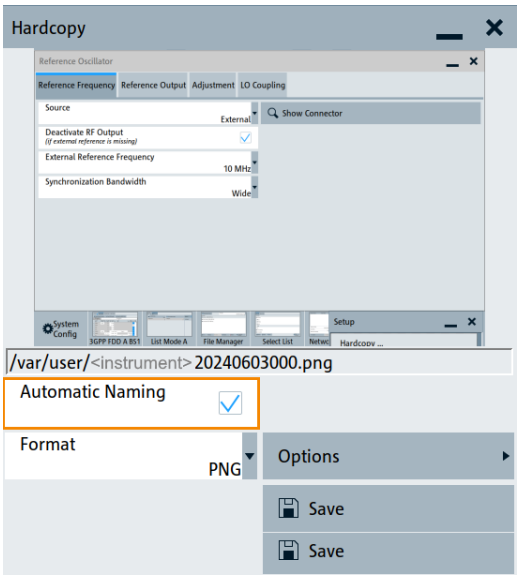
The save/recall function enables you to save current settings in a file. To document the most important settings for a performed signal generation, you can also save a hard-copy of the current display.

- Hardcopy settings 552
- Creating a hardcopy of the display 555

10.11.1 Hardcopy settings

Access:

► Press the HCOPY key.



The remote commands required to define these settings are described in Section 13.12, "HCOPy subsystem", on page 755.

Settings:

Automatic Naming 553
File 553
Format 553
Options 553
Save 553
Hardcopy Options > Common 553
- Automatic Naming 554
- Format 554
- Region 554

Hardcopy Options > Automatic Naming 554
- Path 554

└ Clear Path....554
└ Prefix, Year, Month, Day....555
└ Current Auto Number....555

Automatic Naming
If enabled, creates the output filenames automatically according to the rules set with the Hardcopy Options > Automatic Naming settings.

Remote command:
`:HCOPy:FILE[:NAME]:AUTO:STATe` on page 759

File...
In "Automatic Naming > Off" mode, accesses the standard file select dialog for selecting the filename and folder the hardcopy is stored in.

If you have enabled "Automatic Naming", the instrument displays the automatically generated filename.

Remote command:
`:HCOPy:FILE[:NAME]` on page 757

Format
Selects the output file format, for example `*.bmp`, `*.jpg*.xpm` and `*.png`.

Remote command:
`:HCOPy:IMAGe:FORMat` on page 756
`:HCOPy:DEVice:LANGuage` on page 756

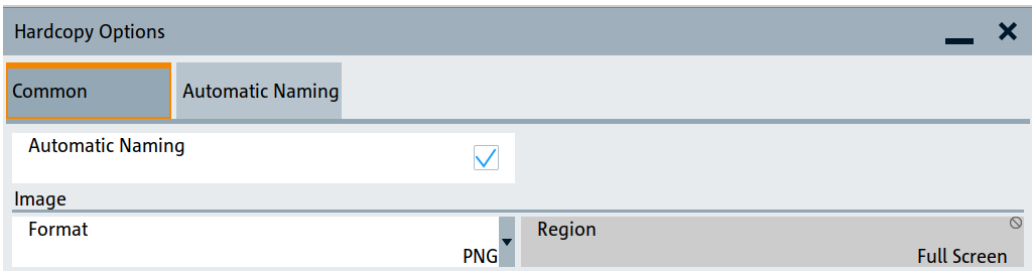
Options...
Accesses Hardcopy Options dialog.

Save
Saves a hardcopy of the current display as a file.

Remote command:
`:HCOPy[:EXECute]` on page 757

Hardcopy Options > Common
Access: select "Hardcopy > Options... > Common".

With the provided settings, you can customize the file format and the syntax of the automatically assigned filename.



Automatic Naming ← Hardcopy Options > Common
If enabled, creates the output filenames automatically according to the rules set with the Hardcopy Options > Automatic Naming settings.

Remote command:
`:HCOPy:FILE[:NAME]:AUTO:STATe` on page 759

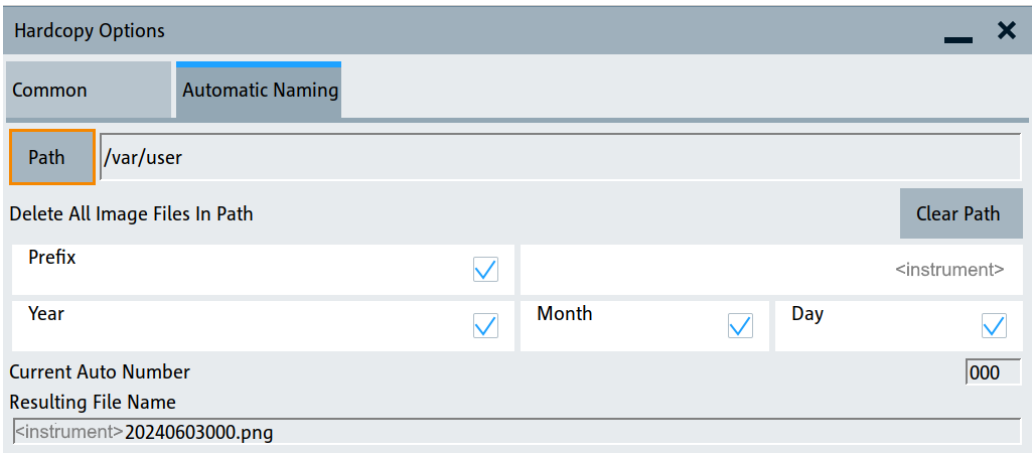
Format ← Hardcopy Options > Common
Selects the output file format, for example `*.bmp`, `*.jpg*.xpm` and `*.png`.

Remote command:
`:HCOPy:IMAGe:FORMat` on page 756
`:HCOPy:DEVice:LANGuage` on page 756

Region ← Hardcopy Options > Common
Displays the snapshot area.

Remote command:
`:HCOPy:REGion` on page 757

Hardcopy Options > Automatic Naming
Access: select "Hardcopy > Options... > Automatic Naming".



Provided are the following settings:

Path... ← Hardcopy Options > Automatic Naming
Selects the directory.

Note: To select the destination path, specify also a filename. Otherwise an error message is displayed and selection is canceled.

Remote command:
`:HCOPy:FILE[:NAME]:AUTO:DIRectory` on page 758

Clear Path ← Hardcopy Options > Automatic Naming
Deletes all image files with extensions `*.bmp`, `*.jpg`, `*.png` and `*.xmp` in the directory set for automatic naming.

Before the command is executed, a warning message prompts you to confirm the deletion of the files.

Remote command:
:HCOPy:FILE[:NAME]:AUTO:DIRectory:CLEar on page 758

Prefix, Year, Month, Day ← Hardcopy Options > Automatic Naming
Determines the rules for "Automatic Naming".

Per default, the automatically generated filename is composed of:

<Path>/<Prefix><YYYY><MM><DD><Number>.<Format>, where Y, M and D mean year, month, Day; Number is the Current Auto Number.

You can activate or deactivate each component separately.

The "Resulting filename" indicates the current filename syntax.

Remote command:
:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix on page 760
:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix:STATe on page 760
:HCOPy:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe on page 759
:HCOPy:FILE[:NAME]:AUTO[:FILE]:MONTh:STATe on page 759
:HCOPy:FILE[:NAME]:AUTO[:FILE]:DAY:STATe on page 759

Current Auto Number ← Hardcopy Options > Automatic Naming
Indicates the number which is used in the automatically generated filename.

Note: When initially switching on the instrument, the number is reset to the lowest possible value. Starting with number 0 the output directory is scanned for existing files. As long as files with the same name are existing, the number is increased by 1. The number is automatically set so that the resulting filename is unique within the selected path. The current number is not in the save/recall file but is temporarily stored within the database. At the following save operation, the number is increased.

Remote command:
:HCOPy:FILE[:NAME]:AUTO[:FILE]:NUMBer? on page 759

10.11.2 Creating a hardcopy of the display

To create a hardcopy

► Select "System Config" > "Setup" > "User Interface" > "Hardcopy".

Alternatively, you can use the following controls to create a hardcopy quickly:
- Press the [HCOPY] key.
- On the screen, select context-sensitive menu > (print).
- On an external keyboard, press the [Print] key.
- Assign the hardcopy function to the [User] key.

See Section 11.4.2, "How to assign actions to the [★ (User)] key", on page 583.

The R&S SMM100A creates a snapshot of the screen and opens the "Hardcopy" dialog for saving it in a file.

To configure and save the hardcopy

1. To define the output format, select "Format" > "JPG".
2. To enable the instrument to create output filenames, select "Automatic Naming" > "On".
3. Select "Options ...".
4. In the "Hardcopy Options" dialog:
   a) To change the default storage directory, select "Automatic Naming Settings" > "Path".
   b) Define a path and a filename.
   For example, select the default directory `/var/user`.
   c) If necessary, modify the parameters in the "Automatic Naming Settings".
   d) Close the "Hardcopy Options" dialog.
5. In the "Hardcopy" dialog, select "Save".

   The instrument saves a hardcopy of the current instrument display as a `*.jpg` file. Also, creates the filename automatically.

To export a hardcopy

1. Connect the instrument to the LAN.
2. Transfer the file to a remote computer
   See Section 10.10, "Transferring files from and to the instrument", on page 546.
3. On the remote computer, select the file.

11 General instrument functions

The general instrument functions include basic instrument settings, regardless of the selected operating mode and measurement. Some of these settings like screen display and peripherals are initially configured at the setup of the instrument, according to personal preferences and requirements. However, you can individually adjust the settings at any time, for example, for specific applications.

The following special functions help you in service and basic system configuration:

- Section 11.1, "Customizing the user interface", on page 557
  Allows you to adjust the display and keyboard language settings.
- Section 11.2, "Configuring local and global connectors", on page 563
  Allows you to map internal or external signals to the multipurpose connectors.
- Section 11.3, "Checking parameters and dependencies", on page 577
  Allows you to check for interdependencies between parameters and settings.
- Section 11.4, "Organizing frequently used settings as favorites", on page 579
  Enables you to group user-defined settings in a favorites list or to assign actions to the [★ (User)] as quick access for later retrieval.
- Section 11.5, "Managing licenses and license keys", on page 586
  If you have purchased an additional option for the R&S SMM100A, you can enable it using a license key.
- Section 10.3, "Restoring an instrument configuration", on page 523
  At any time, you can restore a default configuration to start a measurement at a defined instrument state, or set the instrument to factory preset.
- Section 16.3, "Performing maintenance tasks", on page 1115
  Special functions like calibration routines and selftests put your instrument to an initial state.
- Section 11.6, "Using the security settings", on page 605
  Special security and protection functions protect your instrument from unauthorized use or activate specific test routines.

11.1 Customizing the user interface

The R&S SMM100A provides basic alignments of instrument settings regarding the user interface, that means the touch panel (screen), the appearance of the displayed dialogs and graphics, and an external keyboard.

Dialog snapshots

The R&S SMM100A enables you to disable the snapshots of dialogs in the taskbar and replaces dialogs with test. For information on how to deactivate the snapshot preview, see Section 11.1.2, "Appearance settings", on page 560.

Start / stop display update

The operating system of the R&S SMM100A refreshes the displayed settings by default in almost real-time, to keep the display updated with the internally used values. However, you can turn off this function to reduce settling times when the instrument is remote controlled.

We recommend that you switch off the display update for optimum sweep performance with short dwell times and for fast settling times.

Consider that in this case the displayed values can differ from the operated values.

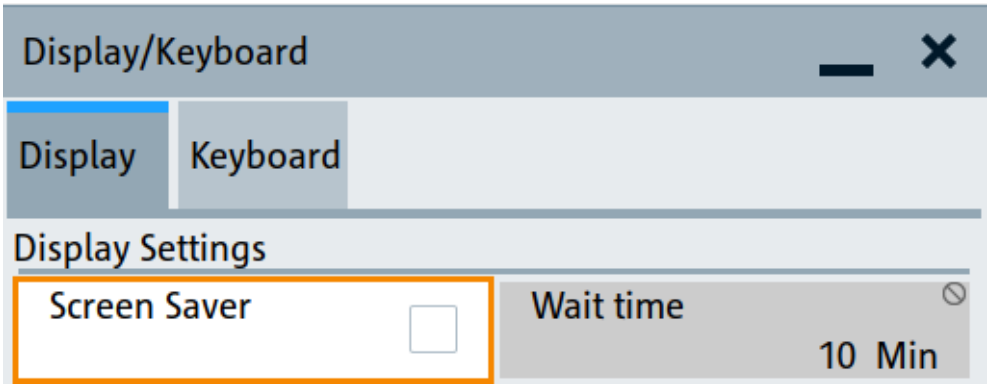
In detail described in the following paragraphs, you can:

- Set display and keyboard language, see Section 11.1.1, "Display and keyboard settings", on page 558
- Customize the GUI appearance, see:
  - Dialog snapshots
  - Section 11.1.2, "Appearance settings", on page 560
- Set date and time for the system clock, see Section 16.3.1, "Date and time", on page 1116
- Configure and activate a Screen Saver
- Deactivate display update to improve performance, see Section 11.1.3, "Display update settings", on page 560
- Determine the state of the RF signal, and the level display in the status bar when you turn on the R&S SMM100A, see Section 11.1.4, "Defining the RF signal state on power on", on page 561.

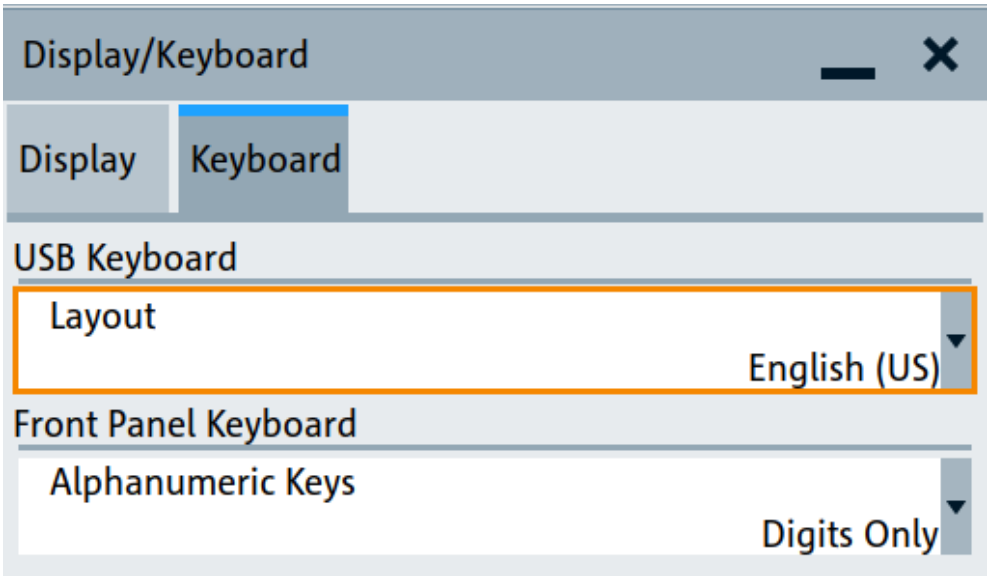
11.1.1 Display and keyboard settings

Access:

1. Select "System Config > Setup > User Interface > Display".



2. Select "Keyboard".



In the "Display" and "Keyboard" dialogs, you can enable the screen saver function and configure the language for the key assignment of an external keyboard and the keypad.

The remote commands required to configure the display and keyboard are described in Section 13.10, "DISPlay subsystem", on page 749 and Section 13.13, "KBOard subsystem", on page 760.

Screen Saver 559
Wait Time 559
Layout 559
Alphanumeric Keys 560

Screen Saver
Activates the screensaver.

If activated, the display including backlight is switched off after the selected Wait Time elapses and if no entries via touch panel, front panel, external mouse, or external keyboard are made

Remote command:
`:DISPlay:PSAVe[:STATe]` on page 750

Wait Time
Enters the idle time that must elapse before the display lamp is shut off when no entries are made.

Remote command:
`:DISPlay:PSAVe:HOLDoff` on page 750

Layout
Selects the language of an external keyboard connected over USB. The function assigns the corresponding keys automatically.

Remote command:
:KBOard:LAYout on page 761

Alphanumeric Keys
Selects the layout of the numeric keypad on the front panel.

"Digits Only" Assigns only numeric keys.

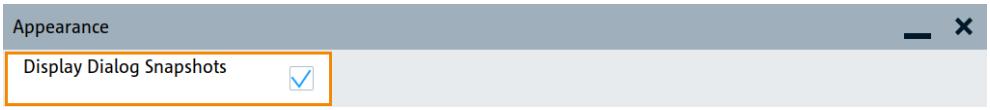
"Digits and Letters" Enables numeric and alphanumeric keys.

Remote command:
:FPANel:KEYBoard:LAYout on page 760

11.1.2 Appearance settings

Access:

► Select "System Config" > "Setup" > "User Interface" > "Appearance".



In this dialog, you can set inactive dialog opaque and enable the display of dialog snapshots.

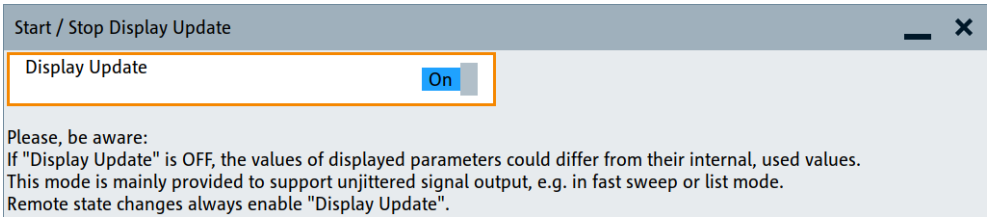
Display Dialog Snapshots..... 560

Display Dialog Snapshots
Displays thumbnails of open dialogs in the task bar.

11.1.3 Display update settings

Access:

► Select "System Config > Setup > User Interface > Start/Stop Display Update".



This dialog enables you, to deactivate updating the display.

The remote command to switch off the display update is described in Section 13.10, "DISPlay subsystem", on page 749.

Display Update is
Disables the automatic refreshing of the displayed values.

Remote command:
`:DISPlay:UPDate[:STATe]` on page 750

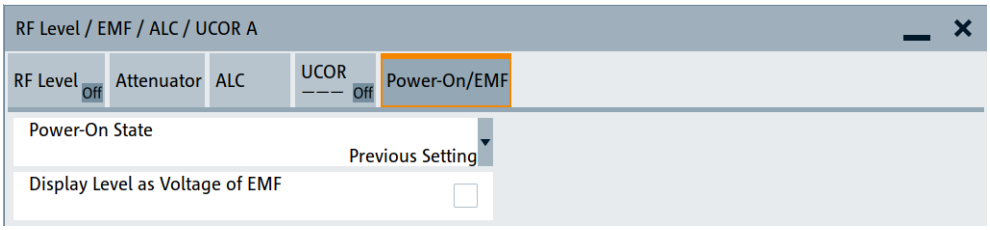
11.1.4 Defining the RF signal state on power on

As additional functions for the level settings, you can determine the state of the RF signal, and the level display in the status bar when you turn on the R&S SMM100A.

Power-On/EMF settings

Access:

► Select "RF" > "RF Level" > "Power-On / EMF".



The "Power-On/EMF" dialog contains all settings for configuring the power-on behavior and the level display.

Settings:

Power-On State....561
Display Level as Voltage of EMF....561

Power-On State
Determines the RF signal output state when the instrument is switched on.

You can disable the RF output signal in general, or start it in the same state as it had been when it was switched off.

Remote command:
`:OUTPut<hw>[:STATe]:PON` on page 762

Display Level as Voltage of EMF
Activates display of the signal level as voltage of the EMF (no-load voltage).

If disabled, the level is displayed as a voltage over a 50 Ohm load.

Note:
The setting is not affected by an instrument preset ([Preset] key or `*RST`) and the "Save/Recall" function. It is reset only by factory preset.

Remote command:
`[:SOURce<hw>]:POWer:EMF:STATe` on page 1030

11.1.5 How to set the initial instrument settings

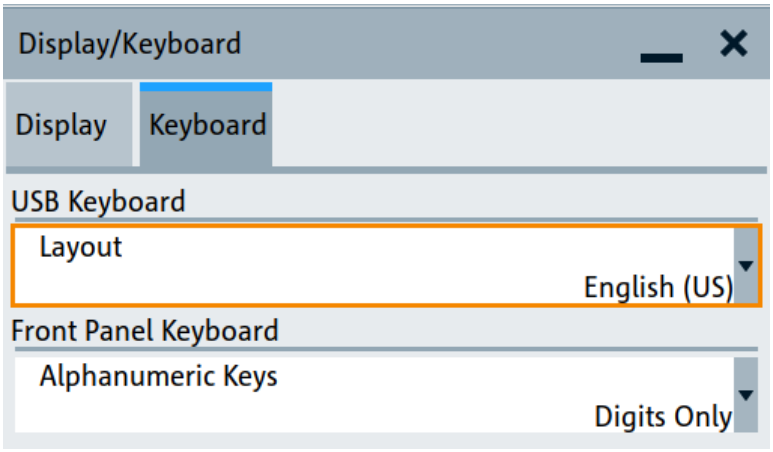
This section describes how to set up the R&S SMM100A initially.

11.1.5.1 Setting the keyboard language

You can select the language of the external keyboard connected to the instrument.

To adjust the keyboard settings

1. Press the [Setup] key.
2. Select "User Interface > Keyboard".



3. Select the "Layout".

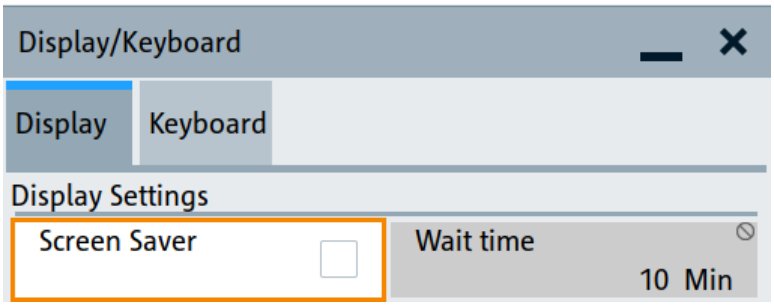
   The dialog closes and the changes take effect immediately.

11.1.5.2 Setting the screen saver

You can enable a screen saver that automatically turns off the display after a user-defined period of time. The screen saver is activated if no settings are made on the touch screen, or via keys or the rotary knob during the selected wait time.

To activate the screen saver

1. Press the [Setup] key.
2. Select "User Interface > Display"
3. Activate the "Screen Saver".



4. Define the "Wait Time" in minutes.

   The instrument turns off the display after the defined period of time.

5. To reactivate the display, tap the screen or press any key on the front panel.

To deactivate the screen saver

1. Press the [Setup] key.
2. Select "User Interface > Display"
3. Disable the "Screen Saver" state.

11.1.5.3 Adjusting appearance of the user interface

You can disable the snapshot preview of dialog in the taskbar .

1. Press the [Setup] key.
2. Select "User Interface > Appearance".
3. If necessary, enable "Display Dialog Snapshots".

   The changes take effect immediately.

11.2 Configuring local and global connectors

The R&S SMM100A is equipped with multipurpose bi-directional connectors.

Grouped according to their impact, the R&S SMM100A provides the following connector types:

- Section 11.2.5, "Global connectors settings", on page 570
- Section 11.2.2.2, "Baseband local connectors", on page 565

Grouped according to their impact on the baseband or on the RF signal, the same connectors are divided into:

- Section 11.2.3, "Trigger marker clock settings", on page 566
- Section 11.2.4, "RF connectors settings", on page 568

11.2.1 Required options

The R&S SMM100A is always equipped with six User interfaces.

Additional options are not required.

11.2.2 About local and global connectors

Signal to connector mapping

As described in Section 4.4.1, "About common baseband characteristics", on page 85, the R&S SMM100A uses several internally generated and externally supplied signals. To handle these signals and more than two baseband signals, the R&S SMM100A introduces the concept of signal to connector mapping. The available signals are not dedicated to a particular connector but can be mapped to one or more globally shared User or local T/M/C connectors.

The signal mapping and the polarity, the trigger threshold, and the input impedance of the input connectors are configurable parameters. The connectors settings are grouped in the Global connectors settings and Local connectors settings dialogs.

For an overview of the required configuration steps, refer to "To map the signal to a connector" on page 577.

11.2.2.1 Global connectors

The R&S SMM100A is equipped with User x interfaces which can be freely assigned a selection of signals and which can be configured as both inputs and outputs.

A common threshold and input impedance is effective for all trigger and clock signal inputs provided at the User connectors. The settings influence the custom digital modulations, the generation of waveforms or multicarrier signals, and all digital standards.

Also, the R&S SMM100A is equipped with one Inst Trig connector. The instrument trigger setting influences all sweeps and is effective in the list mode.

See Section 7.10, "Varying the RF signal in list or sweep mode", on page 334.

The Table 11-1 gives an overview of the signals that can be applied to and output at the User connector.

Table 11-1: Mapping control signals to the User x connectors

Connector	Direction	Assigned signal	Remark
User 1 to 6	Input	"Global Trigger 1/2" "Global Clock 1/2" "Global Next Segment 1/2" "Baseband Sync In"	-
		"BER Data" "BER Clock" "BER Data Enable" "BER Restart"	Option: R&S SMM-K80
	Output	"Baseband Marker 1/2/3" "Baseband Sync Out" "Always 0/1"	-
		"BER TestGen Data" "BER TestGen Clock" "BER TestGen Data Enable" "BER TestGen Restart"	Option: R&S SMM-K80
User 4, 5, 6	Input	"Pulse In"	-
	Output	"Signal Valid" "Signal Valid Neg" "Pulse Out" "Pulse Sync" "Pulse Video"	-
User 6	Input	"Feedback"	-
	Output	"Manual Trigger"	-

11.2.2.2 Baseband local connectors

Apart from the multipurpose global User connectors, the baseband coder board is equipped with local T/M/C connectors.

The Table 11-2 gives an overview of the signals that can be applied and output at the T/M/C connectors.

Table 11-2: Mapping control signals to the local T/M/C connectors (System Configuration > BB Sources = Coupled)

Connector	Direction	Assigned signal
T/M/(C) 1	Output	"Baseband Marker 1" "Symbol Clock"
T/M 2	Output	"Baseband Marker 2"
T/M 2	Input	"Feedback" "Data"

11.2.2.3 Trigger marker clock and RF connectors

The Trigger marker clock settings and RF connectors settings dialogs provide an overview of the current mapping of the logical signals to the corresponding connectors. The dialogs are summary representation of related settings, as configured with the Global connectors settings and Local connectors settings settings.

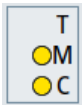
11.2.2.4 Status indicators

Connector status LEDs

A dedicated LED indicates the connector status:

- green: an input connector
- yellow: an output connector
- no light / gray: the connector is not active

TMC block

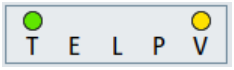


For a quick overview of the control signal sources, the block diagram provides the "TMC" block on the left side of the "Baseband" block.

If the baseband generator is enabled, a dedicated LED indicates the status of the control signal:

- Green: Uses an external signal.
- Yellow: Uses the signal as an output signal.

TELPV block



For a quick overview of the control signal sources, the block diagram provides the "TELPV" block next to the "RF" block.

If the "RF" block is enabled, a dedicated LED indicates the status of the control signal:

- Green: Uses an external signal.
- Yellow: Uses the signal as an output signal.

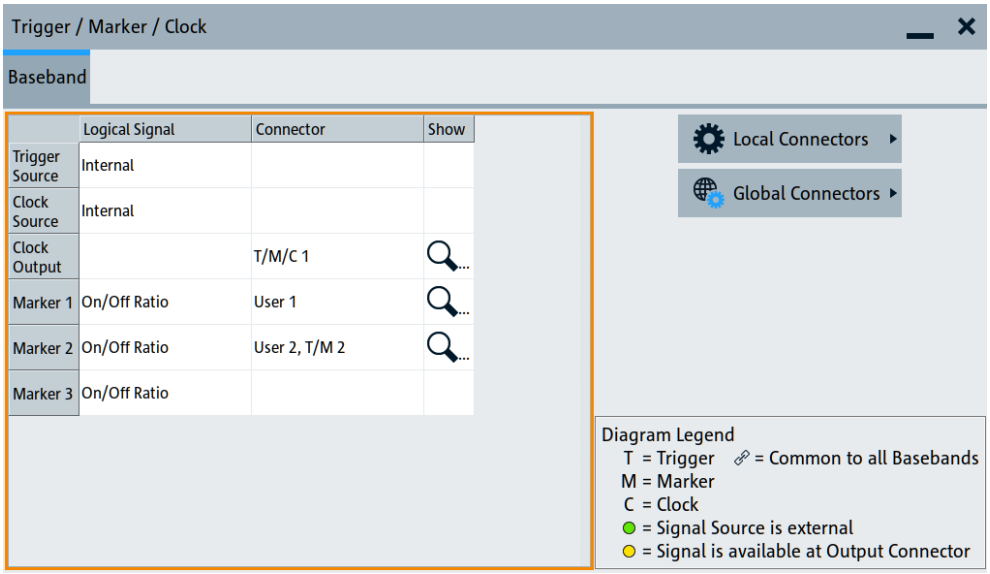
If enabled, the "TELPV" block also displays the status of the signal valid signal ("V") and the pulse signal ("P").

11.2.3 Trigger marker clock settings

Access:

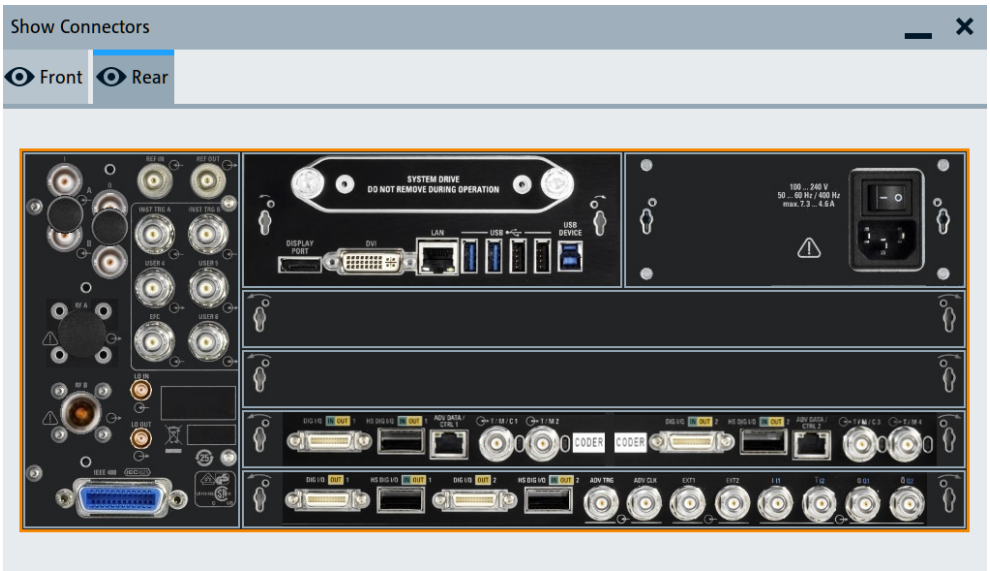
1. Perform one of the following:
   - In the "Block Diagram", select the TMC block on the left side of the "Baseband" blocks.
   - Select "Baseband" > "Trigger Marker Clock".

The "Trigger Marker Clock" gives an overview of the current mapping of the logical signals to the connectors, as configured in the Global Connectors and Local Connectors dialogs. Clicking the connector name directly accesses the related connector settings.
The dialog consists of several tabs, each tab corresponds to one of the available basebands.



2. Use the built-in Show/Show Connector function to display the physical location of the selected connector.

   A blinking LED on the rear panel indicates the selected connector, too.



The eye icon in the tab header indicates the panel (front, rear or both) the selected connector is located at.

11.2.3.1 Overview table

Logical Signal
Displays the logical signal, as configured in the "Trigger In", "Marker" or "Clock" tab of the corresponding digital standard, see for example Section 4.4.2.1, "Trigger settings", on page 106.

Connector
Displays the assigned connector:

- As selected in the Global Connectors dialog.
- As selected in the Local Connectors dialog.
- Dedicated RF connectors, like "LO In/Out" or "Inst Trig".

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

11.2.3.2 Local and global connectors settings

Opens a dialog to configure local connectors or global connectors.

The button is available in the following dialogs or tabs:

- "Trigger / Marker / Clock" dialog that is accessible via the "TMC" block in the block diagram.
- "Trigger In", "Marker" and "Clock" tabs of baseband signal configuration dialogs that you can open via the "Baseband" block in the block diagram. These tabs are available, for example, for "ARB" baseband signals.

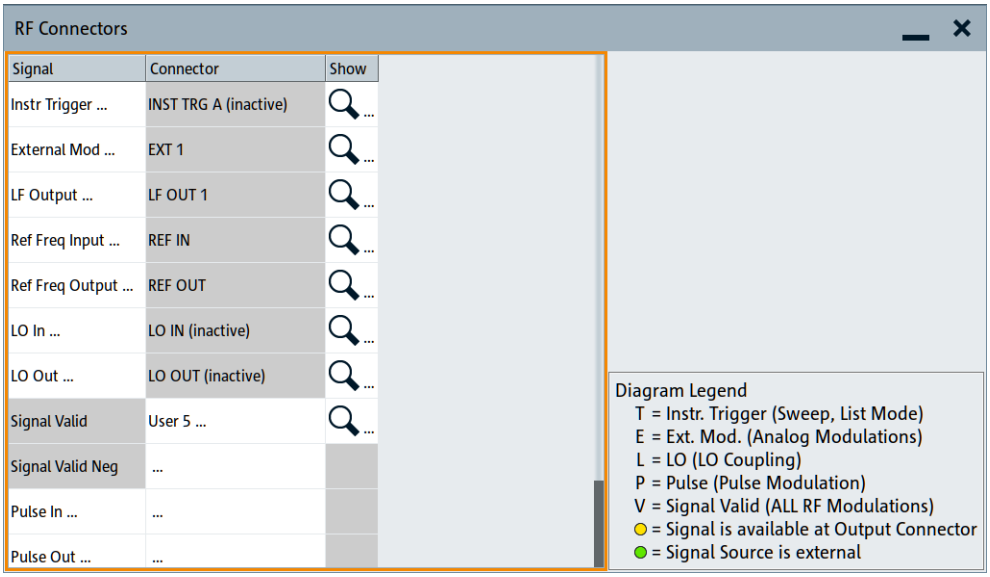
See also Section 11.2, "Configuring local and global connectors", on page 563.

11.2.4 RF connectors settings

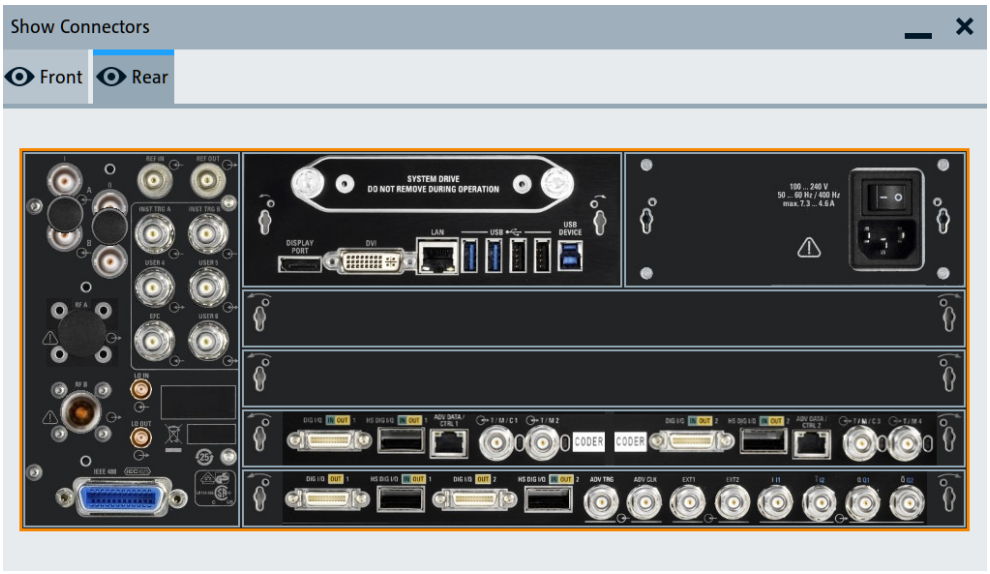
Access:

1. In the control signal block next to the "RF" block, select TELPV block.

   The "RF Connectors" dialog gives an overview of the mapping of the logical signals to the connectors; the displayed connectors depend on the installed options. The signal assignment to the dedicated RF connectors, for example LO In/Out or Inst Trig, is fixed.



2. Select the signal type ("Signal") to open the dialog with related signal settings.
3. Use the built-in Show/Show Connector function to display the physical location of the selected connector.



The eye icon in the tab header indicates, if the connector is on the front panel or rear panel. A blinking blue rectangle marks the connector or multiple connectors, if supported.

Settings:

Signal....570
Connector....570
Show/Show Connector....570

Signal
Opens the dialog with the corresponding settings.

Connector
Displays the assigned connector:
- As selected in the Global Connectors dialog.
- As selected in the Local Connectors dialog.
- Dedicated RF connectors, like "LO In/Out" or "Inst Trig".

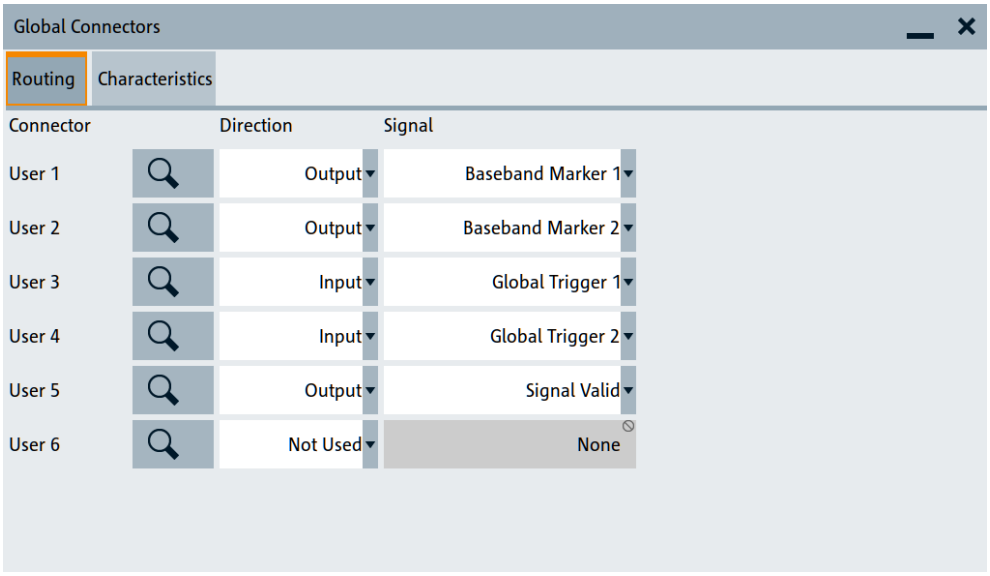
Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

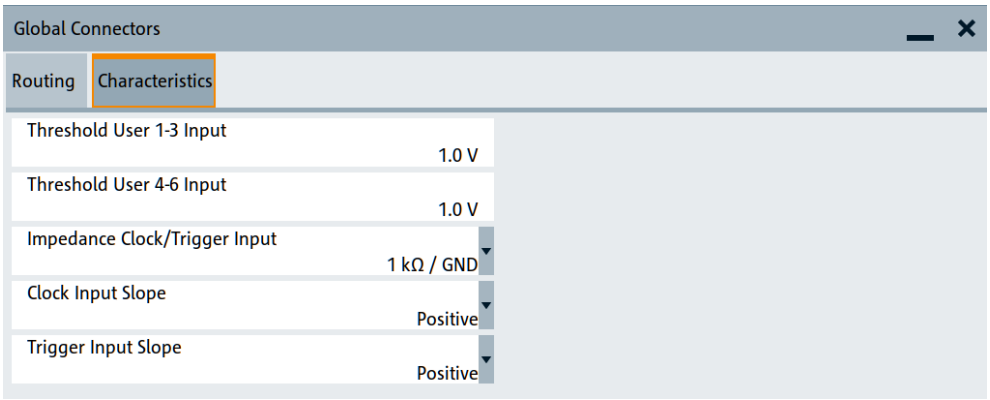
11.2.5 Global connectors settings

Access:

1. To access global connector settings via the signal control blocks of the block diagram, select the TMC block.
2. In the opening dialogs, try one of the following:
   - Select "Connector" > "User x" to select a global connector "User x".
   - Select "Global Connectors".
3. To access global connector settings via the baseband block of the block diagram, select one of the following:
   - Select "Baseband" > "ARB"/"Custom Digital Modulation" > "Trigger In" > "Global Connectors".
   - Select the tabs "Trigger In", "Marker" or "Clock" of the corresponding digital standard.

   The "Global Connectors" dialog comprises the settings necessary to configure the signal to connector routing and the physical characteristics of the input connectors for trigger, clock and control signals.





Use the built-in Show/Show Connector function to display the physical location of the selected connector. Also, a blinking LED on the rear panel indicates the selected connector.

Settings:

Show/Show Connector....571
Direction....572
Signal....572
Execute Trigger....573
Threshold User1-3 Input....574
Threshold User4-6 Input/Threshold Pulse Input....574
Impedance Clock/Trigger Input....574
Clock Input Slope....574
Trigger Input Slope....574

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

Direction
Sets the direction of the signal at the connector that can be input or an output.

If you do not use the connector, select "Not Used".

Remote command:
`[:SOURce]:INPut:USER<ch>:DIRection` on page 800
`:OUTPut:USER<ch>:DIRection` on page 800

Signal
Determines the control signal that is input or output at the selected connector. Whether the connector is used as an input or an output is selected by the parameter Direction.

The Table 11-1 lists the available control signals.

"Global Trigger 1/2"
Input for triggering custom digital modulations, digital standards and ARB. A trigger event affects the signal generation in all basebands for which the "Global Trigger" signal is enabled.

"Global Clock 1/2"
Input for external clock signal for synchronizing the internal clocks in all basebands to an externally applied clock signal. The active edge can be configured.

"Global Next Segment 1/2"
Input next segment for triggering of multi-segment waveform files (see Section 4.9, "Generating multi-segment waveform files", on page 204).

"Baseband Marker 1/2/3"
Marker signal output for triggering and control of external devices with user-definable marker signals.
Available marker signals depend on the system configuration, see Table 11-1.

"Feedback"
Input for global feedback signal, required for 3GPP HSUPA HARQ Feedback, 3GPP Dynamic Power Control or EUTRA/LTE Closed Loop BS tests.

"Pulse In"
Input of external pulse signal or input of external trigger/gate signal for internal pulse generator (see Section 7.11.4.3, "Pulse generator settings", on page 383).

"Pulse Out"
Output of the internal pulse signal generated by the internal pulse generator (see Section 7.11.4.3, "Pulse generator settings", on page 383).

"Signal Valid"
Automatically generated output signal that marks the valid signal times (valid level and frequency) for all analog modulations.
The signal is indicated by the "T/E/P/V" status LEDs near to the "RF" block.

"Signal Valid Neg"
Inverted version "Signal Valid A"; the output signal is low during the valid signal times.

"Sync" Output for internal sync signals for pulse modulation.
Sync signals are generated at the beginning of a list or a sweep and used for synchronization to other instruments (see also Section 7.10, "Varying the RF signal in list or sweep mode", on page 334).

"Pulse Video" Output of the external or internal pulse modulation signal (video signal).

"Baseband Sync Out"/"Baseband Sync In"
Option: R&S SMM-B9
Signals available in enabled primary-secondary instrument mode.

- "Baseband Sync Out"
  One or more outputs of a dedicated synchronization (and trigger) signal that has to be fed into the slave instruments.
- "Baseband Sync In"
  In the slave instruments, at most one input for the synchronization (and trigger) signal.
  Can be assigned to any global connector.

See also Section 9.2.1, "Connecting multiple instruments in primary-secondary instrument mode", on page 476.

"Always 0"/"Always 1"
Control signal with low or high level.

"Manual Trigger"
Output of a short pulse signal that can serve as a common external trigger signal for triggering of several R&S SMM100A.
See Example "Triggering several R&S SMM100A instruments simultaneously" on page 481.

"BER Data"/"BER Clock"/"BER Data Enable"/"BER Restart"
Option: R&S SMM-K80
Input signals for BERT/BLER testing.

"BER TestGen Data"/"BER TestGen Clock"/"BER TestGen Data Enable"/"BER TestGen Restart"
Option: R&S SMM-K80
Output signals for BERT/BLER testing.

"None" No signal is assigned to the connector.

Remote command:
`[:SOURce]:INPut:USER<ch>:SIGNal` on page 802
`:OUTPut:USER<ch>:SIGNal` on page 802

Execute Trigger
If "User 6" > "Direction" > "Output" and "Signal" > "Manual Trigger", generates a short pulse signal and outputs it at the "User 6" connector.

The signal can serve as a common external trigger signal for triggering of several R&S SMM100A, see Example "Triggering several R&S SMM100A instruments simultaneously" on page 481.

Remote command:
:OUTPut:USER<ch>:TRIGger[:IMMediate] on page 803

Threshold User1-3 Input
Sets the high/low threshold in volts for the signal at the User1-3 connectors.

The input signal is defined with the parameter Signal. The same threshold applies for all 3 connectors and any input signal.

Remote command:
[:SOURce]:INPut:USER:TRIGger:LEVel on page 803
[:SOURce]:INPut:USER:CLOCk:LEVel on page 803

Threshold User4-6 Input/Threshold Pulse Input
Sets the high/low threshold in volts for the signal at the User4-6 connectors.

The input signal is defined with the parameter Signal. The same threshold applies for all 3 connectors and any input signal (e.g. external pulse modulation or trigger signal).

Remote command:
[:SOURce]:INPut:USER:PULM:LEVel on page 804

Impedance Clock/Trigger Input
Selects the input impedance for the external trigger/clock inputs.

Set the value to 1 kΩ/GND for high clock rates.

Remote command:
[:SOURce]:INPut:USER:TRIGger:IMPedance on page 804
[:SOURce]:INPut:USER:CLOCk:IMPedance on page 804

Clock Input Slope
Sets the polarity of the active slope of an externally applied clock signal.

Remote command:
[:SOURce]:INPut:USER:CLOCk:SLOPe on page 804

Trigger Input Slope
Sets the polarity of the active slope of an applied instrument trigger.

Remote command:
[:SOURce]:INPut:USER:TRIGger:SLOPe on page 804

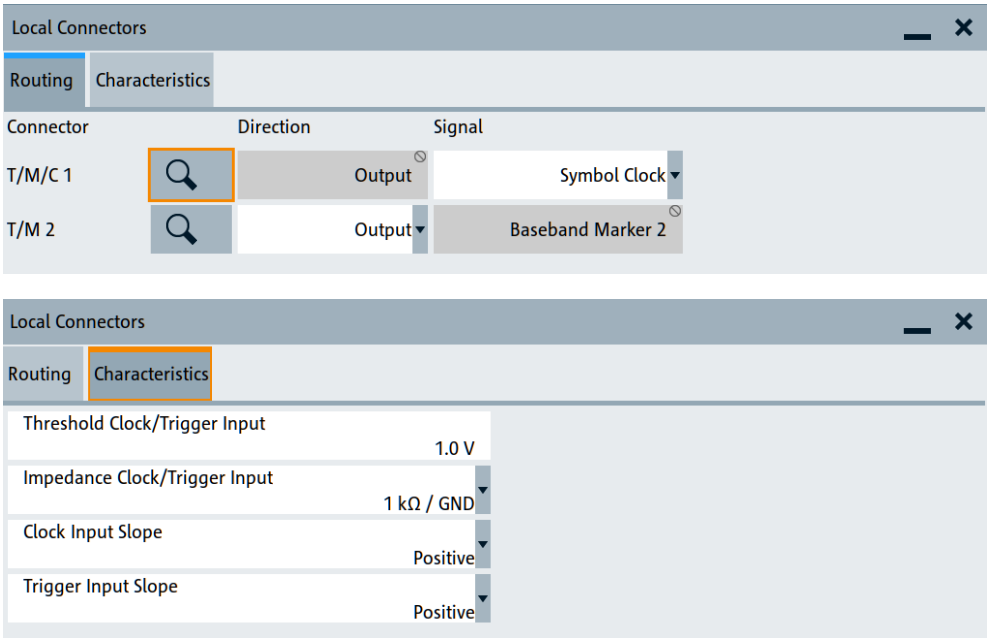
11.2.6 Local connectors settings

Access:

1. Perform one of the following:
   - In the "Block Diagram", select the TMC block to access the "Trigger Marker Clock" dialog and:
     – Select a local T/M/C connector or
     – Select "Local Connector Settings".

- Select "Baseband > Custom Digital Modulation > Trigger In > Local Connector Settings" or respectively the "Trigger In", "Marker" or "Clock" tab of the corresponding digital standard.

The "Local Connectors" dialog comprises the settings necessary to route the signals to the local connectors and to determine the physical characteristics of the input connectors for trigger, clock and marker signals.



2. Use the built-in Show/Show Connector function to display the physical location of the selected connector.

   A blinking LED on the rear panel indicates the selected connector, too.

Show/Show Connector
Opens a dialog that displays the location of the connector on the front panel or rear panel of the instrument. A blinking rectangle shows the connector.

Direction
Determines whether the connector is used as an input or an output.

Remote command:
`[:SOURce<hw>]:INPut:TM<ch>:DIRection` on page 799
`:OUTPut<hw>:TM<ch>:DIRection` on page 799

Signal
Determines the control signal that is input or output at the selected connector. Whether the connector is used as an input or an output is selected by the parameter Direction.

Refer to Table 11-2 for an overview of the available control signals.

"Data" Input for external serial data signal

"Baseband A Marker 1"
A broad selection of suitable marker signals is offered in the "Marker" tab of the corresponding digital standard.

"Symbol Clock A"
Output of the internal clock signal used for digital modulations. The signal is generated automatically when the standard is switched on.

"Feedback"
Input for local feedback signal, required for 3GPP HSUPA HARQ Feedback, 3GPP Dynamic Power Control or EUTRA/LTE Closed Loop BS tests.

Remote command:
`[:SOURce<hw>]:INPut:TM<ch>:SIGNal` on page 800
`:OUTPut<hw>:TM<ch>:SIGNal` on page 801

Threshold Clock/Trigger Input
Sets the high/low threshold in volts for the trigger and clock signal inputs of the baseband section.

Remote command:
`[:SOURce<hw>]:INPut:TM:CLOCk:LEVel` on page 805
`[:SOURce<hw>]:INPut:TM:TRIGger:LEVel` on page 805

Impedance Clock/Trigger Input
Selects the input impedance for the external trigger/clock inputs.

Remote command:
`[:SOURce<hw>]:INPut:TM:CLOCk:IMPedance` on page 805
`[:SOURce<hw>]:INPut:TM:TRIGger:IMPedance` on page 805

Clock Input Slope
Sets the polarity of the active slope of an externally applied clock signal.

Remote command:
`[:SOURce<hw>]:INPut:TM:CLOCk:SLOPe` on page 805

Trigger Input Slope
Sets the polarity of the active slope of an externally applied trigger signal.

Remote command:
`[:SOURce<hw>]:INPut:TM:TRIGger:SLOPe` on page 806

11.2.7 Routing signals to the connectors

This section provides step-by-step instructions to route control signals from input connectors or to output connectors of these signals. It covers the following topics:

- "General workflow" on page 577
- "To map the signal to a connector" on page 577
- "To find out the input connector location" on page 577

General workflow

The table Table 11-3 shows the main configuration steps and related settings.

Table 11-3: Mapping signal to connector workflow

Workflow task	Related settings
Checking the signal to connector mapping	"Trigger Marker Clock" "Global Connectors" > "Routing" "Local Connectors" > "Routing"
Configuring and enabling the control signal	"Trigger In", "Marker" or "Clock" tabs of the baseband signal dialog
Cabling the connector and the source or sink of the control signal	-

To map the signal to a connector

To map the signal to the connector, proceed as follows:

1. Check the current connector configuration.
2. If necessary, change the signal direction and the signal type.
3. Configure the control signal, for example a trigger signal or a marker signal.
4. Enable the control signal.
5. Connect a suitable external instrument or device to the connector of the control signal.

See also Section 3.3.4, "Working with marker signals", on page 56.

To find out the input connector location

Proceed as follows:

1. In the block diagram, select the "TMC" block to open the "Trigger / Marker / Clock" dialog.
2. In the block diagram, select the "TELPV" block to open the "RF Connectors" dialog.
3. For the corresponding connector, select the "Show Connector" icon.

   The "Show Connectors" dialog opens and displays the location of the selected connector on the front panel or rear panel of the instrument.

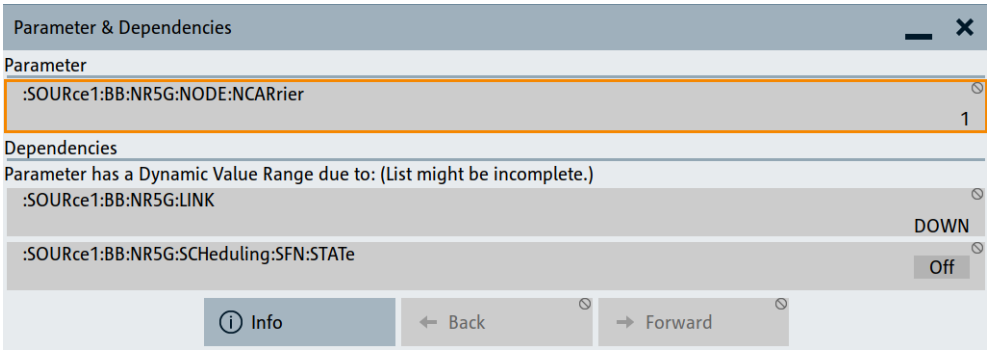
If enabled, the LED next to the connector is green or yellow, see Section 11.2.2.4, "Status indicators", on page 566.

11.3 Checking parameters and dependencies

You can check settings on a parameter-level for incoming dependencies. These dependencies include R&S SMM100A configurations that affect properties of the

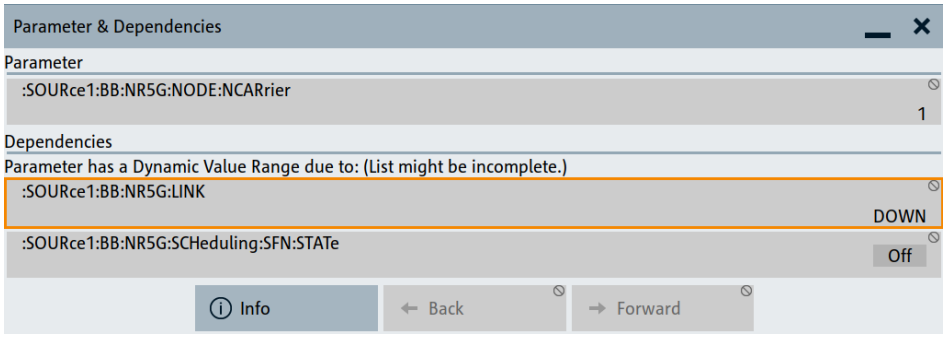
parameter. Properties are, for example, selectable values, ranges, minimum or maximum value depending on the parameter type. After the dependency check, a dialog displays R&S SMM100A configurations that include a list of dependent parameters or dependent settings that affect the parameter.

1. Select the parameter that you want to check.
2. Right-click the parameter, to open the context menu.
3. Select "Show Incoming Dependencies".

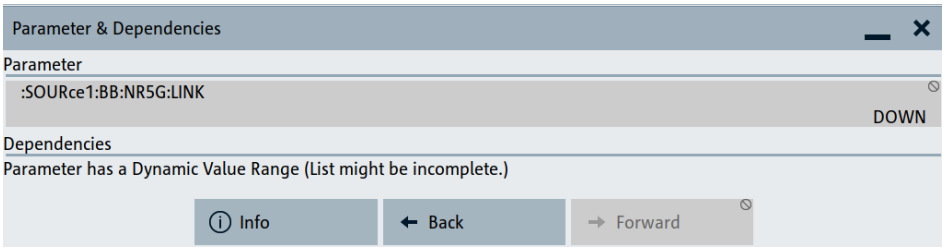


The "Parameter & Dependencies" dialog opens. The "Parameter" panel of this dialog displays the SCPI command including its setting or query parameters. The "Dependencies" panel displays dependent parameters and their settings that affect the setting of the parameter, that you want to check initially (2).

4. In the "Dependencies" panel, you can further check for dependencies within the dependent parameters.
   a) Select the parameter that you want to check from the list in the "Dependencies" panel, e.g.:
   `:SOURce1:BB:NR5G:LINK DOWN` for the "Link Direction" > "Downlink".



b) Select "Show Incoming Dependencies".



The list in the "Dependencies" panel is empty. I.e., the "Link Direction" setting does not depend on any further parameters or settings.

5. Optionally, navigate via "Back" and "Forward" to move up or down the dependency tree for parameters with dynamic value range.

Settings:

Info
Accesses the help of the selected parameter, see Section 11.3, "Checking parameters and dependencies", on page 577.

Back/Foward
Toggles between parameter dependencies for dependent parameters.

If you select "Show Incoming Dependencies" for parameters or settings from the "Dependencies" panel, you can move back or move forward through the dependency tree-like structure.

11.4 Organizing frequently used settings as favorites

The R&S SMM100A provides two possibilities to define frequently used settings and procedures for later retrieval individually.

User menu and [★ (User)] key

These two functions work similar to the favorites function of a browser or other programs. They allow you to create a list of frequently used actions or to group frequently used settings in one dialog.

You can collect the parameters of your configuration in a favorites list, i.e. in the "User Menu", or define settings and actions with the [★ (User)] key:

- "User Menu" to group settings of specific tasks.

  Similar to a favorites function, you can use this menu for:
  - Grouping the settings required for a task in one dialog.
  - Saving and recalling the settings of a task.
  - Transferring the settings for use on multiple instruments.
- [★ (User)] key, with customizable function.

You can perform the following steps using this key:

– Open the "User Menu" (default functionality).
– Add or remove settings and functions.
– Execute actions and access functions.

Possible applications

The ★ (User) key and the "User Menu" are useful for the following situations:

- There are functions or tasks you have to perform in a defined order but the setting parameters are distributed across several dialogs.
- There are functions or tasks you have to perform frequently but they are not accessible via the front panel keys.
- The required functions are grouped in a dialog that is not directly accessible from the block diagram.
- Your task involves loading and executing of SCPI scripts.
  See Section 12.10, "Using remote command scripts", on page 689.
- A quick access to saved setups is required.
- There are functions and tasks you have to perform on several instruments.

Dialog identification

To identify each dialog, the instrument uses a dedicated dialog ID. The dialog ID contains the dialog position on the display and the current active tab. The action that triggers the instrument to open a dialog uses this identification.

Save/Recall vs. recall setup

If you need to restore a specific signal generation setup and perform further configurations based on this particular instrument state, the R&S SMM100A provides two options:

- "Save/Recall" function
  For a detailed description, refer to Section 10.5, "Saving and recalling settings", on page 529.
- "Recall Setup" function
  If the "Recall Setup" is the only user action assigned to the [★ (User)] key, pressing this key triggers the R&S SMM100A to load the user-defined preset file immediately.

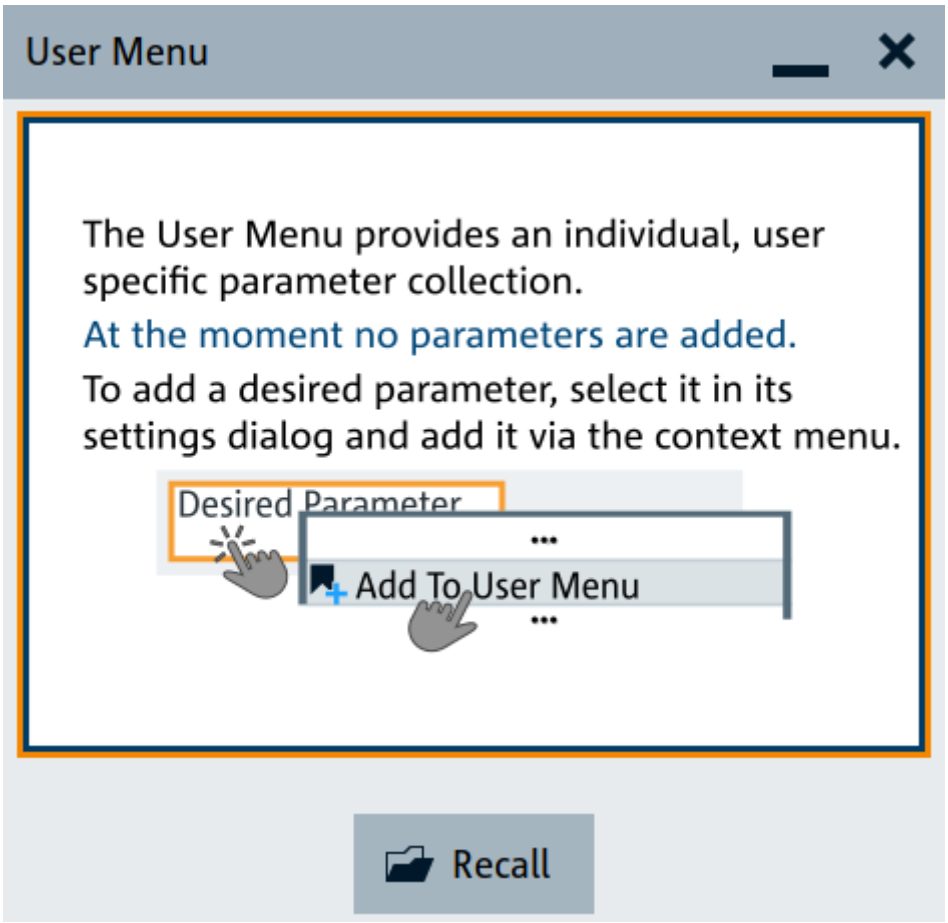
Recalling a user-defined preset file using the [★ (User)] key is even faster than the immediate recall function provided by the [Save/Rcl] key.

11.4.1 Configuring settings quickly with the user menu

Access:

1. Press the [★ (User)] key.

   The "User Menu" dialog opens.



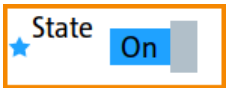
   If you execute this action for the first time, the dialog displays instructions on how to use the "User Menu".

2. If you already have a saved user menu file on the instrument, you can load with "Recall User Menu".

Creating a user menu

To create your own user dialog with settings:

1. Open a dialog with settings you frequently use.
2. Select a parameter.
3. Open the context menu and select "Add to User Menu".

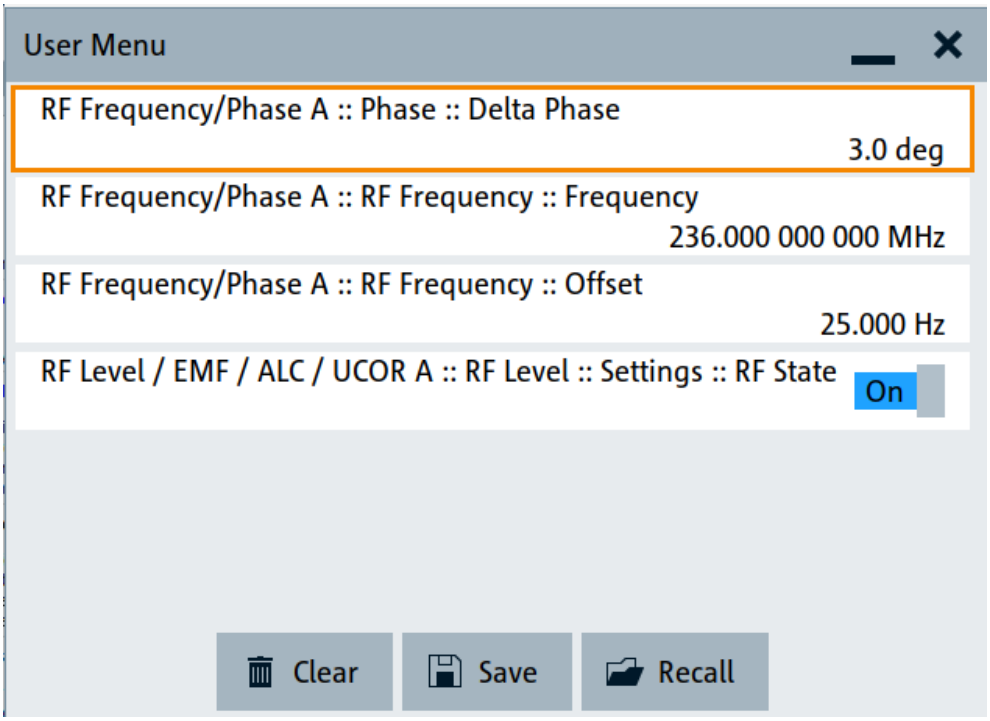


A favorites icon ★ indicates that the parameter is used in the "User Menu".

The "User Menu" button in the taskbar confirms that you have created a "User Menu" with at least one entry.

4. Press the [★ (User)] key.

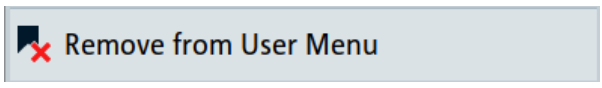
   The "User Menu" dialog shows all parameters that you have added to the list.



   You can modify the parameter settings directly in this dialog, e.g .change a state or set values, as you do in the particular dialog the parameter originally belongs to.

5. To remove an entry, select the parameter either in the "User Menu" or in the dialog where it originally belongs to.

   a) Open the context menu and select "Remove from User Menu".



6. To remove all entries at once, select "Clear User Menu".

7. To save your individual favorites list, select "Save User Menu", and follow the file managing instructions.
   The file system automatically assigns the file extension `*.user_menu`.
8. To recall a previously saved user menu, select "Recall User Menu" and proceed accordingly.

Providing a user menu favorites list for several instruments

To transfer files from or to an instrument:

1. Create the favorites list, as described in "Creating a user menu" on page 581.
2. Save the favorites list.
3. To tansfer a file from or to an instrument, the R&S SMM100A provides several options, see "File handling" on page 522.

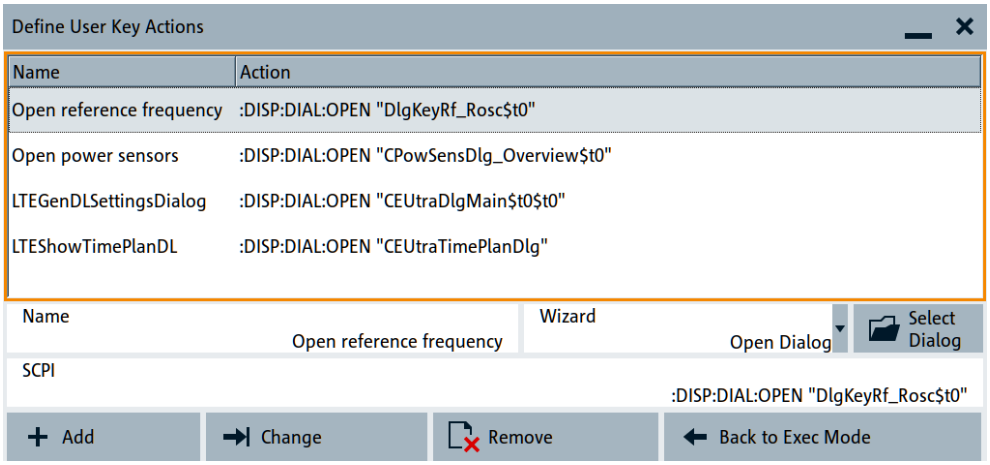
11.4.2 How to assign actions to the [★ (User)] key

The customizable [★ (User)] key has no predefined function assigned. You can individually define actions to be executed or functions to be accessed when pressing this key.

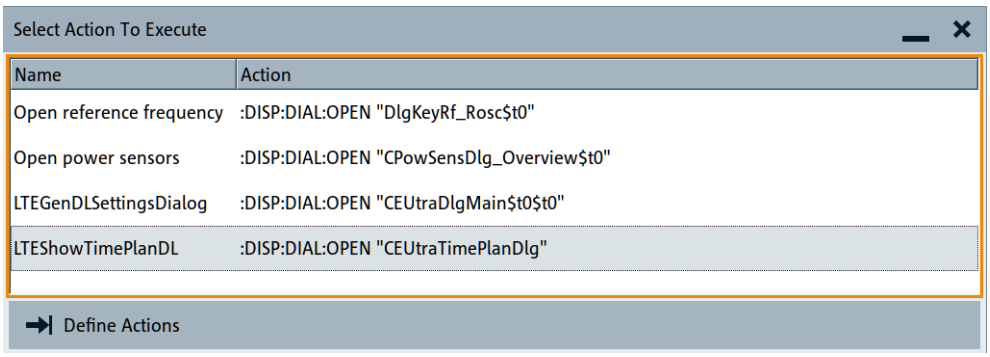
To assign a frequently used dialog to the [★ (User)] key:

1. Open the dialog you want to quickly access.
   For example, select "Baseband" > "EUTRA/LTE" > "DL Frame Configuration" > "Time Plan" > "Detach Time Plan".
2. Select "System Configuration" > "Setup" > "User Interface" > "Define User Key".
3. To create an action:
   a) Specify the "Name".
      E.g. *LTE_ShowTimePlanDL*.
   b) Select "Wizard" > "Open Dialog"
   c) Select "Select Dialog" and select a settings dialog from the list

   The corresponding SCPI command is automatically displayed and can be modified.
4. Select "Add" to save the new action in the list of user key actions.



5. To execute the created action, press ★ (User).
   In the list of actions ("Define User Key Actions" dialog), navigate to the required action.
   In this example, this is "LTEShowTimePlanDL".



   The R&S SMM100A opens the dialog.

   Tip: If you have assigned only one action to the user key, the R&S SMM100A performs the action immediately.

11.4.3 User menu settings

The "User Menu" dialog contains function keys to organize, save and load a favorites list. You can also modify, add or delete list entries directly in the dialog.

Clear User Menu
Removes all entries from the "User Menu" at once.

Save User Menu
Saves the current "User Menu" under the defined filename.

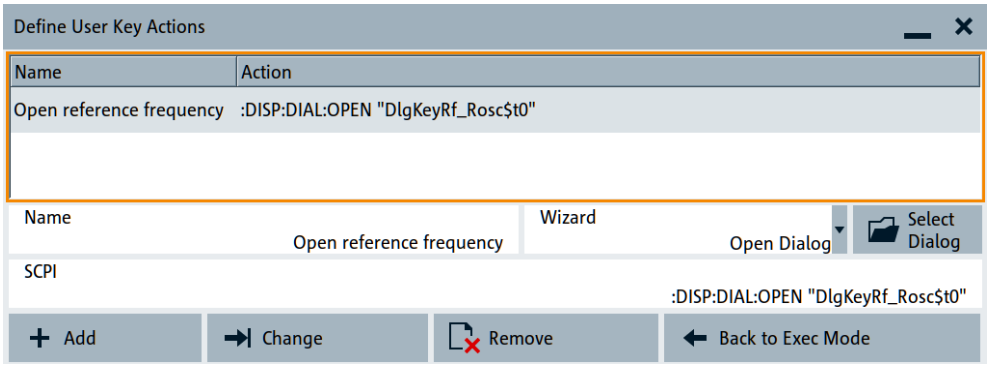
Recall User Menu
Loads the selected "User Menu" file.

This function enables you to use the user specific favorites file on another instrument. However, if functions or parameters are not provided due to varying configuration of the instrument, the settings of these particular parameters take no effect.

11.4.4 Define user key actions settings

Access:

► Select "System Config" > "Setup" > "User Interface" > "Define User Key".



The dialog displays a list of the currently enabled actions and provides functions to define new, edit or remove existing actions. If no actions have been defined, the list is empty.
See Section 11.4.2, "How to assign actions to the [★ (User)] key", on page 583.

The remote commands required to define these settings are described in Section 13.10, "DISPlay subsystem", on page 749.

Name
Enters a user-defined name for the action.

Wizard
Defines the action to be executed.

"Load SCPI Script"
Selects and executes the SCPI script.

"Recall Setup" Opens the file dialog for selecting a saved setup with user-defined settings.

"Open Dialog"
Selects an open settings dialog or menu.

"Open Dialog, with Position and Size/append to SCPI"
Selcts an open settings dialog or menu.
Use the "Open Dialog, append to SCPI" function to define a sequence of several dialogs to be opened simultaneously or one after the other.
Tip: Use the command `:SYSTem:WAIT` to add a delay between the subsequent commands.

Select
Depending on the selected "Wizard", provides access to:
- the standard "File Select" function for loading an SCPI script or setup file
- a list of all currently opened dialogs.
  See SCPI.

SCPI
For the currently selected action, displays the corresponding SCPI command with the associated parameter for dialog identification (dialog ID). The automatically displayed SCPIs are enabled for subsequent modification.

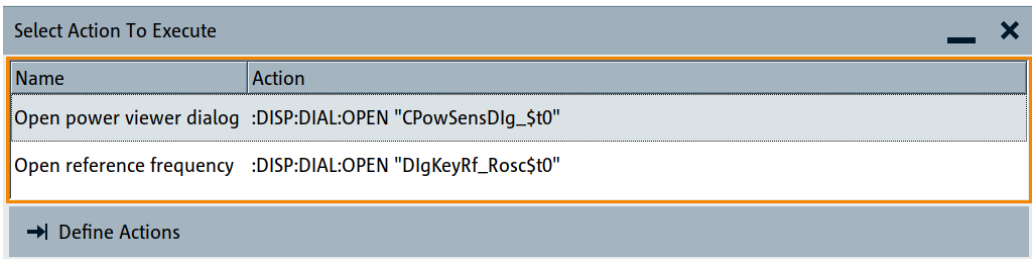
Remote command:
`:DISPlay:DIALog:OPEN` on page 752
See also `:DISPlay:DIALog:ID?` on page 751

Add, Change, Remove
Standard functions for managing of the actions.

Back to Execute Mode
Opens the "Select Action to Execute" dialog. Select an Action form the list to execute it.

To return to the "Define User Key Actions" dialogs, select Select Action to Execute > Define Actions.

Select Action to Execute > Define Actions



Opens the "Define User Key Actions" settings dialog.

11.5 Managing licenses and license keys

The R&S SMM100A provides options for all required applications, as, e.g., for digital standards, you can purchase and activate.

Various license types enable you to manage licenses for options as follows:
- Activate an option locally on an instrument.
- Share an option with other instruments.
- Activate an option for a certain period of time as needed.

An option is ready to operate after it is enabled with a license keycode supplied with the option. The license key is delivered as a file or on paper. Unregistered licenses

must be registered for a particular instrument before the corresponding option can be enabled for operation.

For reliable operation, a software option usually requires the latest firmware version. The required version is specified in the delivery. If your instrument works with a former firmware version, update the firmware before enabling the software option.

The firmware update is described in the release notes provided on the product page of the R&S SMM100A.

Occupied Licenses

A license server allows you to use one or more options with floating license for a specified period of time.

Provided the R&S SMM100A is connected one or more license servers, it shows the currently unoccupied, i.e. available options. You can borrow the license for one or more options and specify the required time period.

The maximum number of options you can occupy is determined by the minimum number of available options on the server, and the maximum number of options you can install on the instrument, including the permanently installed options.

Once you have occupied an option, the instrument saves the license locally, and blocks it for other instruments. During the occupied period, you do not necessarily need permanent access to the license server. If you need the option for a longer time than you have occupied, you can extend the requested occupation period up to 7 days.

When the occupation period elapses, the license expires automatically. After 1 hour follow up time, the option is available again on the license server.

You cannot return or disable the license of an option manually before the occupation period has elapsed.

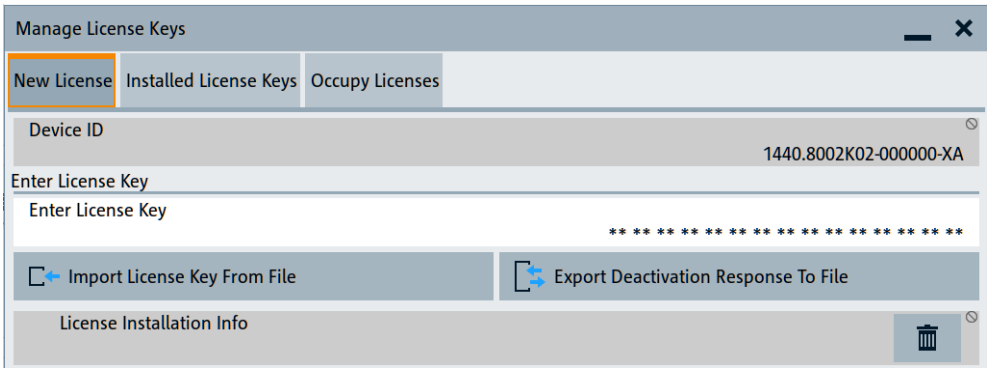
If the R&S SMM100A has no connection to the license server, it displays a warning message.

11.5.1 Manage license keys settings

The "Manage Licnese Keys" dialog provides all information on the available licenses. Instrument-related steps guide you through the process of registering or deactivating licenses.

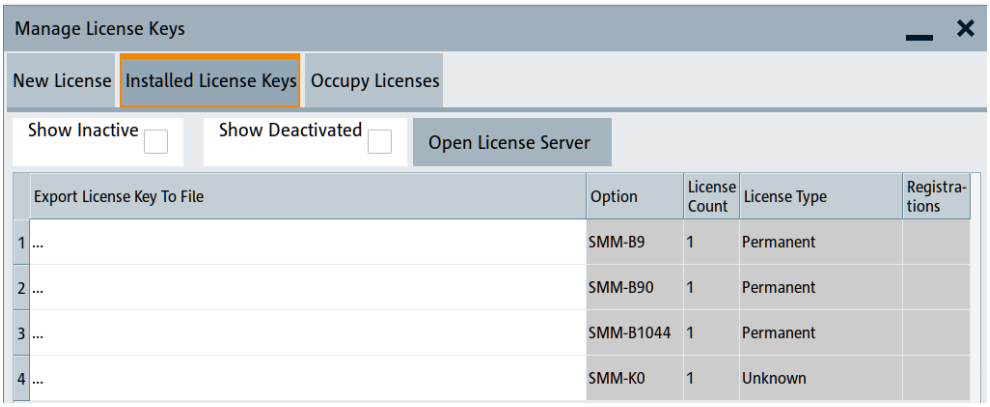
Access:

1. Select "System Config" > "Setup" > "Instrument Assembly" > "Manage License Keys" > "New License".



In this tab, you can activate licenses for newly purchased or newly registered options.

2. Select "Installed License Keys".

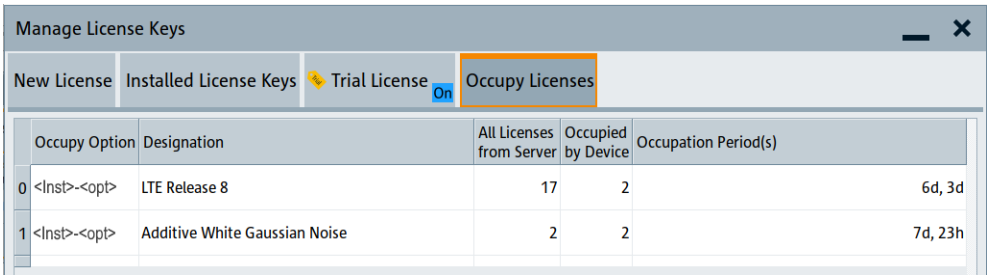


This tab lists all active options, with information on the available number of an option, the license type and registration. You can query inactive or disabled options also.

3. Select "Open License Server".
4. Select "Manage Waveform Packages".

This tab enables you to select and register purchased waveform packages.

5. Select "System Config > Setup > Instrument Assembly > Manage License Keys > Occupy Licenses".



The tab lists all options available on the license server, the number of options already occupied by the R&S SMM100A and the state of their occupation period. The occupation period indicates the remaining time you can use the option.
How to occupy a license or to extend the occupation period, see Section 11.5.3, "How to occupy or extend a license", on page 602.

The "Manage License Keys" dialog covers all required parameters for activating or deactivating newly purchased or newly registered options, and provides access to the onboard license server, see Section 11.5.2, "Using the license server", on page 593.

Settings:

Device ID....589
Enter License Key....590
Import License Key from File....590
Export Deactivation Response to File....590
License Installation Info....590
Installed License Keys....590
- Show Inactive....590
- Show Deactivated....590
- Installed License Keys Table....590

Open License Server....591
Manage Waveform Packages....591
- Number of Licenses/Waveforms....591
- Select Waveform....591
- Register Selected Waveform....591
- License Table....591

Occupy Licenses....592
- License Info....592
- Select Free Licenses....592
- Occupation Period....592
- Occupy....592
- License <no>: Extend Occupation Period to....593
- Renew....593

Device ID
Displays the instrument-specific identification number. The device ID is a unique string with the following structure:

`<stock number>-<serial number>-<checksum>`

Enter License Key
Type here the license key provided with the option.

For license keys delivered as a file, use Import License Key from File....

Import License Key from File...
Opens a dialog for selecting the file with the license key.

Use this function also to import the deactivation key file generated by the R&S License Manager online tool (see How to move a portable license).

Export Deactivation Response to File...
Exports the generated deactivation response key to a file and opens a file management dialog to save the file.

This key is required during the unregistration process, e.g. when you want to deinstall an option or have a portable option, which you want to register later on another instrument (see How to move a portable license).

License Installation Info
Indicates status information on the performed actions.

Installed License Keys
Access: select "System Config > Setup > Instrument Assembly > Manage License Keys > Installed License Keys".

Comprises information on the installed options.

Show Inactive ← Installed License Keys
Enables the display of the inactive (expired) licenses in the Installed License Keys Table.

Show Deactivated ← Installed License Keys
Enables the display of the deactivated licenses in the Installed License Keys Table.

See How to move a portable license for information on how to activate deactivated licenses.

Installed License Keys Table ← Installed License Keys
Shows information on the currently installed options.

"Export License Key to File"
Opens a dialog to save the generated license key file. This file is required during the unregistration process.
If you have a portable unregistered option, you can register it later on another instrument (see How to move a portable license).

"Option" Displays the short designation of the option.

"License Count"
Displays the number of the licenses for the selected option key.

"License Type" Displays the type of license.
A license type determines the common qualification application duration and the portability of a license. The following license types are provided: evaluation, permanent, portable, quantified, time-controlled with a duration of 1, 3, 6 or 12 months. A license can also be deactivated or expired.
For time limited licenses, the left time of applicability is displayed too.

"Registrations" (reserved for future use)

Open License Server
Opens the R&S License Server of the R&S SMM100A, see Section 11.5.2, "Using the license server", on page 593.

Manage Waveform Packages
Access: select "System Config > Setup > Instrument Assembly > Manage License Keys > Installed License Keys > Manage Waveform Packages".

Opens the "Manages Waveform Packages" dialog that enables you to register waveform files.

With a waveform packages license, the R&S SMM100A can play a waveform file generated with the R&S WinIQSIM2 software, even if it is not equipped with the corresponding digital standard option for using R&S WinIQSIM2 (R&S SMM-K2xy/K4xy).

Note: One waveform packages license per waveform is required, and for multisegment waveforms, you need a license per segment.
Once registered license cannot be moved to another instrument.

A waveform packages license does not allow R&S SMM100A to play waveforms of options R&S SMM-K256/-K352/-K353/-K354.

Number of Licenses/Waveforms ← Manage Waveform Packages
Displays the number of the available and used R&S SMM-K200 licenses.

Select Waveform ← Manage Waveform Packages
Opens a standard dialog to select the waveform to be registered.

Register Selected Waveform ← Manage Waveform Packages
Executes the registration.

License Table ← Manage Waveform Packages
Gives an overview of the registered waveforms, the registration date and the number of used licenses.

"Waveform" Displays the directory, path and file name of the waveform file.

"Registration Date"
Displays date and time of registration.

"Used License(s)"
Shows the number of licenses the waveform file requires.

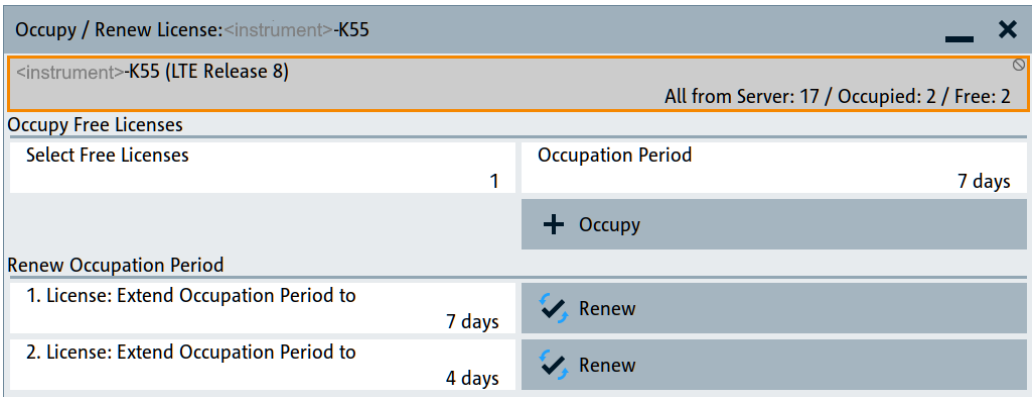
Occupy Licenses
The license server allows you to borrow one or more options with floating licenses for a specified time. You can retrieve a non-occupied license and save it locally for up to 7 days.

Access:

Select "System Config" > "Setup" > "Instrument Assembly" > "Manage License Keys" > "Occupy Licenses".

The table lists all options that are available on the license server. It covers the short and long name, the number of available options on the server, the number of already occupied options and the remaining time periods for their use.

To occupy or renew a license, select "Occupy Option".



Remote command:
`[:SOURce]:OCCupy:OPTion:CATalog?` on page 1019

License Info ← Occupy Licenses
Displays the current occupancy state of the selected option.

"<instrument>-<option>"
Short name of the option.

"(<designation>)"
Long name of the option.

"All from Server: <no>"
Number of options available on all connected license servers.

"Occupied: <no>"
Number of options occupied by the instrument.

"Free: <no>" Remaining number of options that can be occupied on the instrument.

Select Free Licenses ← Occupy Licenses
Sets the number of licenses to occupy.

Occupation Period ← Occupy Licenses
Sets the occupation period for the selected option in days.

Occupy ← Occupy Licenses
Executes the occupation process.

The R&S SMM100A saves the selected options locally and removes the licenses from the list of available options on the license servers.

Remote command:
[:SOURce]:OCCupy:OPTion on page 1019

License <no>: Extend Occupation Period to ← Occupy Licenses
Extends the occupancy duration set before to the required length.

Note: You can only extend an already set occupation period.
Reset or return an occupied period before the time has elapsed is not possible.

Renew ← Occupy Licenses
Executes the extension of the occupation period.

The R&S SMM100A saves the selected options locally and removes the licenses from the list of available options on the license servers.

Remote command:
[:SOURce]:OCCupy:OPTion:RENew<ch> on page 1020

11.5.2 Using the license server

The R&S SMM100A now supports handling of software licenses using the license server from Rohde & Schwarz.

As a browser application you can access the R&S License Server either in a browser and also directly in the R&S SMM100A. The onboard license server integrated in the instrument firmware has connection to a *local smartcard* memory. The local smartcard holds local licenses, i.e. licenses that are intended for use on this specific instrument.

As opposed to local licenses, the application also manages licenses referred to as *floating licenses*.

For managing floating licenses, the same license server application runs on a PC at customer's site. In this context referred to as *remote license server*, with connection to the customers memory, the *remote smart card*. The remote smartcard holds floating licenses, i.e. licenses you can use on instruments everywhere without restrictions on the location.

When you need a specific application, you can obtain a license from the server. When you no longer need the license, return it to the server.

The license server releases a returned floating license for use in another instrument only after a follow-up time of 10 minutes.

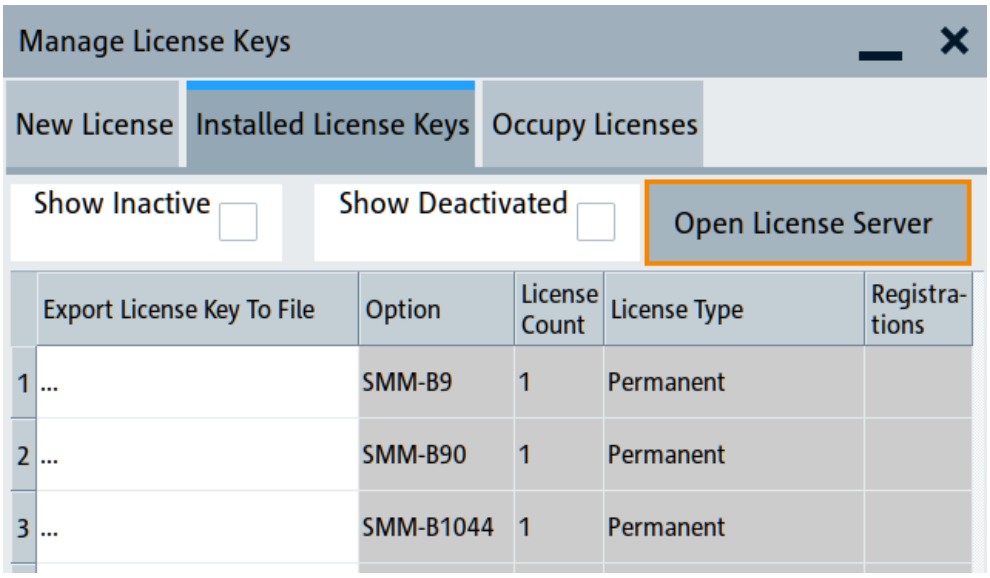
At startup, the license server checks the available floating licenses. During this check, it returns the licenses immediately.

The floating license server application is part of the configuration at purchase. Included in delivery, you get an installation package that consists of a smart card dongle with the software and the corresponding user documentation.

To open the license server

Access:

1. Select "System Config > Setup > Instrument Assembly > Manage License Keys > Installed License Keys".



2. Select "Open License Server".

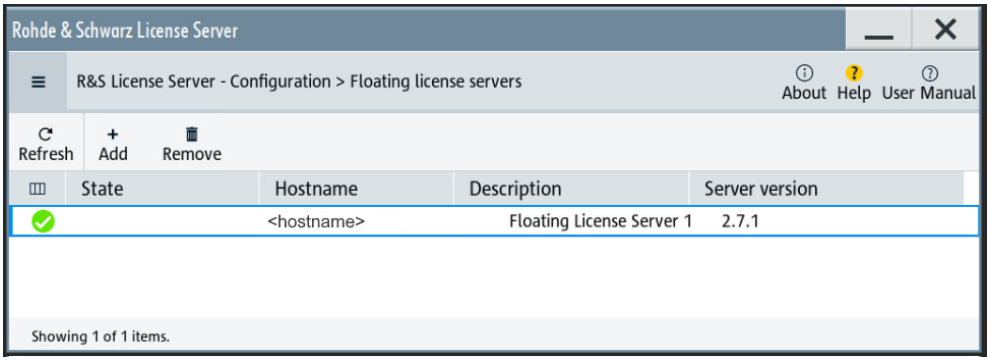


Figure 11-1: R&S license server dialog

The license server opens in a browser window and starts initially in the "Configuration" view for configuring floating license servers. It lists already configured floating license servers, with information on the host address, designation and state. You can add or remove a floating license server configuration and customize the information to be displayed. The control elements in the upper area enable you to access the "Analytics" or "Licenses" views.

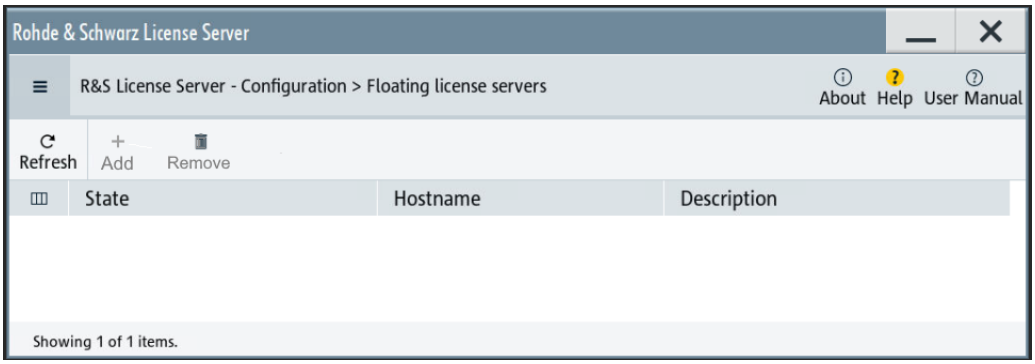
The icons in the status bar on the right lead you to information on the license server:

- "About": shows the software version.
- "User Manual": opens the embedded license server user manual.
- "Help": provides the functional description on a specific dialog and its settings.

For security reasons, the license server of the R&S SMM100A enables you to restrict the access to the floating licenses from an external instrument.

For information on how to restrict the access to the connections, see "To restrict remote connection access" on page 600. To release a restriction, see "To enable remote connection access" on page 601.

For more information, see the user manual of the license server.



Short glance at the main views

The section provides a brief insight into the main windows of the license server. For details and handling of the application, refer to the embedded user documentation.

1. To access a view, select the menu button.
2. Select "Configuration".

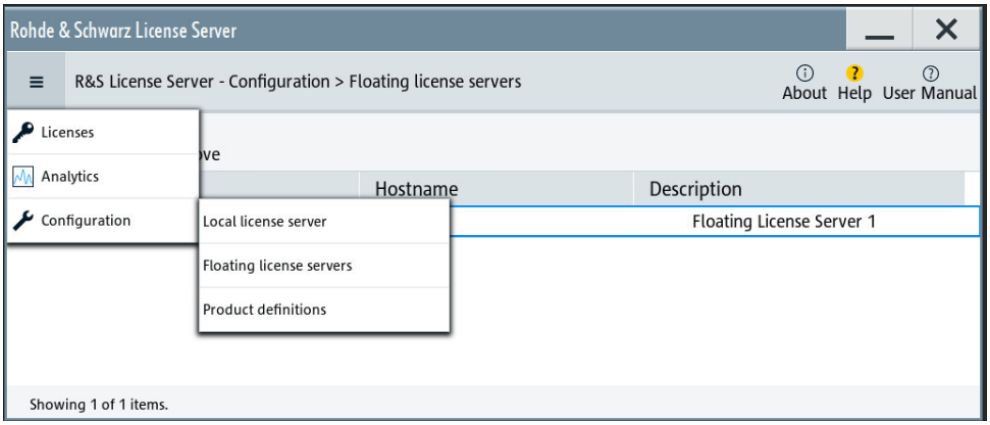


Figure 11-2: Configuration menu

Accesses the configured license servers, access lists and installed product definitions.

a) Select "Local license server".

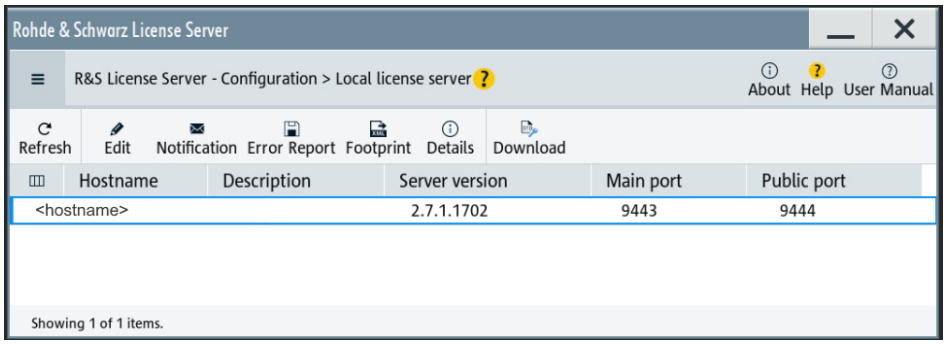


Figure 11-3: Example of a local license server view

Shows the onboard license server of the instrument. With the column selection, you can indicate or unhide characteristics of the available server. The task bar buttons provide access to the corresponding functions and access lists.

b) Select "Floating license server".

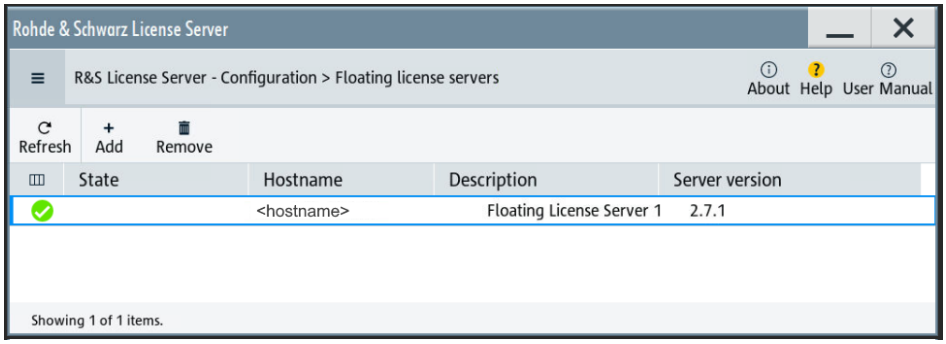


Figure 11-4: Example of a floating license server view

To add the connection to a floating license server, see "To add a remote connection to an external license server" on page 602.

c) Select "Product definitions".

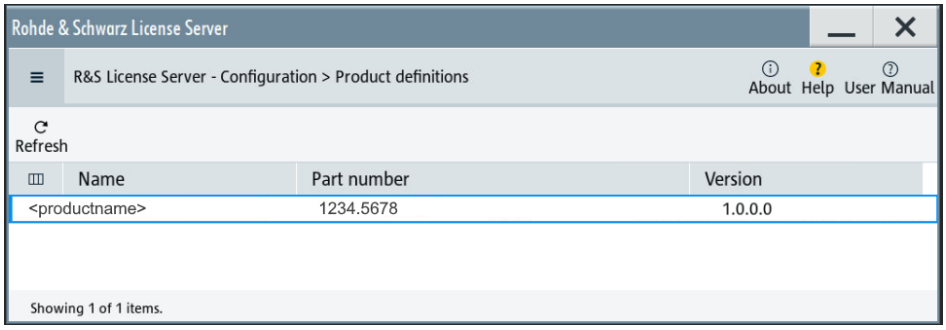


Figure 11-5: Example of a product definition view

Shows installed product definitions. To view the available characteristics, use the column selection.

3. Select "Licenses".

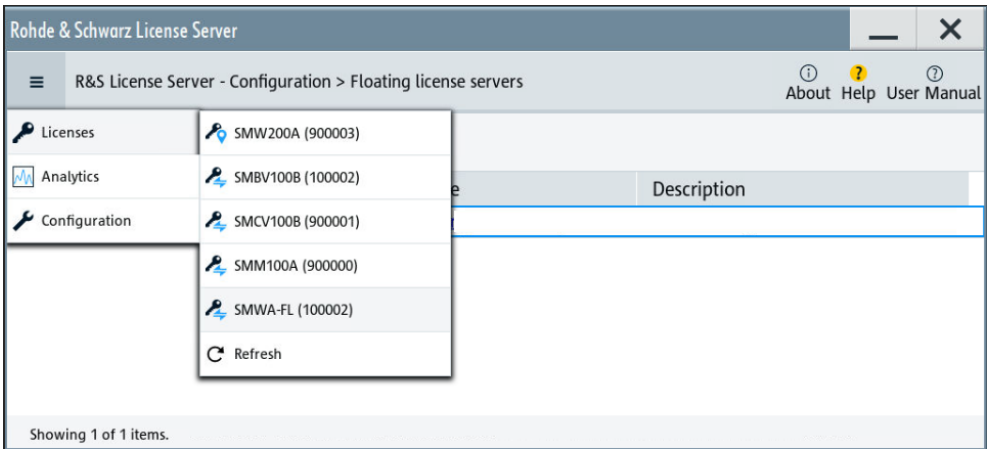


Figure 11-6: Licenses menu

Provides access to the available license servers.

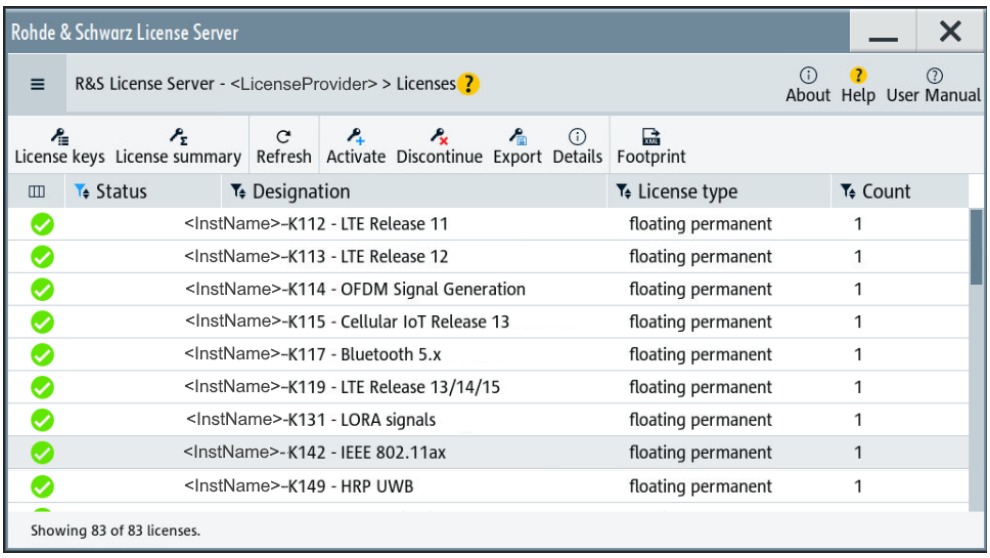


Figure 11-7: Example of a license keys view

The "License keys" view lists the license key options that are available on the selected server. To show additional information, use the column selection.
The task bar functions enable you to activate or deactivate a license, to get details on an option and export license keys or information on the selected product.

4. Select "Analytics".

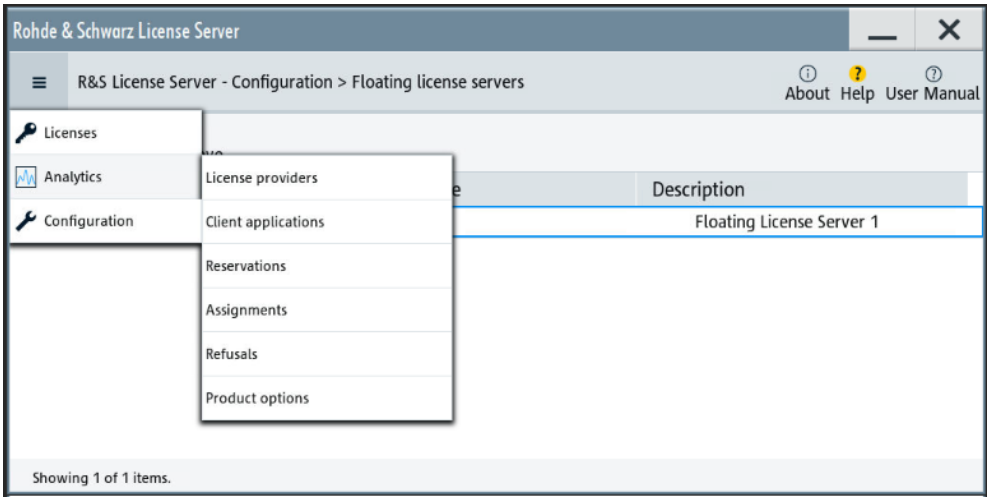


Figure 11-8: Analytics menu

Provides access to the license providers, client applications and enables you to export statistics data for evaluation in external applications.

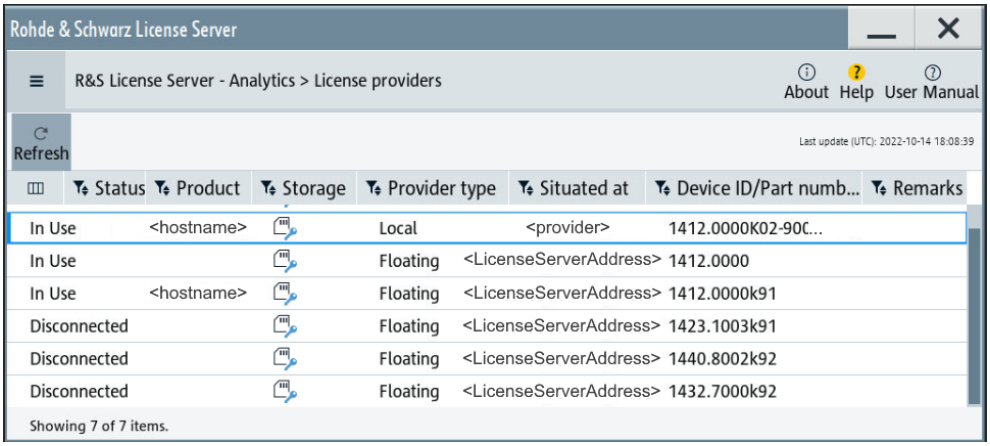


Figure 11-9: Example of the license providers view

Shows information on configured client applications, license providers and license types. To show additional information, use the column selection.

To manage licenses on the R&S SMM100A

To request or return a license, proceed as follows:

1. Access: see "To open the license server" on page 594.

   The browser application opens.
2. Select "Licenses"
3. Select a license server in the menu list, e.g. "R&S SMM100A".

   The "License keys" view lists the enabled options available on the selected server.
4. Select "Status" > "Select all" to list also options that are currently deactivated.

The "Licenses" view shows all active, inactive and time limited options.

5. To get detailed information on a specific option:
   a) Select the option in the list.
   b) In the task bar, select "Details".

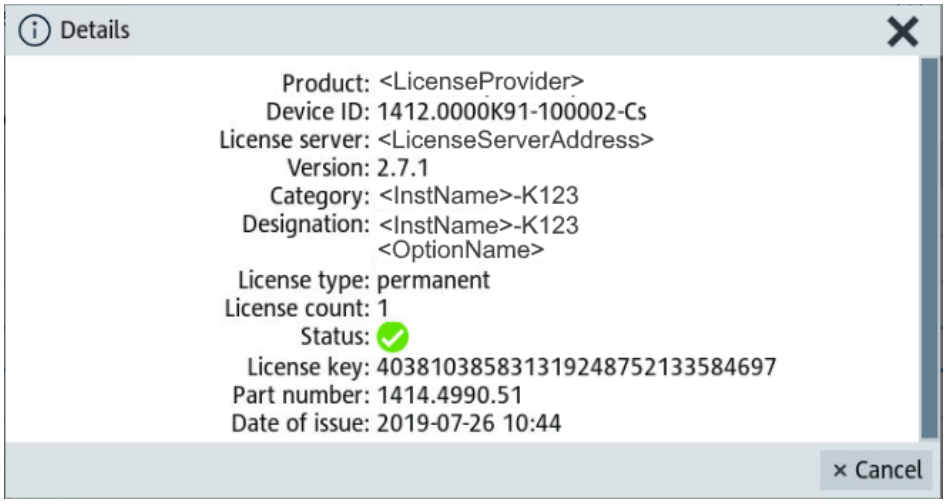
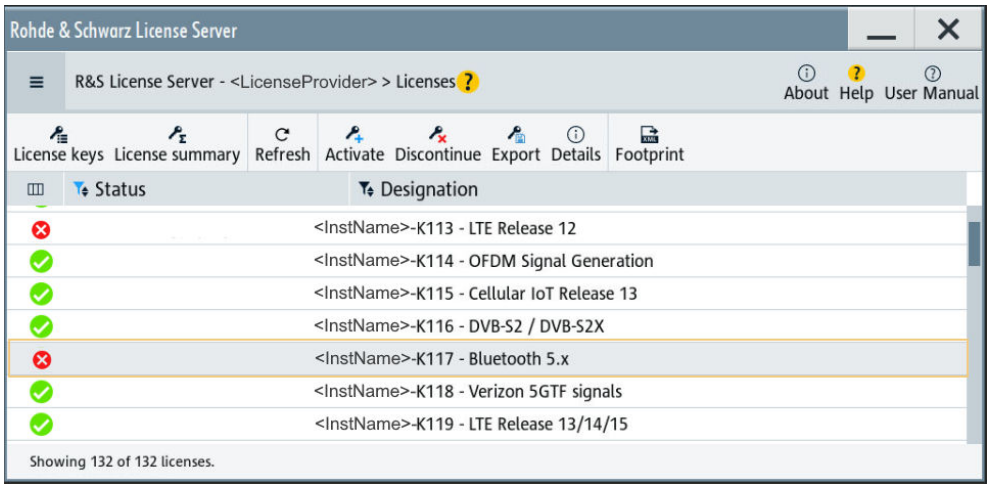


Figure 11-10: Example of the license characteristics of an option

6. To enable a discontinued license: , select Activate in the taskbar.



   a) Select the license you want to activate.
   b) In the task bar, select Activate.

7. To return a license, proceed the same way:
   a) Select the license.
   b) Deactivate the license with Discontinue.

8. Follow the instructions on the screen.

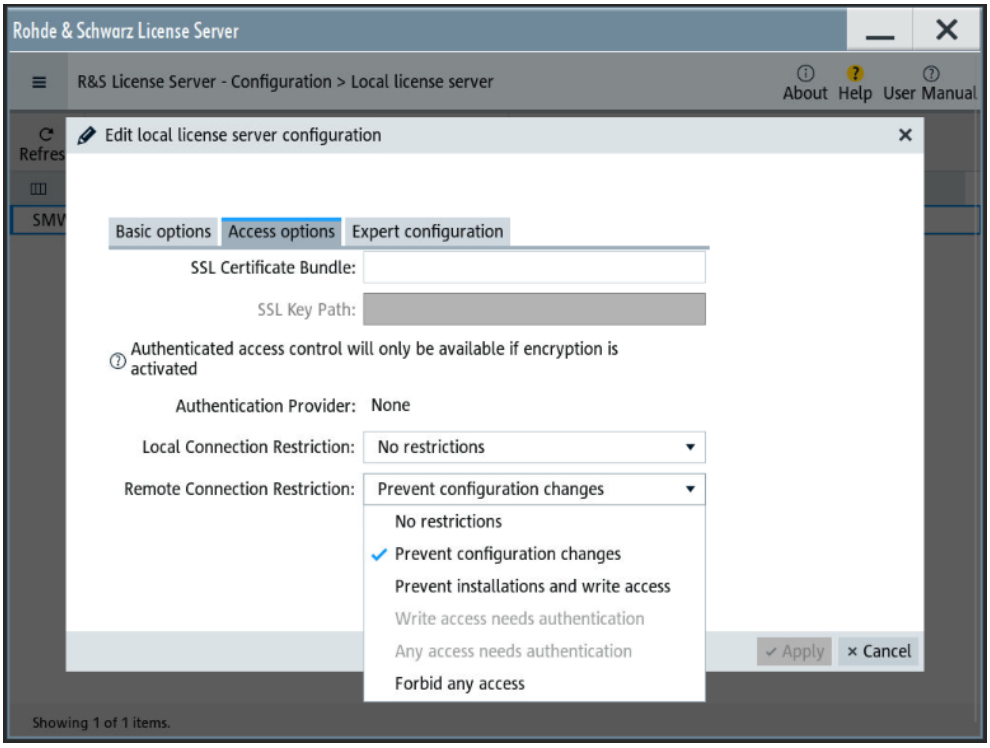
To restrict remote connection access

If you want to restrict the remote connection to the floating license server of the R&S SMM100A, you can configure specific levels to prevent unauthorized access:

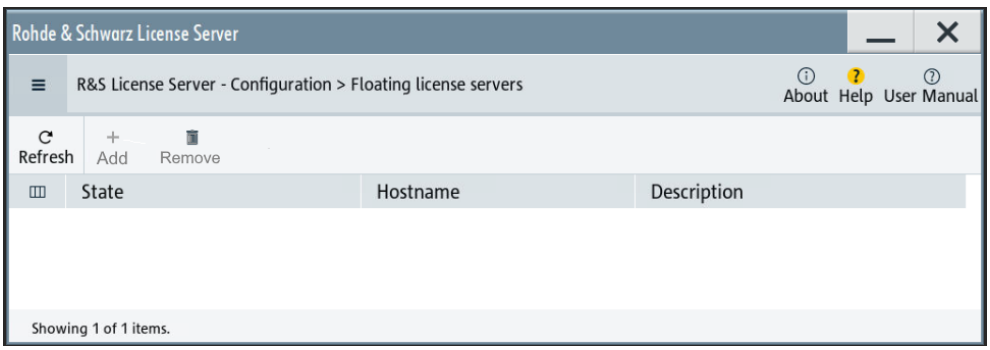
1. Open the license server as described in "To open the license server" on page 594.

   The onboard license server browser opens.

2. Select "Configuration" > "Local license server".
3. In the task bar, select "Edit".
4. Select the "Access options" tab.
5. Under "Remote Connection Restriction" restrict the access according to your requirements.



6. Confirm with "Apply" and close the dialog.



The R&S SMM100A blocks the remote connection of an external floating license server. The "Add" and "Remove" buttons are disabled (grayed out).
The restriction also disables the remote access to the "Edit" mode of the local server. You can release the restricted access only directly on the instrument.

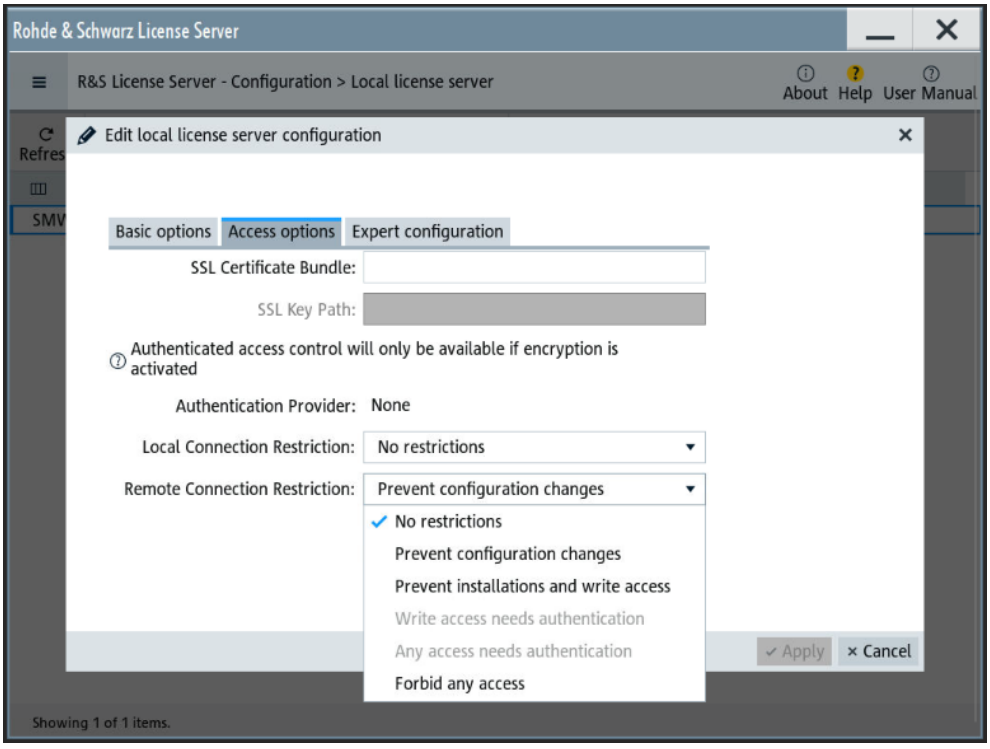
To enable remote connection access

If the remote connection to the floating license server is blocked, you can release the restriction or configure specific levels to prevent unauthorized access:

1. Open the license server as described in "To open the license server" on page 594.

   The onboard license server browser opens.

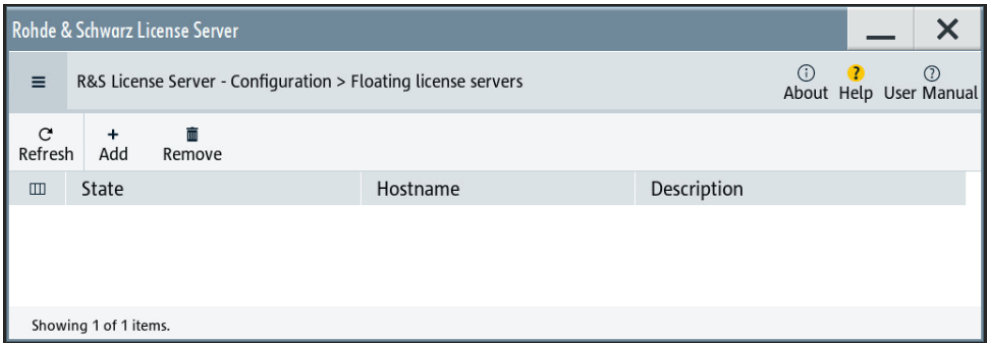
2. Select "Configuration" > "Local license server".
3. In the task bar, select "Edit".
4. Select the "Access options" tab.
5. Under "Remote Connection Restriction" release the access according to your requirements.



6. Confirm with "Apply" and close the dialog.

   If your selection no longer restricts the access, you can assign a floating license server.

7. Select "Configuration" > "Floating license server".

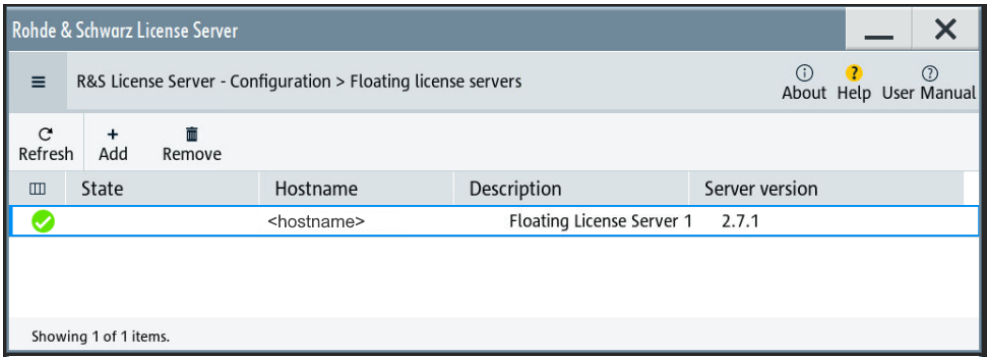


The "Add" and "Remove" buttons in the task bar are no longer blocked.

To add a remote connection to an external license server

1. Open the license server as described in "To open the license server" on page 594.

   The onboard license server browser opens.
2. Select "Configuration" > "Floating license server".
3. Select "Add".
4. Enter hostname and port of the license server you want to use.
5. Confirm with "Add".



The access to the server is established.

11.5.3 How to occupy or extend a license

The R&S SMM100A also supports the use of currently non-occupied software licenses provided by license servers of Rohde & Schwarz. When connected to one or more license servers, you can retrieve licenses for temporary installation and use directly on the instrument.

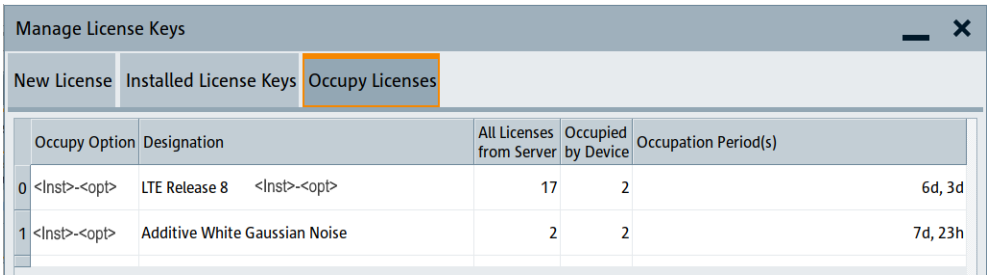
The following description shows how to assign and handle occupied licenses.

To occupy an option

The example shows how to occupy an LTE option for use in the instrument.

If all licenses are occupied, the license management of the instrument blocks the settings under "Occupy Free Licenses". But you can still extend the period of already occupied licenses, the instrument lists under "Renew Occupation Period", see "To extend the occupation period for an option in use" on page 603.

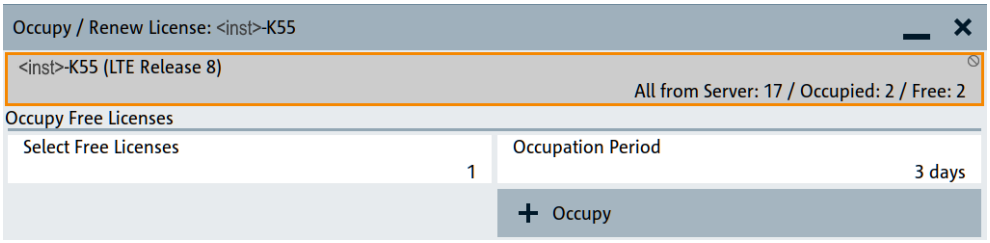
1. Access:
   Select "System Config > Setup > Instrument Assembly > Manage License Keys > Occupy Licenses".



   The table displays one row per option, even if more than one license is available. Column "All Licenses from Server" shows the number of free licenses.

2. To access the configuration dialog, select "Occupy Option" in the corresponding row.

   The subdialog for configuring the occupancy opens.



   In the information field of the dialog, you can see the number of available licenses for the selected option. It is not yet installed on the instrument ("Occupied: 0"), and you can occupy options up to the number of free licenses.

3. In the "Select Free Licences" field, set "1".
4. In the "Occupation Period" field, select e.g. "3 days".
5. Confirm and assign the selection with "Occupy".

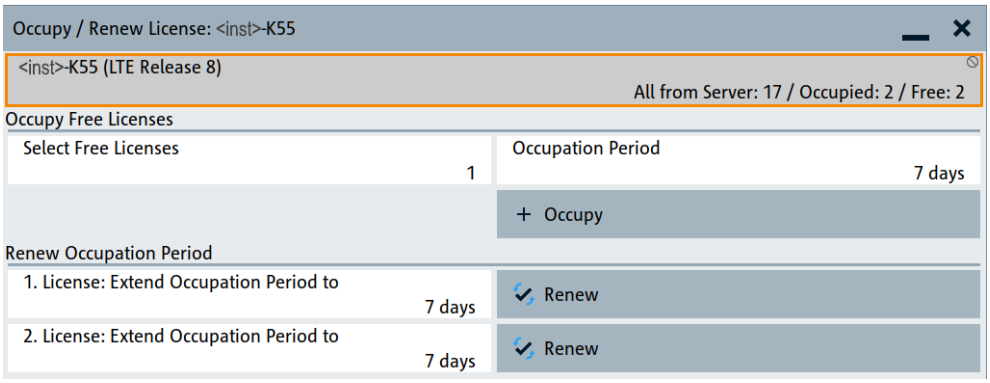
   Now you can use the option on the instrument. The number of available licenses on the servers is reduced by 2 for the set occupation period.

To extend the occupation period for an option in use

If an option is already occupied, the R&S SMM100A lists each option under "Renew Occupation Period".

1. Access: Navigate to the "Occupy / Renew License: ..." dialog, as described in "To occupy an option" on page 602.

2. To extend the occupation time, select the option in section "Renew Occupation Period".
3. Set the required time, e.g. "4 days".



The maximum period is 7 days.

11.5.4 How to move a portable license

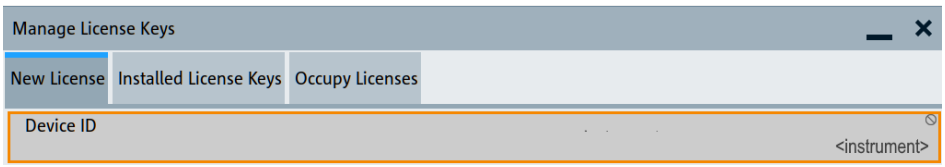
This example is intended to explain how to perform the required steps at the instrument.

Use a USB flash drive to transfer the license key files between the instruments and the browser.

We assume knowledge about the handling of the R&S License Manager online tool and the description of the whole process.

1. Open your browser. Enter https://extranet.rohde-schwarz.com/service.
   Select "Manage Licenses > Move Portable License".

   The first step requires the Device IDs of the source and target instruments.
2. To find out the Device IDs, proceed as follows:
   a) On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > New License > Device ID".



   b) On the target instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys".
   c) In the "New License" tab, select "Device ID".
   d) In the browser, select "Manage Licenses > Move Portable License > Select Devices".
   e) Enter the Device IDs.

3. On the source instrument, select "System Config > Setup > Instrument Assembly > Installed License Keys > License Keys Table".
   a) Navigate to the portable license that you want to move.
   b) Select the "Export License to File" column.

   A standard file manager dialog opens.
4. Enter a filename.
5. Save the exported license key, e.g. `k123_portable_key_to_move.xml`.
6. In the browser, select "Manage Licenses > Move Portable License > Select License (from file)":
   a) Select the exported license key.
   b) Check the selection.
   c) Create the deactivation key.
   d) Save it to file.
7. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > New License > Import License Keys from File".
   Select the transferred deactivation key.
8. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > New Licence > Export Deactivation Response to File".
9. In the browser, go to "Manage Licenses > Move Portable License > Install Deactivation Key (from file)".
10. Enter the deactivation response of the instrument.

    The license is deactivated for the source instrument.
11. In the "Manage Licenses > Move Portable License", go to step "Create License" to generate a license key for this portable option and the selected target instrument.
    a) Download the license key as a file.
    b) Transfer it to the target instrument.
12. In the target instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > New License > Import License Keys from File".
13. Select the created license key file.

    The portable option is installed on the target instrument.

11.6 Using the security settings

The protection function of the R&S SMM100A provides several levels to activate particular functions like self-test or tests for service purposes specifically.

Protection

The five protection levels are automatically active on startup that means all protected functions are locked.

To unlock a protection level:

► In the "System Config > Setup > Security > Protection" dialog, enter the correct password.

To lock a protection level:

► Clear the corresponding checkbox.

Protection levels

The following functions are protected in the respective levels:

- Protection level 1
  Protects against accidental changes, like, for example, the clock and date, several internal adjustments functions and the self-test, as well as network settings or the instrument hostname.
  You can access this level with the password 123456.
- Protection level 2
  Unlocks protected service functions. It is accessible to authorized personnel of Rohde & Schwarz service department only.
- Protection level 3 to 5
  Are reserved for internal use.

Security

The security concept of the R&S SMM100A helps you to protect your instrument against uncontrolled access and changes.

All modified security settings require that you enter the Security Password and confirm with Accept.

Provided security services are:

- **General** security parameters, such as:
  - **USB storage** that secures controlled access to the mass memory of the instrument
  - **Volatile mode** that prevents information to be written to the internal memory permanently.
  - **Sanitizing** that prevents the instrument from leaving a secure environment with stored user information.
  - **Annotation** frequency and amplitude prevent reading the display.
  - **User interface** prevent manual operation and reading the display.
- **Password** management secures controlled user access to the instrument

With the two-step password concept, you can assign a user-defined password for the operating system, and a security password for accessing the mass storage of the instrument.
See Section 11.6.5, "Password management", on page 615.

- **LAN services** secure controlled network access
  You can individually lock and unlock supported LAN interface services, including the SMB client and SMB server that use versions 1.0 and 2.0 of the SMB protocol. Remote control over LAN requires you have enabled the interface, but you can disable not needed LAN services individually.
  Note: Disabling LAN services needed for remote control over LAN locks the instrument access persistently. You cannot address the instrument any longer.
  See Section 11.6.4, "Configuring LAN services", on page 612.
- **User interface** prevents front panel operation and/or reading the display.

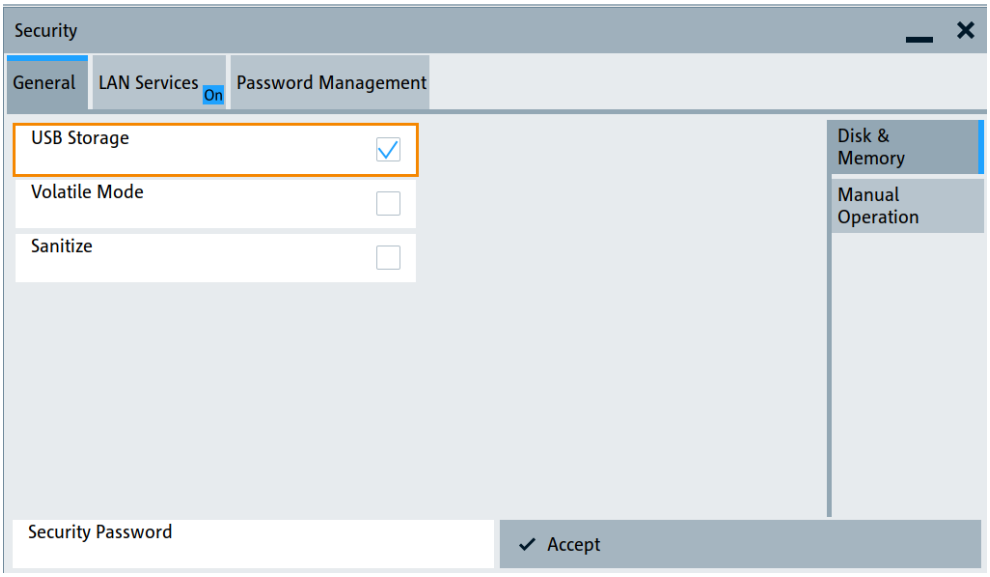
For more information, see the document R&S SMM100A Instrument Security Procedures.

- Disk & memory security settings....607
- Manual operation security settings....609
- Protection level settings....611
- Configuring LAN services....612
- Password management....615
- Preventing unauthorized access....618

11.6.1 Disk & memory security settings

Access:

1. Select "System Config" > "Setup" > "Security" > "Security".
2. Select "General" > "Disk & Memory".



The "Disk & Memory" tab secures controlled access to the mass memory and prevents information from leaving a secure environment.

The remote commands available to control security settings are described in Section 13.18, "SYSTem subsystem", on page 1054.

USB Storage
Activates the access to external USB storage media.

To apply the change enter the security password and confirm with "Accept".

See Section 10.10.4, "Using a USB storage device for file transfer", on page 550.

Note: Remove all USB memory devices before disabling the USB storage. If any USB memory device remains connected, disabling is blocked, and the instrument returns a warning message.

Volatile Mode
Activates volatile mode, so that no user data can be written on the internal memory permanently.

In volatile mode:
- Data that the instrument normally stores on the internal memory is redirected to volatile memory.
- The user directory is mapped to the volatile memory. You access the temporary data just as data stored in the `/var/user/`, see Section 10.4, "Protecting data", on page 528.
- Data on the internal memory cannot be changed. It is protected against modification or erasure.
- You can only save data:
  – Temporarily in the volatile memory
  – On a connected external storage device, such as a memory stick

To apply the change enter the security password and confirm with "Accept".

Enabling the volatile mode also requires a reboot, prompted by the instrument.

The icon indicates the enabled volatile mode.

Remote command:
`:SYSTem:SECurity:VOLMode[:STATe]` on page 1077

Sanitize
Executes the erase procedure that sanitizes the internal memory.

The sanitizing function makes sure that no user information is stored on the instrument when it leaves the secure environment.

To apply the change enter the security password and confirm with "Accept".

Note: If the instrument is subject to high security, and you have disabled volatile mode, the internal memory holds user-data, and thus poses a security risk.

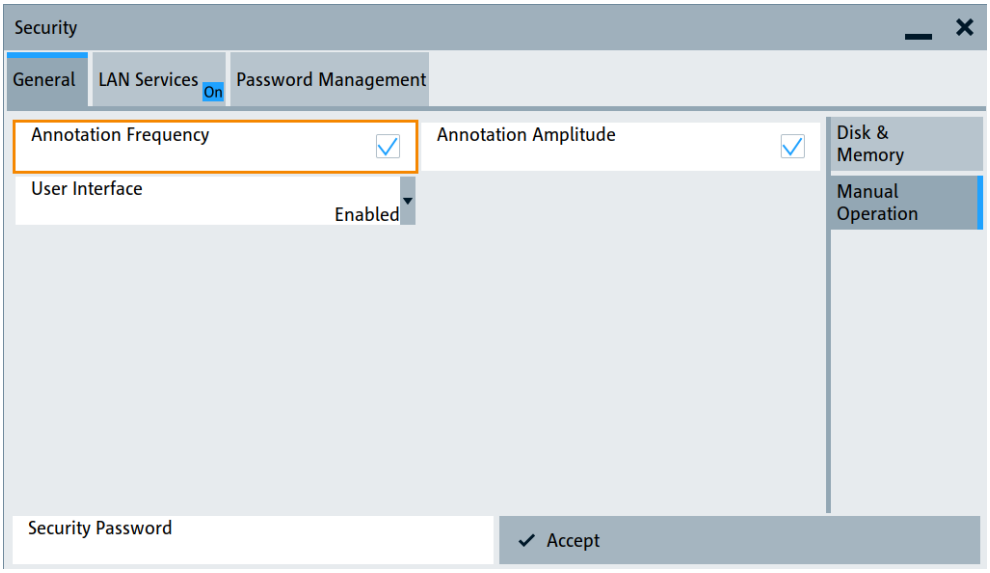
See also Section 11.6, "Using the security settings", on page 605 for more information on the security concept.

Remote command:
`:SYSTem:SECurity:SANitize[:STATe]` on page 1076

11.6.2 Manual operation security settings

Access:

1. Select "System Config" > "Setup" > "Security" > "Security".
2. Select "General" > "Manual Operation".



The "Manual Operation" tab enables you to lock front panel operation and/or reading the display.

The remote commands available to control security settings are described in:

- Section 13.10, "DISPlay subsystem", on page 749
- Section 13.18, "SYSTem subsystem", on page 1054.

Annotation Frequency
Enables the display of the currently used frequency in the status bar.

To apply the change enter the security password and confirm with "Accept".

How to: see "To disable frequency and level indication in the status bar" on page 621.

Remote command:
`:DISPlay:ANNotation:FREQuency` on page 751

Annotation Amplitude
Enables the display of the currently selected level in the status bar.

To apply the change enter the security password and confirm with "Accept".

How to: see "To disable frequency and level indication in the status bar" on page 621.

Remote command:
`:DISPlay:ANNotation:AMPLitude` on page 750

User Interface
Allows you to lock the controls for manual operation and the display individually.

To apply the change enter the security password and confirm with "Accept".

How to: see "To disable the user interface" on page 621.

See also Section 11.6, "Using the security settings", on page 605.

"Enabled" Enables the display and all controls for the manual operation of the instrument.

"Touchscreen Off"
Locks the touch sensitivity of the screen.
This security feature protects the instrument against unintentional change of settings by accidentally touching of the screen.

Still available controls for manual operation are:
- The keys at the front panel, including the rotary knob
- The external mouse and keyboard
- Remote operation over VNC

The instrument indicates the locked touchscreen by an icon .
Unlocking is possible via VNC, external controls or remote control.

"VNC Only" Locks the keys at the front panel, the touchscreen and externally connected keyboard and mouse.
The display on the screen remains and shows the current settings and changes.
The instrument indicates the activated "VNC only" feature by the icon .
Unlocking is possible via VNC or turning off and on again.

"Display Only" Locks the manual operation of the instrument. The display on the screen remains and shows the current settings and changes.
This security feature protects the instrument against unauthorized access, but still shows the current settings and processes, for example when you operate the instrument via remote control.

The function disables:
- The touchscreen functionality of the display
- The keys at the front panel of the instrument
- The external mouse and keyboard

The instrument indicates the locked controls by a padlock softkey.
How to unlock: see "Unlocking (reactivating) the user interface for manual operation" on page 622.

"Disabled" Locks the display and all controls for the manual operation of the instrument.
This security feature protects the instrument against unauthorized reading and access, for example when you operate the instrument via remote control.

The function disables:
- The display
- The touchscreen
- The keys at the front panel of the instrument
- The external mouse and keyboard

The screen shuts off and displays a padlock symbol instead.
How to unlock: see "Unlocking (reactivating) the user interface for manual operation" on page 622.

Remote command:
`:SYSTem:ULOCk` on page 1063
`:SYSTem:DLOCk` on page 1062
`:SYSTem:KLOCk` on page 1062

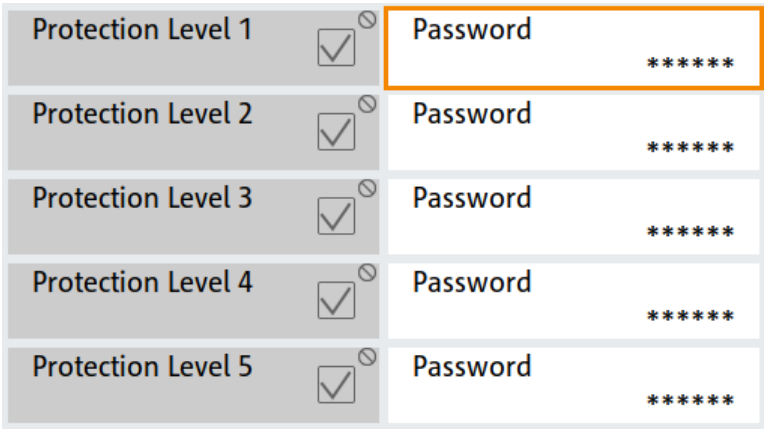
Enabling a locked user interface for manual operation
Follow the instructions listed in "Unlocking (reactivating) the user interface for manual operation" on page 622.

Remote command:
`:SYSTem:ULOCk` on page 1063
`:SYSTem:DLOCk` on page 1062
`:SYSTem:KLOCk` on page 1062

11.6.3 Protection level settings

Access:

► Select "System Config" > "Setup" > "Security" > "Protection".



The "Protection" dialog provides access to the unlocking of different protection levels.

Several functions in the instrument are password-protected to prevent for example accidental changes, "Protection" on page 606.

The remote commands required to unlock a protected stage are described in Section 13.18, "SYSTem subsystem", on page 1054.

Protection Level/Password
Unlocks the selected level of protection, if you enter the correct password.

The default protection level 1 password is 123456.

To lock the protection level again, clear the checkbox.

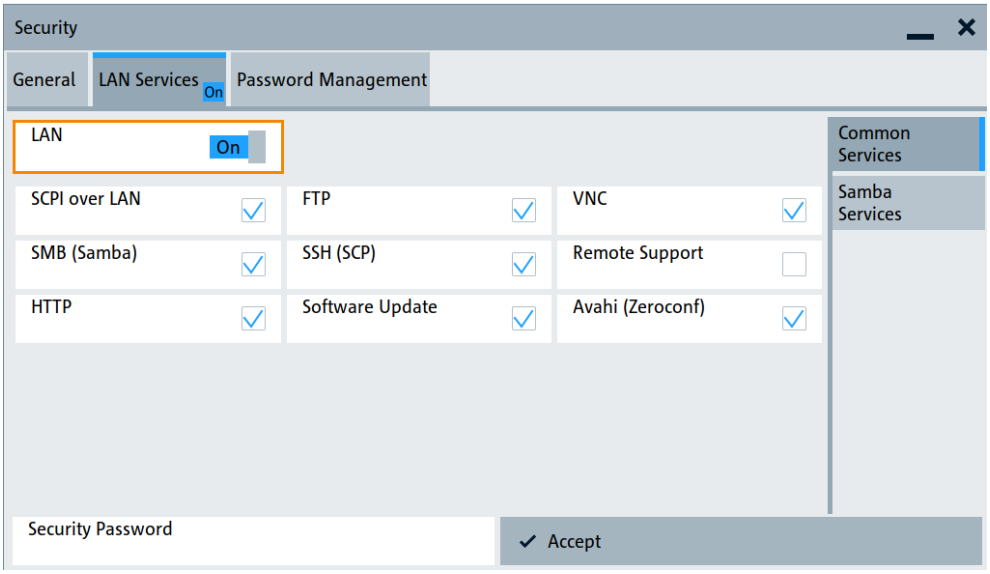
Remote command:
`:SYSTem:PROTect<ch>[:STATe]` on page 1065

11.6.4 Configuring LAN services

Access:

1. Select "System Config > Setup > Security > Security > LAN Services > Common Services".
2. **NOTICE!** Risk of loosing access over LAN. Disabling the LAN interface or the common services "SCPI over LAN", "VNC" and "HTTP" locks the remote access to the instrument.

   Do not disable the LAN interface or LAN services needed for remote control while you operate the instrument remotely.
   Proceed with step step 4 for troubleshooting disabled services.

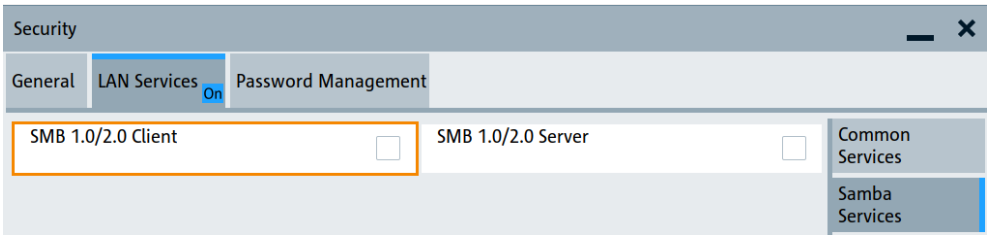


   In the "Common Services" side tab, you can individually disable the supported services of the LAN interface.
3. Disable LAN services as needed.

a) Disable the service.
b) To confirm disabling, enter the security password.
c) Select "Accept".

4. If you have locked the access accidentally, you have the following options:
   - Update the instrument firmware using ISO image (`<instrument>_<version-number>.iso`).
     Note: A firmware update with the ISO image resets the instrument. The instrument reset dismisses user-specific configurations and deletes user data. Contact the Rohde & Schwarz (https://www.rohde-schwarz.com/support) to get the ISO image.
   - Ship the instrument to your local service department. The service center experts can enable the remote access over LAN without loosing user-specific settings and data.
     See www.services.rohde-schwarz.com.

5. Select "System Config > Setup > Security > Security > LAN Services > Samba Services".



In the "Samba Services" side tab, you can activate former versions of the SMB client and SMB server.

The remote commands available to control security settings are described in Section 13.18, "SYSTem subsystem", on page 1054.

How to:

- "To disable LAN access in general" on page 619
- "To disable LAN services individually" on page 619
- "To enable SMB version 1.0/2.0 client and server" on page 620

Common Services....613
└ LAN....614
└ LAN Services....614
Samba Services....615
└ SMB 1.0/2.0 Client....615
└ SMB 1.0/2.0 Server....615
Security Password....615
Accept....615

Common Services
Enables the LAN interface and supported LAN interface services.

LAN ← Common Services
Enables the LAN interface in general, and thus provides remote access over all unlocked services.

Remote command:
`:SYSTem:SECurity:NETWork[:STATe]` on page 1076

LAN Services ← Common Services
Enables the supported LAN interface services individually.

"SCPI over LAN"
Access over LAN to control the instrument remotely, by using SCPI (Standard Commands for Programmable Instruments) commands.
See also "To set up the controller with R&S VISA" on page 674 and "To start remote control with R&S VISA" on page 677

Remote command:
`:SYSTem:SECurity:NETWork:SOE[:STATe]` on page 1075

"VNC" Access over VNC (Virtual Network Computing) interface, a graphical desktop sharing system that uses RFB protocol to control the instrument remotely.
See also Section 12.9, "Setting up remote operation over VNC", on page 683.

Remote command:
`:SYSTem:SECurity:NETWork:VNC[:STATe]` on page 1076

"SSH (SCP)" Access over SSH (Secure Shell), a network protocol for secure data communication.

Remote command:
`:SYSTem:SECurity:NETWork:SSH[:STATe]` on page 1075

"Remote Support"
Remote support over SSH (SCP).
The service provides communication for service purposes only.

Remote command:
`:SYSTem:SECurity:NETWork:REMSupport[:STATe]` on page 1074

"HTTP" Access with HTTP (Hyper Text Transfer Protocol), the application protocol for hypermedia information systems.

Remote command:
`:SYSTem:SECurity:NETWork:HTTP[:STATe]` on page 1073

"FTP" Access with FTP (File Transfer Protocol), used to transfer files from a host to the instrument and vice versa.
See also Section 10.10.2, "Accessing the file system using FTP", on page 547.

Remote command:
`:SYSTem:SECurity:NETWork:FTP[:STATe]` on page 1073

"SMB (Samba)"
Access to SMB (Server Message Block), used for providing shared access to files, printers and serial ports of a network.
See also Section 10.10.3, "Accessing the R&S SMM100A file system using SMB (Samba)", on page 549.

Remote command:
`:SYSTem:SECurity:NETWork:SMB[:STATe]` on page 1075

"Avahi (Zeroconf)"
Avahi, a service for automatic configuration of the instrument in a network environment.

Remote command:
`:SYSTem:SECurity:NETWork:AVAHi[:STATe]` on page 1073

"Software Update"
Allows updating the software.

Remote command:
`:SYSTem:SECurity:NETWork:SWUPdate[:STATe]` on page 1075

Samba Services
Enables support of SMB client and SMB server version 1.0 and 2.0 of the SMB protocol.

Support of version 1.0 and 2.0 is additional to the current SMB protocol version supported in the firmware. This firmware supports SMB protocol up to version 3.1.1.

SMB 1.0/2.0 Client ← Samba Services
Enables support of the SMB client compatible with SMB protocol versions 1.0 and 2.0.

SMB 1.0/2.0 Server ← Samba Services
Enables support of the SMB server compatible with SMB protocol versions 1.0 and 2.0.

Security Password
Enters the password that is required to enable or to disable the settings protected by a security password. Default is *123456*.

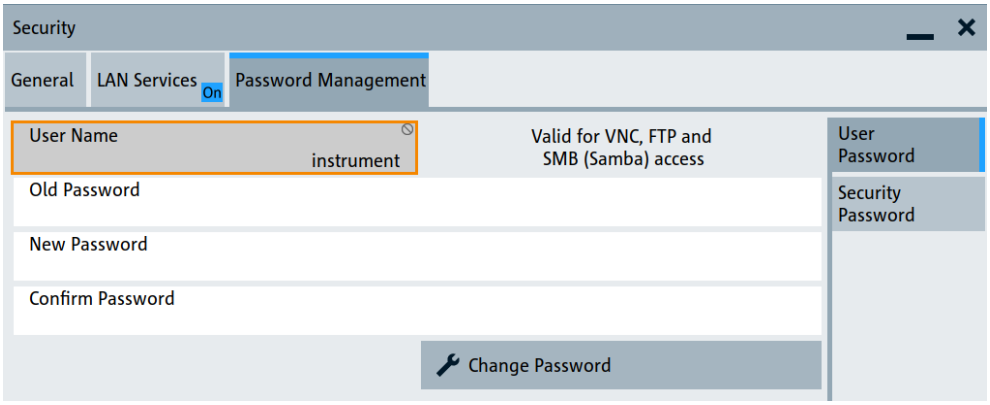
How to: "To change the security password" on page 619

Accept
Applies the modified settings, provided the security password is entered and correct.

11.6.5 Password management

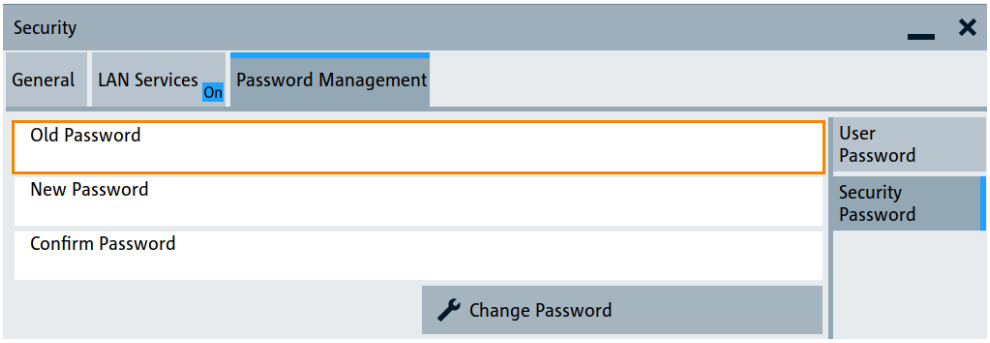
Access:

1. Select "System Config > Setup > Security > Security > Password Management > User Password".



In this tab, you can assign the security and a user-defined password.

2. Select "System Config > Setup > Security > Security > Password Management > Security Password".



How to:

- "To change the user password of the instrument" on page 618.
- "To change the security password" on page 619.

Settings:

User Name....616
User Password....617
└ Old Password....617
└ New Password....617
└ Confirm Password....617
└ Change Password....617
Security Password....617
└ Old Password....617
└ New Password....617
└ Confirm Password....618
└ Change Password....618

User Name
Indicates the user name used for access to the Linux operating system and valid for VNC, FTP and SMB (Samba) access.

User Password
Allows you to change and confirm the user password.

Old Password ← User Password
Enters the current user password. The default password is "instrument".

Note: We recommend that you change the default password before connecting the instrument to a network.

How to:
- "To change the user password of the instrument" on page 618.
- "To change the security password" on page 619.

Note: Note that you cannot reset the password to factory state.
If you encounter problems with the password, contact the Rohde & Schwarz customer support, see Section 14.10, "Contacting customer support", on page 1113.

New Password ← User Password
Enters the new user password.

The security password can contain decimal characters only.

Confirm Password ← User Password
Confirms the new user password by repeating.

How to:
- "To change the user password of the instrument" on page 618.
- "To change the security password" on page 619.

Change Password ← User Password
Changes the user password accordingly.

Security Password
Enables you to change and confirm the security password.

Old Password ← Security Password
Enters the currently used security password. The default password is '123456'.

Note: We recommend that you change the default password before connecting the instrument to a network.

How to:
- "To change the user password of the instrument" on page 618.
- "To change the security password" on page 619.

The security password is required when changing the status of the USB and LAN interface or other security settings.

Note: Note that you cannot reset the password to factory state.
If you encounter problems with the password, contact the Rohde & Schwarz customer support, see Section 14.10, "Contacting customer support", on page 1113.

New Password ← Security Password
Enters the new security password.

The security password can contain decimal characters only.

Confirm Password ← Security Password
Confirms the new security password by repeating.

How to:
- "To change the user password of the instrument" on page 618.
- "To change the security password" on page 619.

Change Password ← Security Password
Changes the password accordingly.

11.6.6 Preventing unauthorized access

The default computer name and user password are *instrument*. The user password is the password required for VNC, FTP and SMB (samba) connections. If for example, the VNC service or FTP are enabled, anyone in the network who knows the computer name and user password of the instrument can access it.

The default security password is *123456*. The security password is required when changing the status of the USB and LAN interfaces.

To prevent unauthorized access, use the following configurations exclusively or complementary:

- "To change the user password of the instrument" on page 618
- "To change the security password" on page 619
- "To disable LAN access in general" on page 619
- "To disable LAN services individually" on page 619
- "To enable SMB version 1.0/2.0 client and server" on page 620
- "To disable frequency and level indication in the status bar" on page 621
- "To disable the user interface" on page 621

If security is a concern, see the document instrument security procedures for comprehensive description.

To change the user password of the instrument

► **Note:** We recommend that you change the default password before connecting the instrument to a network.

How to:
- "To change the user password of the instrument" on page 618.
- "To change the security password" on page 619.

a) Select "System Config > Setup > Security > Security > Password Management > User Password".
b) Enter the current password in the "Old Password" field.
c) Enter the new password in the "New Password" and "Confirm Password" fields.
d) Select "Change Password".

The user password is changed; the user name is displayed ("Security > Password Management > User Password > User Name").

To change the security password

► **Note:** We recommend that you change the default password before connecting the instrument to a network.

How to:
- "To change the user password of the instrument" on page 618.
- "To change the security password" on page 619.

a) Select "System Config > Setup > Security > Security > Password Management > Security Password".
b) Enter the current password in the "Old Password" field.
The default password is *123456*.
c) Enter the new password in the "New Password" and "Confirm Password" fields.
d) Select "Change Password".

To disable LAN access in general

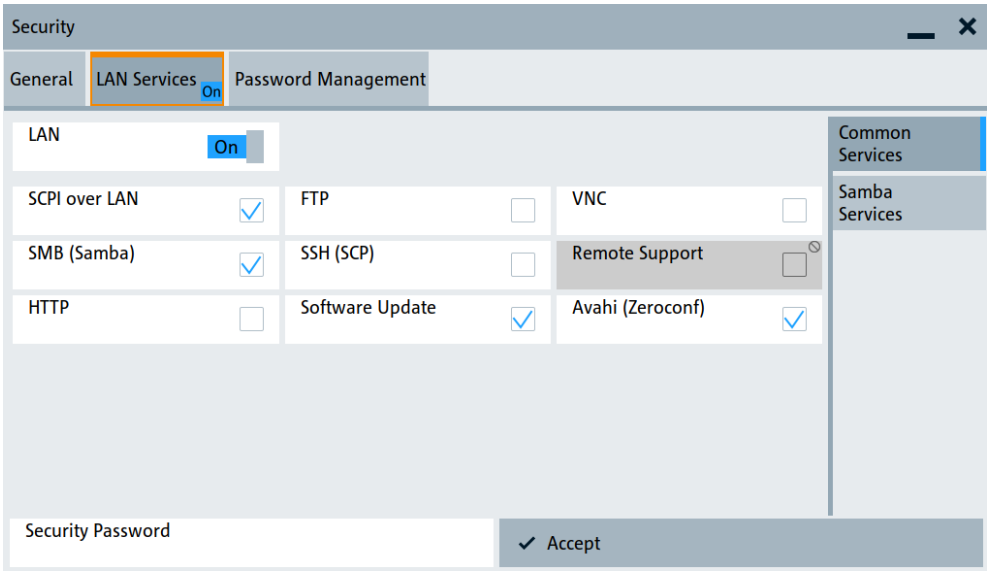
1. **NOTICE!** Risk of loosing access over LAN. Disabling the LAN interface or certain services lock the remote access to the instrument.
The following services lock the remote access when disabled: "LAN", "SCPI over LAN", "VNC" and "HTTP".

   If you have locked the access accidentally, you have the following options:
   - Update the instrument firmware using ISO image (`<instrument>_<version-number>.iso`).
     Note: A firmware update with the ISO image resets the instrument. The instrument reset dismisses user-specific configurations and deletes user data.
     Contact the Rohde & Schwarz (https://www.rohde-schwarz.com/support) to get the ISO image.
   - Ship the instrument to your local service department. The service center experts can enable the remote access over LAN without loosing user-specific settings and data.
     See www.services.rohde-schwarz.com.
2. Select "System Config > Setup > Security > Security".
3. Select "LAN Services > Common Services".
4. Disable "LAN" state.
5. Enter the Security Password.
6. Select "Accept".

   All LAN connections are blocked, including the LAN services. Communication over LAN is not possible.

To disable LAN services individually

1. Select "System Config > Setup > Security > Security".
2. Select "LAN Services > Common Services".
3. Uncheck all services you want to block, for example "FTP > Off" or "VNC > Off".



4. Uncheck the services you want to block, for example "FTP" and "VNC".
5. Enable "LAN" state, if disabled.
6. Enter the Security Password.
7. Select "Accept".

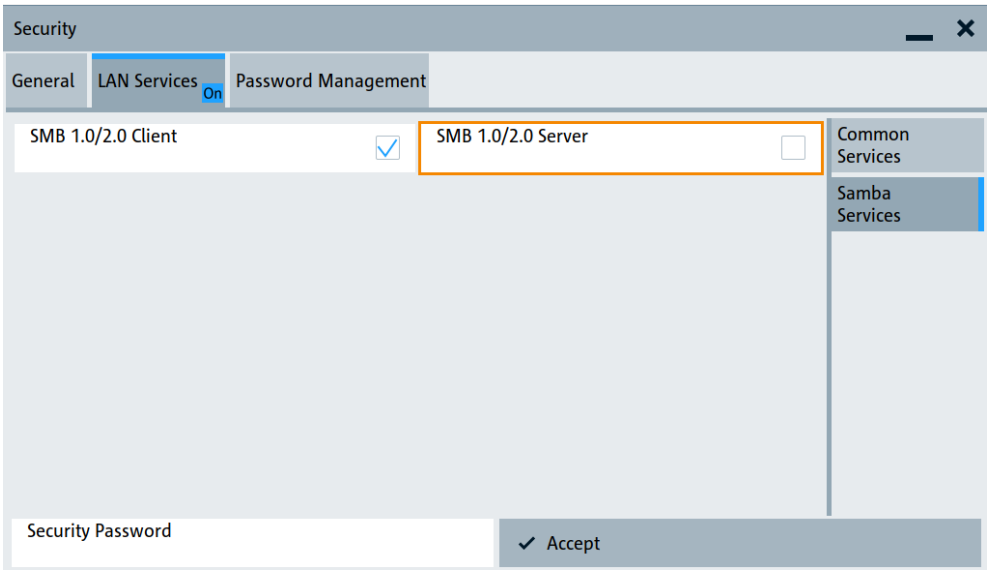
   Communication over LAN is possible for the enabled services only.

To enable SMB version 1.0/2.0 client and server

By default, support of SMB client and SMB server of the SMB protocol versions 1.0 and 2.0 is disabled.

Activate support only, if needed:

1. Select "System Config > Setup > Security > Security".
2. Select "LAN Services > Samba Services".



3. For example, check "SMB 1.0/2.0 Client".
4. Select "SMB 1.0/2.0 Client > On" and "SMB 1.0/2.0 Server > On".
5. Enter the Security Password.
6. Select "Accept".

   Enables the access for the SMB Samba client, the access for the SMB Samba server remains blocked.

To disable frequency and level indication in the status bar

These settings are useful to prevent unauthorized personnel from reading the display, when you remotely control the instrument from a different location.

1. Select "System Config > Setup > Security > General > Manual Operation".
2. Select "Annotation Frequency > Off" or "Annotation Amplitude > Off".
3. Enter the Security Password.
4. Select "Accept".

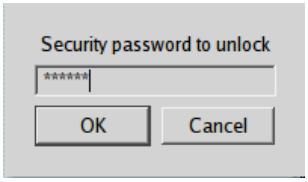
To disable the user interface

1. Select "System Config > Setup > Security > General > Manual Operation".
2. Select "User Interface > Disabled".
3. Enter the Security Password.
4. Select "Accept".

   The screen shuts off and displays a padlock symbol instead.
   There are further possible configurations. For details, see "User Interface" on page 610.

Unlocking (reactivating) the user interface for manual operation

1. In manual operation:
   a) On the instrument's keypad or external keyboard, press any key.
   The instrument prompts you to enter the security password for unlocking.



   If you press the character of the first key, the input field accepts the character immediately.
   b) Delete the entry before inserting the password.
   Enter the security password *123456*.
2. In remote control mode:
   a) Send the command `SYST:ULOC ENABled` to release all locks at once.
   b) Send the command `SYST:KLOC OFF` to unlock the keyboard and touchscreen.
   c) Send the command `SYST:DLOC OFF` to release all locks.

   Via remote control, there is no password required.

11.7 Undoing or restoring actions

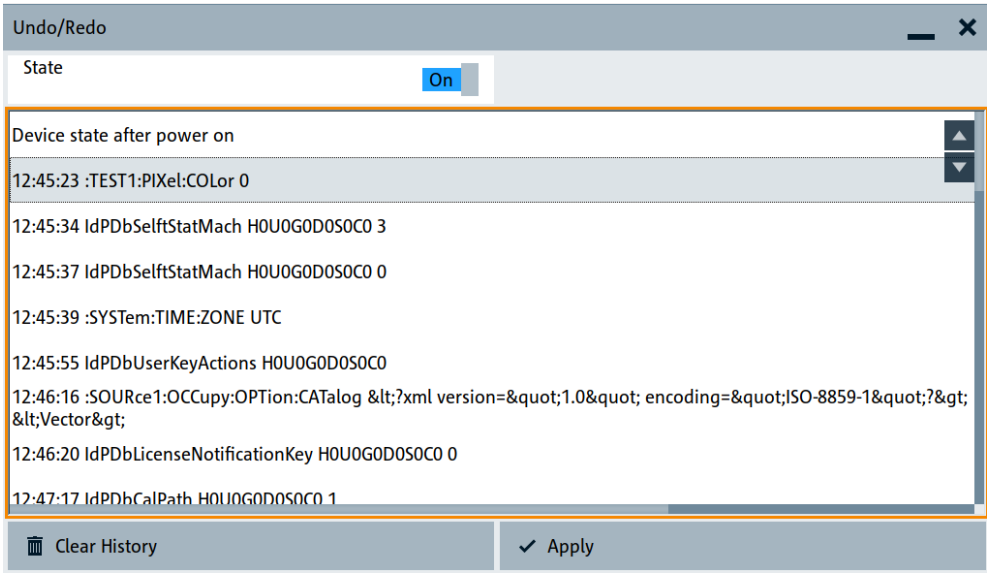
"Undo" is a function that removes the effect of the last action on the instrument and reverts it to an older state. Conversely, "Redo" restores a previously undone action.

You can "Undo/Redo" actions according to two criteria:

- Step by step
  Gradually undo/redo the actions in reverse order as previously performed. Depending on the available memory the "Undo/Redo" steps may restore all actions.
- Multiple steps at once
  Select any specific action in the history list to "Undo/Redo" multiple actions in a single step.
  Note: This mode requires a system restoration file on the instrument.

Access:

► Select "Setup > Settings > Undo/Redo".



The dialog contains all functions for enabling the "Undo/Redo" functionality.

Settings:

State....623
History List....623
Clear History....623
Apply....623

State
Enables the recording of the performed actions.

History List
Lists the performed actions, provided "Undo/Redo" state is "On".

Clear History
Deletes the recorded list of the performed steps.

Apply
Performs the "Undo/Redo".

If you select a previously performed action of the list, all subsequent actions are undone. The list entries remain.

If you select a subsequently executed action, you can restore all the actions undone up to this state.

11.8 Shutting down and rebooting the instrument

On the front panel, the [On/Standby] key switches the instrument from the standby to the ready state or vice versa. In remote operation from a remote computer or in manual control, there is another possibility to shut down the instrument or to reboot the system.

Access:

► Select "System Config > Setup > Maintenance > Shut down".

Remote control commands:

- `:SYSTem:REBoot` on page 1083
- `:SYSTem:SHUTdown` on page 1084

12 Network operation and remote control

As an alternative to the interactive operation directly at the instrument, you can operate the R&S SMM100A also from a remote location.

The various interfaces provide flexible access to the instrument, such as *remote control*, *remote operation* or *remote file access*. These remote access modes are fundamentally different, although they are often considered interchangeable, as described in Section 12.1, "Overview of remote access modes", on page 626.

Figure 12-1 shows the possibilities of the physical connection (interfaces) for remote access.

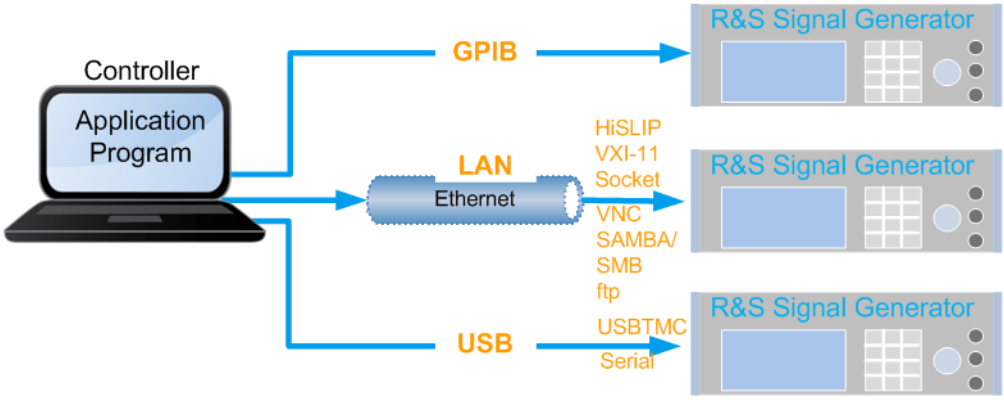


Figure 12-1: Supported remote connections

The following descriptions provide information required for operating the R&S SMM100A remotely. The information applies to all applications and operating modes supported by the instrument. Definitions specified in the SCPI standard are not provided.

For basic knowledge on remote control operation and additional information, see the following documents, available on the Rohde & Schwarz website:

- Getting started: Remote control via SCPI
- Application note 1GP72: "Connectivity of Rohde&Schwarz Signal Generators"
- Application note 1MA208: "Fast Remote Instrument Control with HiSLIP"
- Application note 1GP98: "SCPI Recorder Test Automation on a Fingertip"

- Overview of remote access modes 626
- Remote control interfaces and protocols 627
- Remote control programs and libraries 632
- Status reporting system 635
- Remote access settings 638
- LXI status settings 660
- LXI browser settings 662
- Setting up remote control 669
- Setting up remote operation over VNC 683

- Using remote command scripts.....689
- Using command macros..... 699
- References.....705

12.1 Overview of remote access modes

This section outlines the possible access modes and their major characteristics.

Remote control (SCPI)

- A remote PC controls the instrument, usually via VISA (Virtual Instrument Software Architecture) interfaces.
- Remote control disables the manual operation of the instrument; you can set different lock states.
- The GUI is not visible.
- Remote control commands (SCPI) perform the settings, either individually or in sequences (SCPI programs).
- Using SCPI programs is faster than the manual operation, since they automate repeating applications.

Remote operation (VNC)

- A remote device accesses the instrument via the common platform technology VNC (Virtual Network Computing).
- The protocol allows simultaneous operation from several remote devices and the instrument nevertheless remains locally operable.
- The GUI is visible.
- To perform the settings, you can operate the instrument as with the manual control.
- During remote operation via VNC, the direct control of the instrument is not disabled.
  You can control the instrument from the front panel and via the remote computer alternately.
- Clients supporting remote operation depend on the used remote device, see Table 12-1.
- How to: see Section 12.9, "Setting up remote operation over VNC", on page 683.

Table 12-1: Supported VNC operation modes

Remote device	VNC client	Requirements	Characteristics
Desktop (Windows, Linux, Mac™OS)	• Ultr@VNC • Other dedicated client software	*Ultr@VNC or Client Software* must be installed.	Fast, supports several options like full screen mode or auto-login.
	• Any web browser	*Java Runtime* must be installed and activated in the browser settings.	Fast and convenient - only the instrument address required. Java runtime is sometimes considered as security concern.

Remote device	VNC client	Requirements	Characteristics
	• Web browser with HTML5	*Web sockets* must be supported.	Slower than the other modes. No additional installation or activation required. No security concern.
Smart device (Tablet/ smartphone)	• Dedicated client App	*App* must be installed.	Fast, supports several options like full screen mode or auto-login.
	• Web browser with HTML5	*Web sockets* must be supported.	Support of QR code scanning Slower than a dedicated App.

Remote file access (FTP, SAMBA/SMB)

- A remote client accesses the instrument's file system, using the protocols FTP (file transfer protocol) and SAMBA/SMB (server message block).
- The protocols enable you to transfer files from or to the instrument and to get direct access to its file sharing directory `share`.

How to:

Section 10.10.2, "Accessing the file system using FTP", on page 547.

Section 10.10.3, "Accessing the R&S SMM100A file system using SMB (Samba)", on page 549

"To enable SMB version 1.0/2.0 client and server" on page 620

12.2 Remote control interfaces and protocols

The instrument supports various interfaces for remote control. Table 12-2 gives an overview on the connectivity:

Table 12-2: Remote control interfaces and protocols

Interface	Protocols, VISA*) address string and library	Remarks

Local area network (LAN)	• **HiSLIP** High-Speed LAN Instrument Protocol (IVI-6.1)
	`TCPIP::host address::hislip0[::INSTR]`
	VISA
	• **VXI-11**
	`TCPIP::host address[::LAN device name][::INSTR]`
	VISA
	• **Socket communication** (Raw Ethernet, simple Telnet)
	`TCPIP::host address[::LAN device name]::<port>::SOCKET`
	VISA or socket controller
		The LAN connector is at the rear panel of the instrument.
		The interface is based on TCP/IP, see Section 12.2.1, "LAN interface", on page 628 for details on the address information.

USB	• **USBTMC** `USB::<vendor ID>::<product ID>::<serial number>[::INSTR]` VISA	The USB Device connector is at the rear panel of the instrument. For a description of the interface, see Section 12.2.2, "USB interface", on page 630

Interface	Protocols, VISA*) address string and library	Remarks
GPIB (IEC/IEEE Bus Interface)	• VISA*) address string: `GPIB::<address>[::INSTR]` (no secondary address) VISA (optional)	The optional GPIB bus interface according to standard IEC 625.1/IEEE 488.1 is at the rear panel of the instrument. For a description of the interface, see Section 12.2.3, "GPIB interface (IEC/IEEE bus interface)", on page 631.
*) VISA (Virtual Instrument Software Architecture) 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 over LAN (when using VXI-11 or HiSLIP protocol), USB and serial interface. When using socket communication or the GPIB interface, VISA installation is optional. For basic information, see Remote control via SCPI.		

www.rohde-schwarz.com/rsvisa provides the standardized I/O software library R&S VISA for download at the Rohde & Schwarz website www.rohde-schwarz.com/rsvisa.

How to: Section 12.8, "Setting up remote control", on page 669 describes how to configure the remote control interfaces.

- LAN interface 628
- USB interface 630
- GPIB interface (IEC/IEEE bus interface) 631
- LXI browser interface 631

12.2.1 LAN interface

The LAN interface of the instrument consists of a connector, a network interface card and protocols.

For remote control, the instrument and the controller PC must be connected to a common network with TCP/IP network protocol.

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.
- A dedicated network connection (Point-to-point connection) between the instrument and a single computer.

How to: Section 3.1.7, "Connecting to LAN", on page 29

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.

VISA resource strings

The VISA resource string is required to establish a communication session between the controller and the instrument in the LAN. The resource string is a unique identifier,

composed of the specific IP address of the instrument and some network and VISA-specific keywords.

TCPIP::<host address>[::<LAN device name>][::INSTR]

TCPIP = designates the network protocol
host address = designates the IP address or hostname of the instrument
[::LAN device name] = defines the protocol and the instance number of a subinstrument
[::INSTR] = indicates the instrument resource class (optional)

The **IP address** (host address/computer name) is used by the programs to identify and control the instrument. It is automatically assigned by the DHCP server the first time the device is registered in the network. Optionally, you can also assign its **LAN device name**.

If assigned, the IP address is displayed in the block diagram.

The following section lists the characteristics of the VISA resource strings for the corresponding interface protocols. The emphasized characters determine the protocol.

For description of the interface protocols, control commands and messages, refer to Remote control via SCPI.

HiSLIP

TCPIP::<host address>::hislip0[::INSTR]

hislip0 = HiSLIP device name, designates that the interface protocol HiSLIP is used (mandatory)

hislip0 is composed of `[::HiSLIP device name[,HiSLIP port]]` and must be assigned.

Example:

```
TCPIP::192.1.2.3::hislip0
```

VXI-11

TCPIP::<host address>[::inst0][::INSTR]

[::inst0] = LAN device name, indicates that the VXI-11 protocol is used (optional)

inst0 currently selects the VXI-11 protocol by default and can be omitted.

Example:

```
TCPIP::192.1.2.3::INSTR
```

Socket communication

TCPIP::<host address>::<port>::SOCKET

port = determines the used port number
SOCKET = indicates the raw network socket resource class

Socket communication requires the specification of the port (commonly referred to as port number) and of "SOCKET" to complete the resource string.

Basically, instruments from Rohde & Schwarz use port number 5025 for socket communication.

Example:

```
TCPIP::192.1.2.3::5025::SOCKET
```

12.2.2 USB interface

For remote control using USB, the controller PC and the instrument must be connected over the USB type B interface. Software for instrument control and the VISA program library must be installed on the controller.

The serial interface "RS232" enables you to connect the instrument over serial interface. You can connect to the interface by using the external USB/serial-adapter R&S TS1-USB and a serial crossover (null modem) cable.

For more information, refer to the specifications document.

VISA detects and configures the Rohde & Schwarz instrument automatically when the USB connection is established. You do not have to install a separate driver.

USBTMC (USB Test & Measurement Class Specification) is a protocol that is built on top of USB for communication with USB devices. It defines class code information of the instrument, that identifies its functionality to load the respective device driver. Using VISA library, the protocol supports service request, trigger, and other specific operations.

USB resource string

The resource string represents an addressing scheme that is used to establish a communication session with the instrument. It is based on the instrument address and some instrument- and vendor-specific information.

The USB resource string syntax is as follows:

USB::<vendor ID>::<product ID>::<serial number>[::INSTR]

USB = denotes the used interface
<vendor ID> = is the manufacturer ID for Rohde & Schwarz
<product ID> = is the product identification of the instrument
<serial number> = is the individual serial number at the rear of the instrument
[::INSTR] = indicates the instrument resource class (optional)

RS232 resource string

The RS232 resource string represents the addressing scheme for a device connected to the serial interface of the instrument.

The USB resource string syntax is as follows:

ASRL<port number>[::INSTR]

`ASRL` is the name of the serial interface

`<port number>` is the number of the serial interface

Example:

`ASRL1::INSTR`

12.2.3 GPIB interface (IEC/IEEE bus interface)

To control the R&S SMM100A over the GPIB bus, the instrument and the controller PC must be connected with a GPIB bus cable. A GPIB bus card, the card drivers and the program libraries for the used programming language must be installed on the controller.

For description of the characteristics, control commands and messages of the GPIB interface, refer to Remote control via SCPI.

GPIB address

The controller PC addresses the instrument with the GPIB bus channel, see Section 12.5.3, "GPIB address settings", on page 643. GPIB provides channel addresses from 0 to 30.

The GPIB resource string syntax is as follows:

GPIB::<channel>[::INSTR]

GPIB = denotes the used interface
<channel address> = the used channel
[::INSTR] = indicates the instrument resource class (optional)

Note: If the VISA implementation supports the GPIB interface, you can optionally define the VISA Instrument Control Resource (INSTR). It is used to define the basic operations and attributes for a device, such as reading, writing, or triggering.

Example:

`GPIB::28::INSTR`

28 is the selected GPIB bus channel

12.2.4 LXI browser interface

The LXI browser interface allows easy configuration of the LAN and remote control of the R&S SMM100A without additional installation requirements. The instrument's LXI browser interface works correctly with all W3C compliant browsers.

See Section 12.12.1, "LXI functionality", on page 705 for more about LXI.

The LAN settings are configured using the instrument's LXI browser interface described in Section 12.7.1, "LAN configuration", on page 664.

For LXI status information in the R&S SMM100A, see Section 12.6, "LXI status settings", on page 660.

12.3 Remote control programs and libraries

This section shows how the remote-control programs access the instrument, and the libraries they require for the corresponding interface protocols.

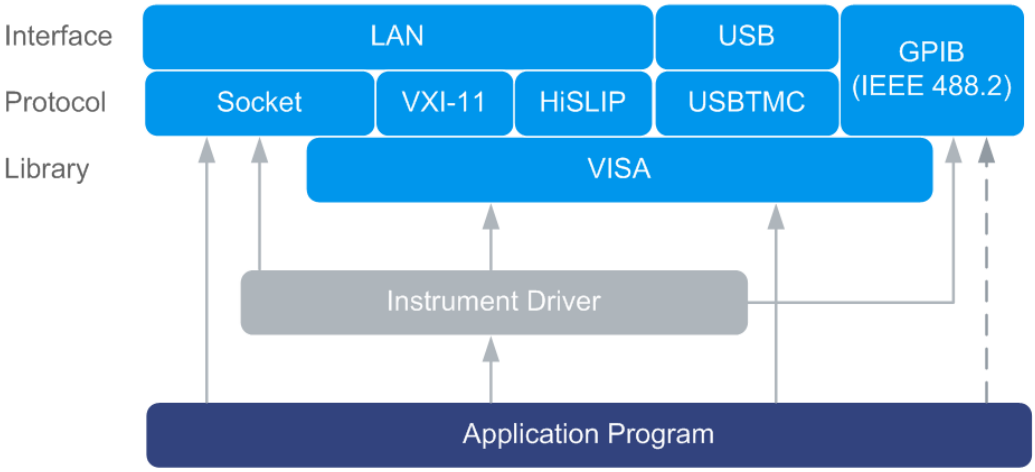


Figure 12-2: Overview of remote control interfaces, protocols and libraries

Possible setups and access functions

The following examples give an overview of dependencies between the available libraries, the possible interfaces and protocols, and whether an instrument driver is provided. For detailed information, see the application note 1GP72.

Example: Remote control (application) program using VISA

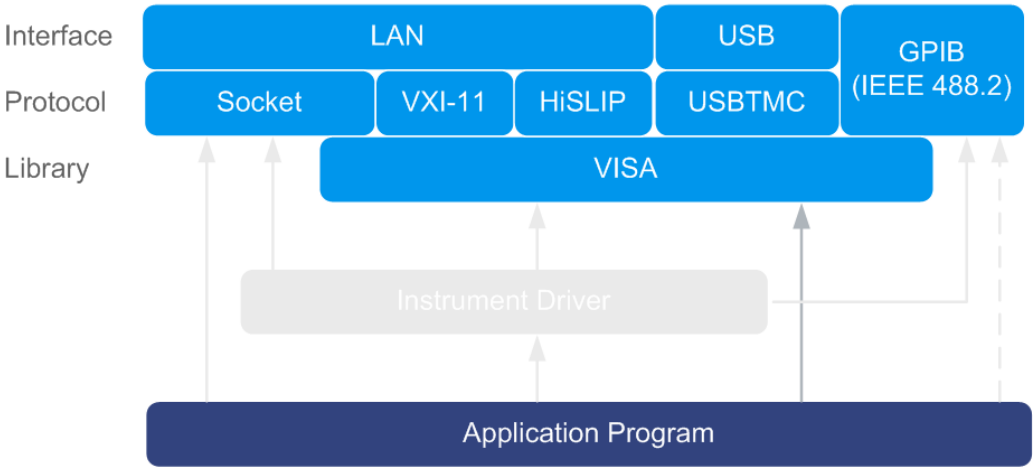


Figure 12-3: Application program using VISA

Protocol	Remote control program
Socket	`viOpen (..., "TCPIP:SMM100A-102030::5025::SOCKET", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
VXI-11	`viOpen (..., "TCPIP:SMM100A-102030::inst0::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
HiSLIP	`viOpen (..., "TCPIP:SMM100A-102030::hislip0::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
USBTMC	`viOpen (..., "USB::0x0AAD::0x0277::100001::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
GPIB	`viOpen (..., "GPIB::28::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`

Example: Remote control program using instrument driver (VISA available)

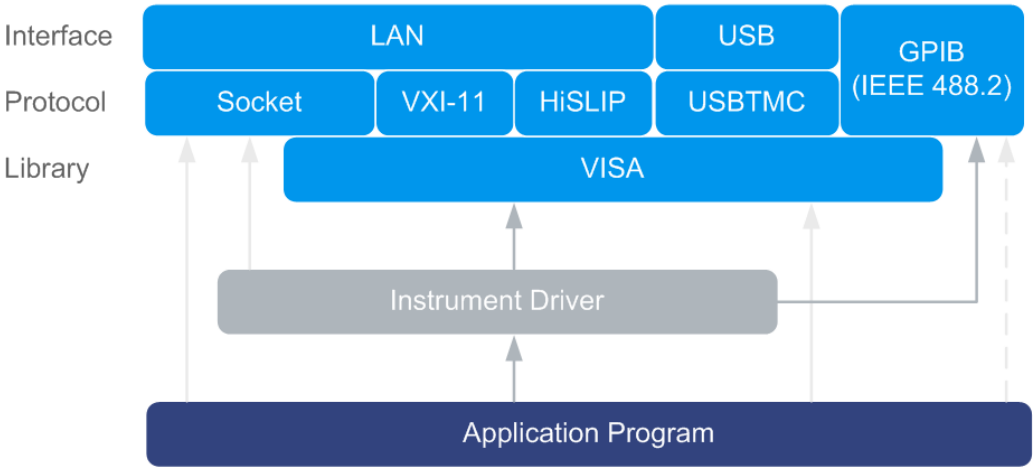


Figure 12-4: Application using instrument driver (VISA available)

Protocol	Remote control program
Socket	`rssmm_init ("TCPIP:SMM100A-102030::5025::SOCKET", ...)` `rssmm_SetFrequency (..., 2e9)`
VXI-11	`rssmm_init ("TCPIP:SMM100A-102030::inst0::INSTR", ...)` `rssmm_SetFrequency (..., 2e9)`
HiSLIP	`rssmm_init ("TCPIP:SMM100A-102030::hislip0::INSTR", ...)` `rssmm_SetFrequency (..., 2e9)`
USBTMC	`rssmm_init ("USB::0x0AAD::0x0277::100001::INSTR", ...)` `rssmm_SetFrequency (..., 2e9)`
GPIB	`rssmm_init ("GPIB::28::INSTR", ...)` `rssmm_SetFrequency (..., 2e9)`

Example: Remote control program using instrument driver (VISA not available)

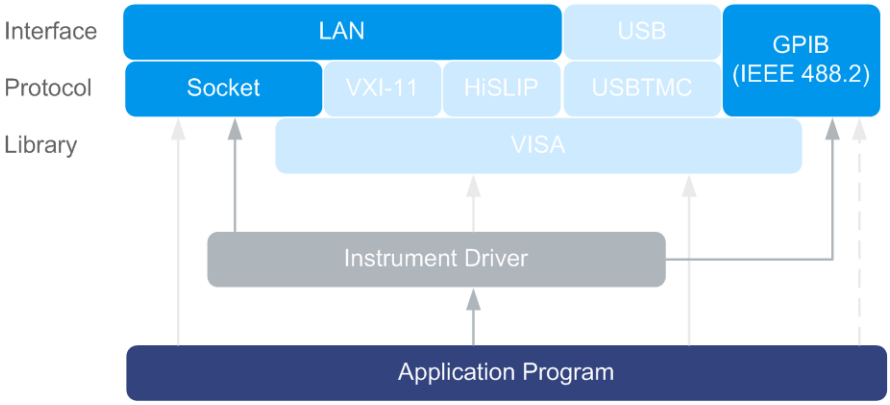


Figure 12-5: Remote control program using instrument driver (VISA not available)

Protocol	Remote control program
Socket	`rssmm_init ("TCPIP:SMM100A-102030::5025::SOCKET", ...)` `rssmm_SetFrequency (..., 2e9)`
GPIB	`rssmm_init ("GPIB::28::INSTR", ...)` `rssmm_SetFrequency (..., 2e9)`

12.4 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 the status of the registers with the remote commands of the Section 13.19, "STATus subsystem", on page 1084.

12.4.1 Overview of the status registers

The Figure 12-6 shows the hierarchical structure of information in the status registers (ascending from left to right).

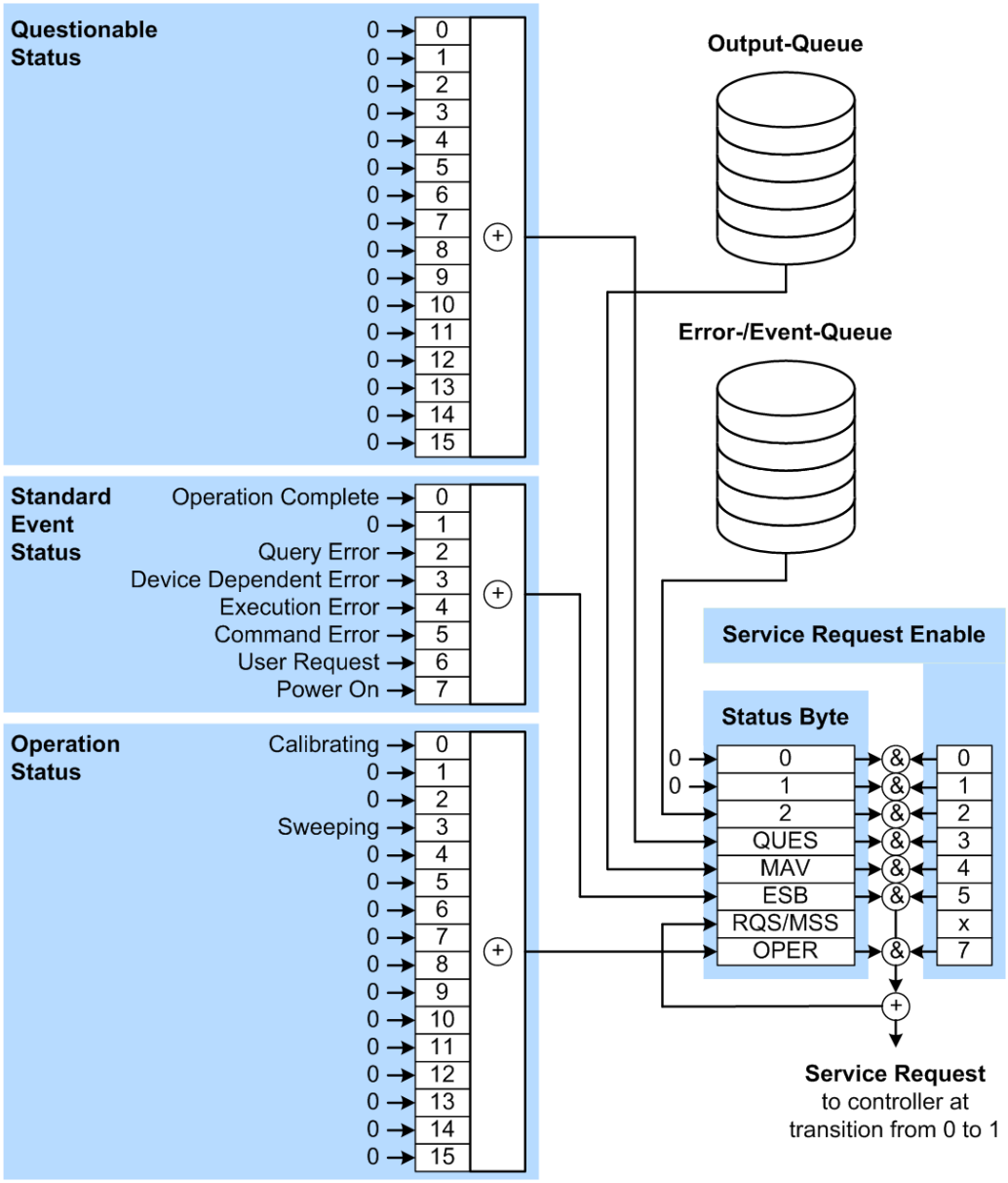


Figure 12-6: Graphical overview of the status registers hierarchy

OPER = Operation Status Summary Bit
RQS/MSS = Service Request Generation
ESB = Standard Event Status Summary Bit
MAV = Message Available in Output Queue
QUES = Questionable Status Summary Bit
2 = Error- /Event-Queue
1, 0 = not used

The following sections describe the instrument-specific bit assignments of the operation status and the questionable status registers.

For more information, see:

- Remote control via SCPI: provides general information on the status reporting system of Rohde & Schwarz instruments. This document also provides information on the standard event status register and the error queue.
- SCPI standard documentation for comprehensive information on the standard

12.4.2 Instrument-specific status operation register

The condition part contains information on currently executed actions. The event part covers information on the actions performed since the last readout of the register.

To read the register, use the query commands `:STATus:OPERation:CONDition?` on page 1085 and `:STATus:OPERation[:EVENt]` on page 1085.

The remote commands for the status questionable register are described in Section 13.19, "STATus subsystem", on page 1084.

Table 12-3: Assignment of the bits used in the operation status register

Bit No.	Meaning
0	Calibrating The bit is set during the calibration phase.
1–2	Not used
3	Sweeping This bit is set during a sweep in automatic or single mode.
4–15	Not used

12.4.3 Instrument-specific status questionable register

This status register contains information on questionable instrument states. Questionable states occur when the instrument is not operated in compliance with its specifications.

To read the register, use the query commands `:STATus:QUEStionable:CONDition` on page 1086 or `:STATus:QUEStionable[:EVENt]` on page 1087.

The remote commands for the status questionable register are described in Section 13.19, "STATus subsystem", on page 1084.

Table 12-4: Assignment of the bits used in the questionable status register

Bit No.	Meaning
0–15	Not used

12.4.4 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 for `*RST` and `SYSTem:PRESet` affect the functional instrument settings. In particular, `DCL` does not change the instrument settings.

Table 12-5: 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 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.						

12.5 Remote access settings

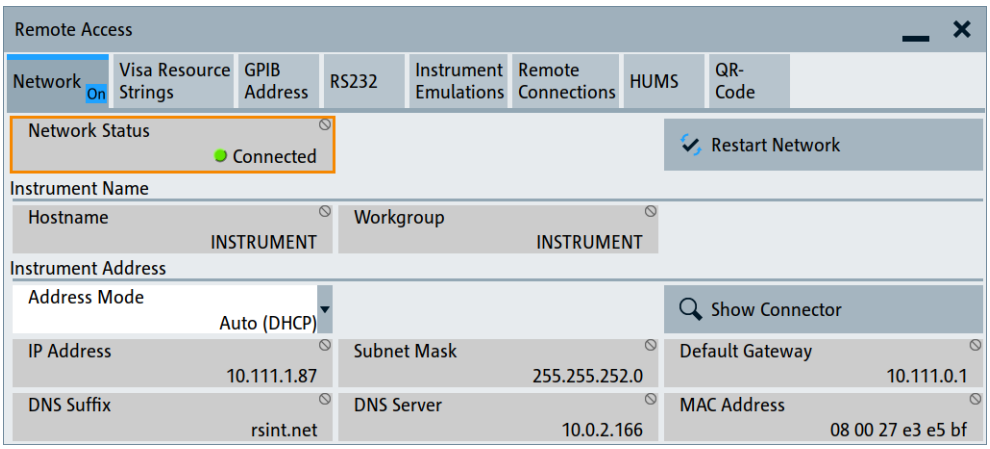
This section describes the settings required for accessing and configuring the provided remote control interfaces. It includes network settings, access addresses, emulation settings for using the command sets of other generators, and the access with smart devices.

- Network settings....639
- VISA resource strings settings....642
- GPIB address settings....643
- RS232 settings....644
- Instrument emulations settings....645
- Active remote connection settings....647
- Closed remote connection settings....648
- HUMS settings....649
- HUMS enhanced settings....651
- QR code....660

12.5.1 Network settings

Access:

► Select "System Config" > "Remote Access" > "Network".



The "Network" dialog provides settings of the general network environment, and specific identification parameters of the instrument in the network. If necessary, you can configure the instrument address settings manually.
How to: "To assign the instrument address manually" on page 671.

The remote commands required to configure the network remotely are described in Section 13.18, "SYSTem subsystem", on page 1054.

Settings:

Network Status....639
Restart Network....639
Hostname....640
Workgroup....640
Address Mode....640
IP Address....640
Subnet Mask....640
Default Gateway....641
DNS Suffix....641
DNS Server....641
MAC Address....641

Network Status
Indicates that the instrument is connected to the network.

Remote command:
`:SYSTem:COMMunicate:NETWork:STATus?` on page 1068

Restart Network
Terminates the network connection of the instrument and sets it up again. You can use this function to fix network problems.

Note: This function restarts only the connection of the instrument to the network. It does not impact the network itself.

Remote command:
:SYSTem:COMMunicate:NETWork:RESTart on page 1068

Hostname
Displays the hostname.

Each instrument is delivered with an assigned hostname, a logical name which can be used instead of the IP address. With the default network settings, the IP address is allocated by the DHCP server. This address can change each time the instrument is reconnected. Unlike the IP address, the hostname name does not change.

Note:
This function is password-protected. Unlock the protection level 1 to access it.

- We recommend that you do not change the default network settings or the hostname to avoid problems with the network connection.
  If you change the hostname, be sure to use a unique name.

Remote command:
:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname on page 1068

Workgroup
Sets the individual windows workgroup name of the R&S SMM100A. This parameter is required in case the instrument is integrated in a windows network.

This function is password-protected. Unlock the protection level 1 to access it.

Remote command:
:SYSTem:COMMunicate:NETWork[:COMMon]:WORKgroup on page 1069

Address Mode
Selects the mode for assigning the IP address.

"Auto (DHCP)"
Assigns the IP address automatically, provided the network supports DHCP (Dynamic Host Configuration Protocol).

"Static" Enables you to assign the IP address manually.

Remote command:
:SYSTem:COMMunicate:NETWork:IPADdress:MODE on page 1067

IP Address
Displays the IP address of the instrument in the network.

To assign the IP address manually, see "To assign the instrument address manually" on page 671.

Remote command:
:SYSTem:COMMunicate:NETWork:IPADdress on page 1067

Subnet Mask
Displays the bit group of the subnet in the host identifier.

The TCP/IP protocol is preinstalled with the subnet mask 255.255.255.0. If the DHCP server is available Address Mode A AUTO (DHCP), the setting is read-only. The subnet mask consists of four number blocks separated by dots. Each block contains 3 numbers in maximum (e.g. 100.100.100.100), but also one or two numbers are allowed in a block (as an example see the preinstalled address).

To assign the subnet mask manually, select Address Mode > Static.

Note: When assigning the subnet mask manually, make sure that the address matches with the subnet mask of the controlling host interface.

How to: "To assign the instrument address manually" on page 671.

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK` on page 1069

Default Gateway
Displays 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.

To assign the gateway address manually, select Address Mode > "Static".

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway` on page 1069

DNS Suffix
Displays the primary DNS (Domain Name System) suffix, that means the DNS name without the hostname part.

The DNS system uses the suffix for registration and name resolution for unique identification of the instrument in the entire network.

To assign the DNS suffix manually, select Address Mode > "Static".

Remote command:
`:SYSTem:COMMunicate:NETWork[:COMMon]:DOMain` on page 1068

DNS Server
Determines the preferred server for name resolution. The DNS server contains the underlying numerical values that are required for name resolution of the hostname as part of the IP address.

To select the DNS server manually, select Address Mode > "Static".

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:DNS` on page 1069

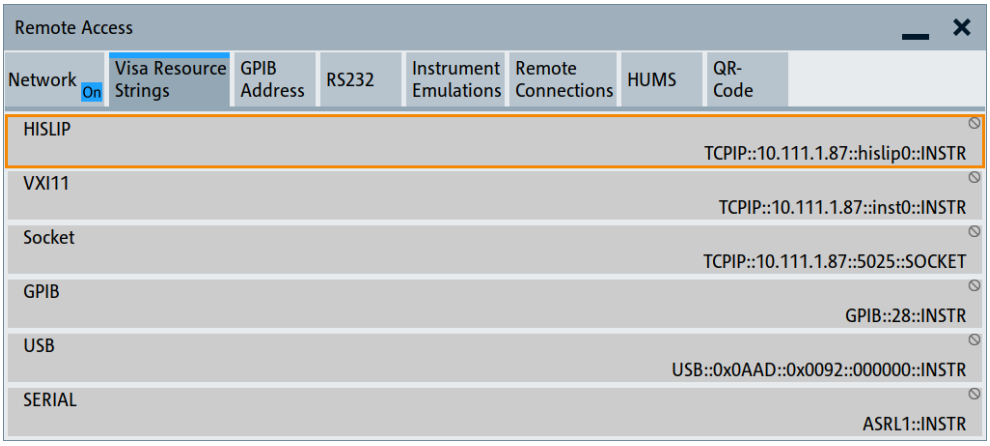
MAC Address
Indicates the MAC (Media Access Control) address, a unique identifier of the network adapter in the R&S SMM100A.

Remote command:
`:SYSTem:COMMunicate:NETWork:MACaddress` on page 1067

12.5.2 VISA resource strings settings

Access:

► Select "System Config" > "Remote Access" > "Visa Resource Strings".



The "Visa Resource String" dialog displays the VISA resource strings provided for remote control over the different interfaces.

The remote commands required to query the address information remotely are described in Section 13.18, "SYSTem subsystem", on page 1054.

Settings:

HISLIP....642
VXI11....642
Socket....643
GPIB....643
USB....643
SERIAL....643

HISLIP
Displays the visa resource string for remote control with HiSLIP protocol.

See also Section 12.2.1, "LAN interface", on page 628.

Remote command:
`:SYSTem:COMMunicate:HISLip:RESource?` on page 1066

VXI11
Displays the visa resource string for remote control over LAN.

See also Section 12.2.1, "LAN interface", on page 628.

Remote command:
`:SYSTem:COMMunicate:NETWork:RESource?` on page 1067

Socket
Displays the visa resource string for remote control over LAN, using the socket communication protocol.

See also Section 12.2.1, "LAN interface", on page 628.

Remote command:
`:SYSTem:COMMunicate:SOCKet:RESource?` on page 1070

GPIB
Displays the visa resource string for remote control over the GPIB interface.

See also Section 12.2.3, "GPIB interface (IEC/IEEE bus interface)", on page 631.

Remote command:
`:SYSTem:COMMunicate:HISLip:RESource?` on page 1066

USB
Displays the visa resource string for remote control over the USB interface.

See also Section 12.2.2, "USB interface", on page 630.

Remote command:
`:SYSTem:COMMunicate:USB:RESource?` on page 1071

SERIAL
Displays the visa resource string for remote control over the serial interface.

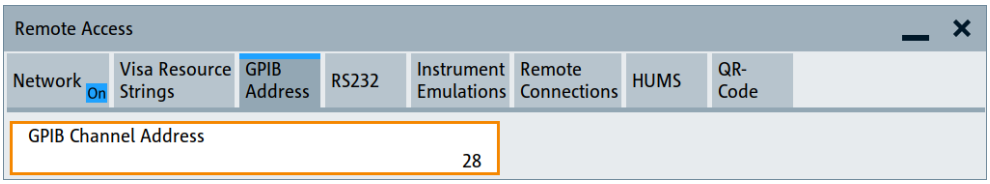
See also Section 12.2.2, "USB interface", on page 630.

Remote command:
`:SYSTem:COMMunicate:SERial:RESource?` on page 1070

12.5.3 GPIB address settings

Access:

► Select "System Config" > "Remote Access" > "GPIB Address".



The "GPIB Address" enables you to select the channel for remote control over the IEC/IEE bus interface.

The remote command to configure the setting remotely is described in Section 13.18, "SYSTem subsystem", on page 1054.

Settings:

GPIB Channel Address 644

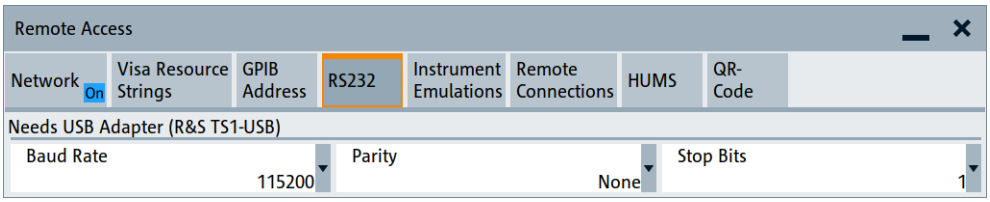
GPIB Channel Address
Sets the GPIB (IEC/IEEE bus) channel address for the connected instrument.

Remote command:
`:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess` on page 1066

12.5.4 RS232 settings

Access:

► Select "System Config > Remote Access > RS232".



The "RS232" dialog enables you to control the instrument over a serial interface using a USB adapter. The controller and the instrument must be connected with the external USB/serial-adapter R&S TS1-USB and a serial crossover (null modem) cable. The USB connection requires the Visa library to be installed on the controller. Visa detects and configures the R&S SMM100A automatically when the USB connection is established.

For more information, refer to the specifications document.

The remote commands required to configure the parameters remotely are described in Section 13.18, "SYSTem subsystem", on page 1054.

Settings:

Baud Rate
Sets the baudrate for the serial remote control interface.

Remote command:
`:SYSTem:COMMunicate:SERial:BAUD` on page 1069

Parity
Sets the parity for the serial remote control interface.

Remote command:
`:SYSTem:COMMunicate:SERial:PARity` on page 1070

Stop Bits
Sets the number of stop bits for the serial remote control interface.

Remote command:
`:SYSTem:COMMunicate:SERial:SBITs` on page 1070

12.5.5 Instrument emulations settings

About instrument emulations

You can remotely control the R&S SMM100A using the command set of another signal generator. With this function you can, for example, replace a signal generator with an R&S SMM100A in an automated test setup, without adjusting the command scripts used.

The R&S SMM100A also covers command sets of Rohde & Schwarz signal generators. To achieve optimal compatibility when replacing an instrument, we recommend that you select the emulation command set for the corresponding signal generator.

You find the remote control command sets supported by the R&S SMM100A in a selection list.

The selected instrument also defines the identification string that is retrieved with query `*IDN?`. If necessary, use the parameter Mode and IDN String to change this string.

As any other parameter, the remote control command set can also be changed remotely by the command `:SYSTem:LANGuage`.

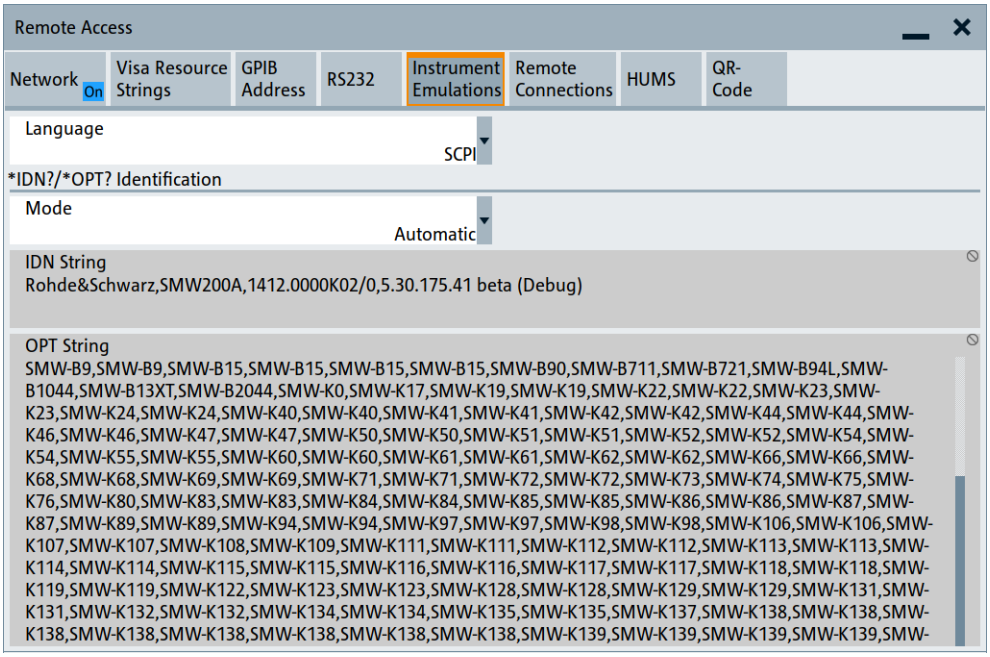
While working in an emulation mode, the R&S SMM100A specific command set is disabled and the SCPI command `:SYSTem:LANGuage` is discarded.

To return to the SCPI command set of the R&S SMM100A, use the corresponding command of the selected command set.

If for example an HP generator is emulated, the HP command `EX` returns to the instrument-specific GPIB command set.

Access:

► Select "System Config" > "Remote Access" > "Instrument Emulations".



The "Instrument Emulations" dialog enables you to emulate a remote control command set of another signal generator.

The remote commands required to configure the emulation settings remotely are described in Section 13.18, "SYSTem subsystem", on page 1054.

Settings:

Language
Selects the instrument whose remote command set is emulated by the R&S SMM100A.

Remote command:
`:SYSTem:LANGuage` on page 1072

Mode
Selects the way the instrument identification is performed.

"Automatic" Sets the "IDN String" and the "OPT String" automatically for the instrument selected with the parameter Language.

"User Defined" Enables you to define the "IDN String" and the "OPT String".

Remote command:
`:SYSTem:IDENtification` on page 1071

Set to Default
In "Mode > User Defined", resets the `*IDN` and `*OPT` strings.

Remote command:
`:SYSTem:IDENtification:PRESet` on page 1071

IDN String
Indicates the identification string of the instrument when queried with the common command `*IDN?`.

In addition to the preset values, you can define your own identification string so that each generator uses an individual identification, like `My_SigGen` for instance, see Mode .

Remote command:
`*IDN?` on page 712
`:SYSTem:IRESponse` on page 1072

OPT String
Indicates the option string of the instrument as queried with common command `*OPT?`.

In Mode > "User Defined", you can define your own option string. A query responds with this option string instead of the automatically created option string.

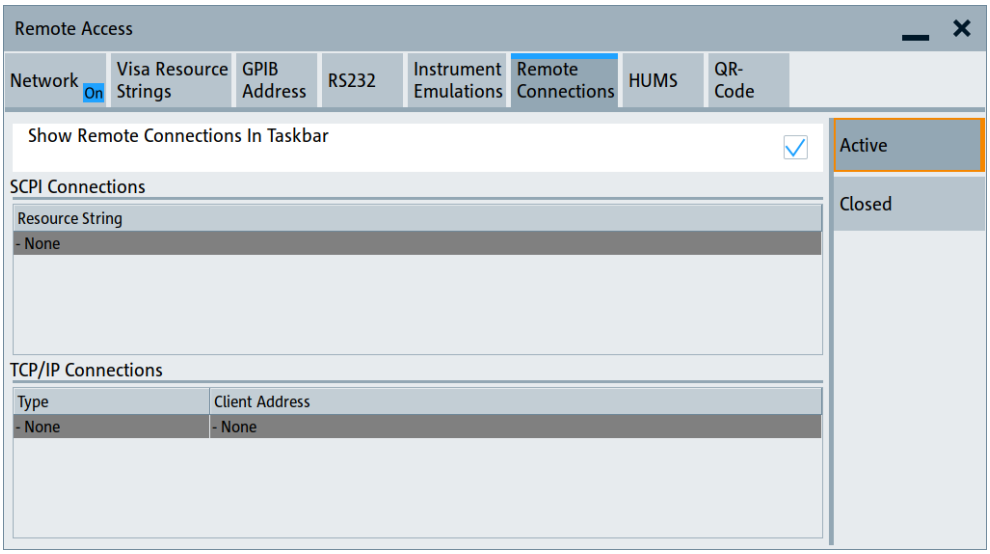
Remote command:
`*OPT?` on page 712
`:SYSTem:ORESponse` on page 1072

12.5.6 Active remote connection settings

This dialog displays the active SCPI and TCP/IP connections.

Access:

1. Select "System Config" > "Remote Access" > "Remote Connections".
2. Select "Active".



The "Active" tab shows the currently active remote connections, and you can enable the display of the active connections in the task bar.

Settings:

Show Remote Connections in Taskbar 648
SCPI Connections 648
TCP/IP Connections 648

Show Remote Connections in Taskbar
Displays the currently active connections in the taskbar.

SCPI Connections
Displays the VISA resources strings of the remote connections currently controlling the instrument via the LAN interface.

Remote command:
n.a.

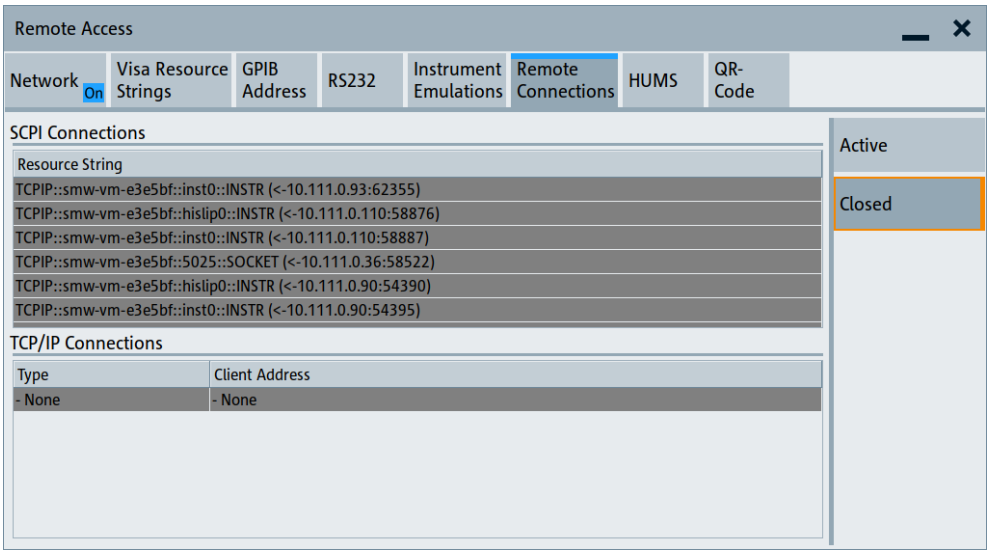
TCP/IP Connections
Displays the types and client addresses of the remote connections currently controlling the instrument via the LAN interface.

Remote command:
n.a.

12.5.7 Closed remote connection settings

Access:

1. Select "System Config" > "Remote Access" > "Remote Connections".
2. Select "Closed".



This dialog displays a history list of the connections that have accessed the instrument before.

Settings:

SCPI Connections....649
TCP/IP Connections....649

SCPI Connections
Lists the VISA resource strings of the last remote connections that have accessed the instrument via the LAN interface before.

Remote command:
n.a.

TCP/IP Connections
Lists the types and client addresses of the last remote connections that had accessed the instrument via the LAN interface before.

Remote command:
n.a.

12.5.8 HUMS settings

Requires R&S SMM-K980.

About health and utilization monitoring system (HUMS)

The R&S SMM100A comes with a health and utilization monitoring system (HUMS) providing information about the R&S SMM100A. Aim is to increase the overall utilization, to avoid downtime and to increase the overall security level of a fleet of instruments.

HUMS provides, for example, information about:

- Instrument identification, hardware components, software packages, licenses
- Usage of remote control, usage via keyboard / mouse, usage of test applications
- Hardware utilization and status, including S.M.A.R.T. data of the system drive
- User-defined static information, for example, an inventory code

Interfaces and protocols

The HUMS installation on the R&S SMM100A includes an SNMP agent and a REST service with HTTP endpoints. So you can access the health and usage information via LAN, using the SNMP protocol or the REST protocol. Accessing the data does not interfere with remote control via SCPI commands or with measurement execution.

Reference information for both protocols is available on the R&S SMM100A at the address *http://<instrument>/api/hums/v1/documents?name=<interface>*.

For *<instrument>*, enter the hostname (e.g. *SMM100A-102030*) or the IP address (e.g. *10.121.0.34*) of your instrument, as for access to the GUI.

For *<interface>* = *snmp*, you get a `.zip` file containing the MIB files for SNMP. For *<interface>* = *rest*, you get a web page with the OpenAPI specification of the REST API.

Address example: *http://SMM100A-102030/api/hums/v1/documents?name=snmp*.

The following table lists the REST endpoints and the SNMP MIB file names.

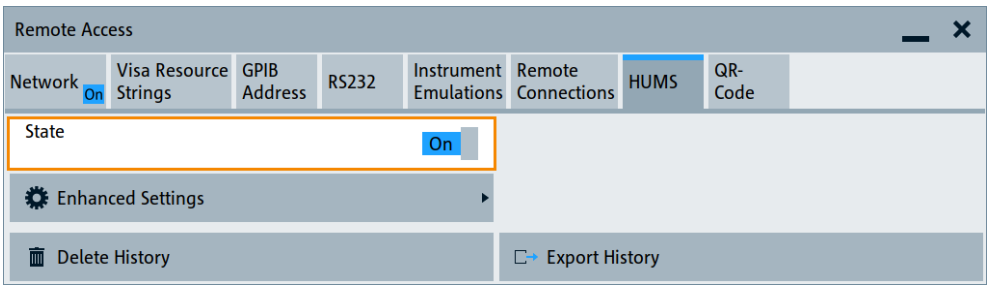
REST endpoint /api/hums/v1/...	SNMP MIB	Description	Typical data
documents	---	developer information	SNMP MIB files, swagger specification of HUMS REST endpoints
greetings	RS-GREETINGS-MIB	identity information	manufacturer, model, serial number, version
equipment/bios	RS-BIOS-INFO-MIB	BIOS information	BIOS manufacturer, version and release date
date-time	RS-TIME-DATE-MIB	time and date information	UTC and local time, timezone, dst (daylight savings time)
device-history	RS-DEVICE-HISTORY-MIB	history events	instrument-specific event information and notifications
device-tags	RS-DEVICE-TAGS-MIB	customer information	user-definable key information, associated with the instrument, e.g. asset number, owner, location
equipment	RS-EQUIPMENT-MIB	footprint information	hardware and software configuration, licenses
hums-info	RS-HUMS-INFO-MIB	basic information on the HUMS service	HUMS version, counter of SNMP and REST requests, amount of collected data, HUMS database size
storage	RS-STORAGE-MIB	S.M.A.R.T. data of drive	system drive temperature, drive health
system-info	RS-SYSTEM-INFO-MIB	a system overview	OS and BIOS version, IP address, locale
system-status	RS-SYSTEM-STATUS-MIB	system status information	global system status, static notifications
utilization	RS-UTILIZATION-MIB	utilization information	instrument activity, e.g., power on time, RF on time, option utilization, remote interface traffic

For detailed information about HUMS and its applications, refer to:

- The R&S®HUMS Health and Utilization Monitoring Service user manual, available on the Rohde & Schwarz website.
- The application note GFM336

Access:

► Select "System Config" > "Remote Access" > "HUMS".



The dialog provides settings to configure the health and utilization monitoring system (HUMS) of the R&S SMM100A.

The remote commands required to define these settings are described in Section 13.9, "HUMS remote control commands", on page 741.

Settings:

State....651
Enhanced Settings....651
Delete History....651
Export History....651

State
Activates HUMS.

Data is only recorded if HUMS is enabled. If disabled, already recorded data can still be retrieved.

The setting is reset by a factory preset to "off".

Remote command:
`DIAGnostic:HUMS:STATe` on page 744

Enhanced Settings
Opens a dialog for configuring enhanced protocol settings, see Section 12.5.9, "HUMS enhanced settings", on page 651.

Access is only available, when HUMS is enabled, see State.

Delete History
Deletes all information from the HUMS service including the device history.

Note: Regarding the instrument security, the sanitization procedure also deletes the history of the HUMS service, see Section 11.6.1, "Disk & memory security settings", on page 607.

Remote command:
`DIAGnostic:HUMS:DEVice:HISTory:DELete:ALL` on page 743

Export History
Triggers an export of the logged data of the HUMS service into a `*.zip` file.

A standard file dialog opens, to save the log file. By default, the file is saved to the directory /var/user/.

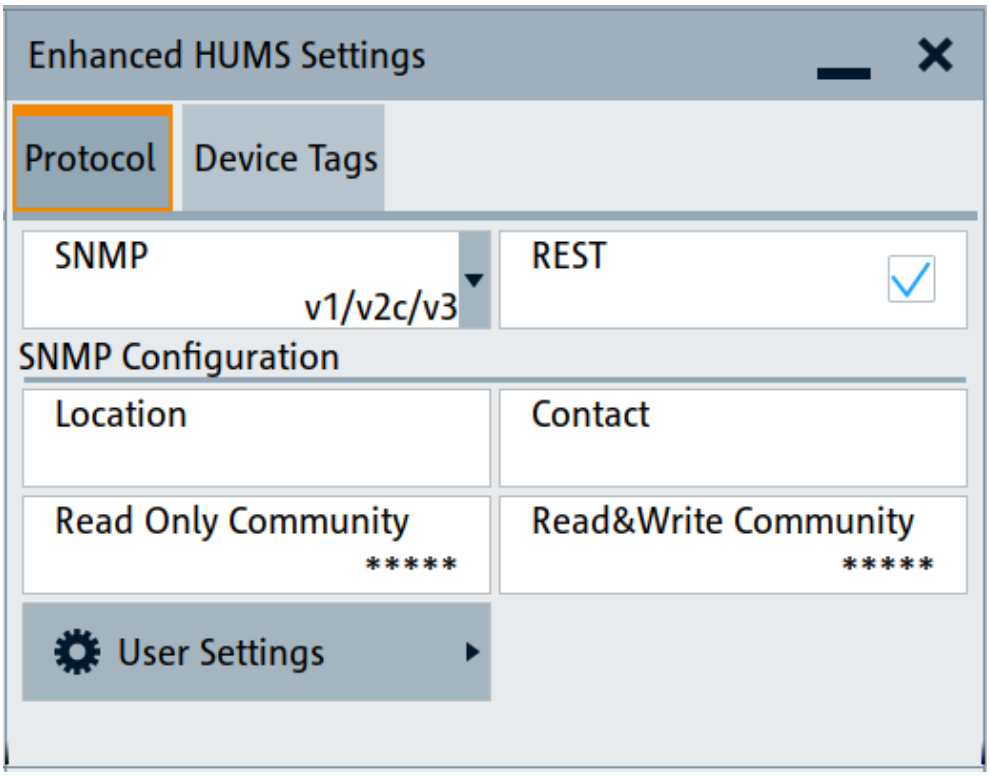
Remote command:
`DIAGnostic:HUMS:DEVice:HISTory?` on page 742
`DIAGnostic:HUMS:SAVE` on page 743

12.5.9 HUMS enhanced settings

Access:

1. Select "System Config > Remote Access > HUMS".
2. Select "State > ON".

3. Select "Enhanced Settings".



The dialog provides enhanced settings for configuring protocol settings and device tags.

The remote commands required to define these settings are described in Section 13.9, "HUMS remote control commands", on page 741.

- Protocol settings....652
- SNMP user settings....654
- Device tag settings....658

12.5.9.1 Protocol settings

The "Protocol" tab of the "Enhanced HUMS Settings" dialog provides protocol settings for SNMP or REST protocol.

Access:

1. Select "System Config > Remote Access > HUMS".
2. Select "State > ON".
3. Select "Enhanced Settings".
4. Select "Protocol".

   The dialog provides enhanced settings for configuring protocol settings and device tags.

Settings:

SNMP....653
REST....653
SNMP Configuration....653
└ Location....653
└ Contact....653
└ Read Only Community....654
└ Read&Write Community....654
User Settings....654

SNMP
Enables the SNMP agent and selects the supported SNMP version to communicate with the service.

The setting is reset by a factory preset to "v1/v2c".

"Off"	The SNMP agent is disabled.
"v1/v2c"	Selects SNMP version 2, which also enables version v1.
"v1/v2c/v3"	Selects all SNMP version v1, v2c and v3.
"v3"	Selects SNMP version v3.

Remote command:
`SYSTem:COMMunicate:SNMP:VERSion` on page 748

REST
Enables the REST API protocol.

The setting is reset by a factory preset to "On".

Remote command:
`SYSTem:COMMunicate:REST:ENABle` on page 745

SNMP Configuration
For SNMPv1 and SNMPv2c authentication, you can assign a community password for read only and/or read and write access. For SNMPv3 authentication, you can define "User" profiles.

Location ← SNMP Configuration
Defines the SNMP location information. This information complies with the server's physical location and is used for identification of the SNMP server. By default, this input field is empty.

Remote command:
`SYSTem:COMMunicate:SNMP:LOCation` on page 747

Contact ← SNMP Configuration
Sets the SNMP contact information. This information complies with the person who manages the SNMP server and is used for identification of the SNMP server. By default, this input field is empty.

Remote command:
`SYSTem:COMMunicate:SNMP:CONTact` on page 746

Read Only Community ← SNMP Configuration
Sets a password for read only access of SNMPv1 or SNMPv2 communities.

The setting is reset by a factory preset to the "<serial number>" of the instrument.

Remote command:
`SYSTem:COMMunicate:SNMP:COMMunity:RO` on page 746

Read&Write Community ← SNMP Configuration
Sets a password for read and write access of SNMPv1 or SNMPv2 communities.

The setting is reset by a factory preset to the "<serial number>" of the instrument.

Remote command:
`SYSTem:COMMunicate:SNMP:COMMunity:RW` on page 746

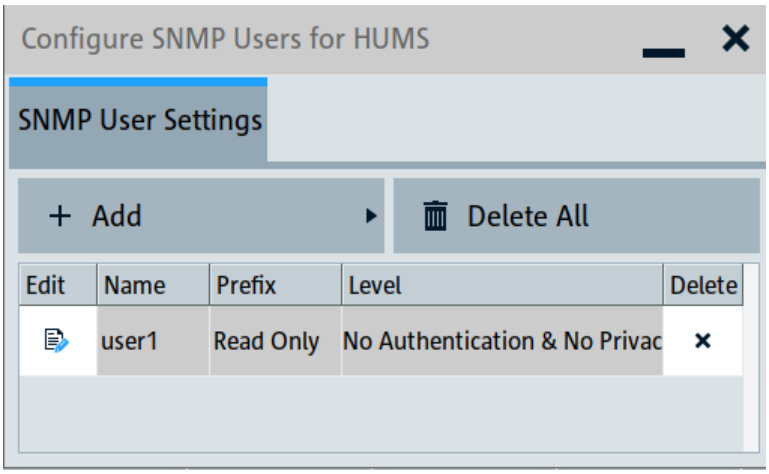
User Settings
Accesses the "Configure SNMP Users for HUMS" dialog.

12.5.9.2 SNMP user settings

For SNMPv3 authentication, you can define user profiles.

Access:

1. Select "System Config > Remote Access > HUMS".
2. Select "State > ON".
3. Select "Enhanced Settings".
4. In the protocol tab, select SNMP communication with SNMPv3, e.g. "SNMP > v1/v2c/v3".
5. Select "User Settings".



The "Configure SNMP User for HUMS" dialog provides an overview of all defined SNMP users and their profiles. With the "Add" and "Delete All" controls, you can add or remove users.

Settings:

Add....655
Delete All....655
User table....655
└ Edit....656
└ Name....656
└ Prefix....656
└ Level....656
└ Delete....656
Add SNMP User for HUMS....656
└ SNMP User Name....657
└ SNMP User Prefix....657
└ SNMP User Level....657
└ SNMP User Public Passphrase....658
└ SNMP User Encrypted Passphrase....658
└ Add / Update....658

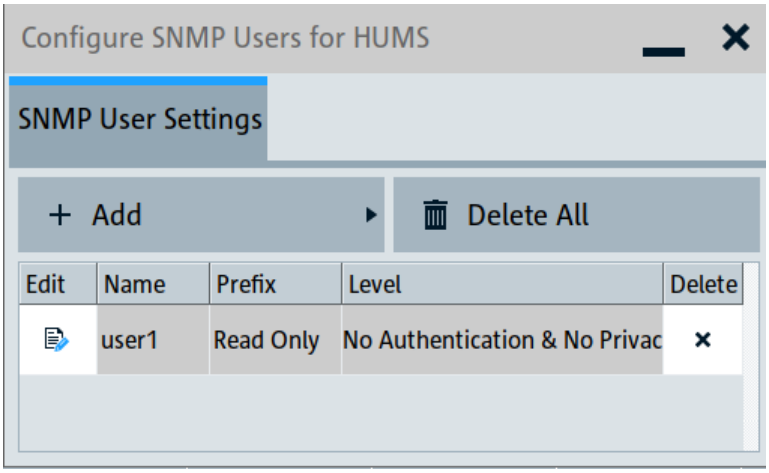
Add
Accesses the "Add SNMP User for HUMS" dialog.

In this dialog, you can define a user and its profile, see "Add SNMP User for HUMS" on page 656.

Delete All
Removes all users from the list.

Remote command:
`SYSTem:COMMunicate:SNMP:USM:USER:DELete:ALL` on page 748

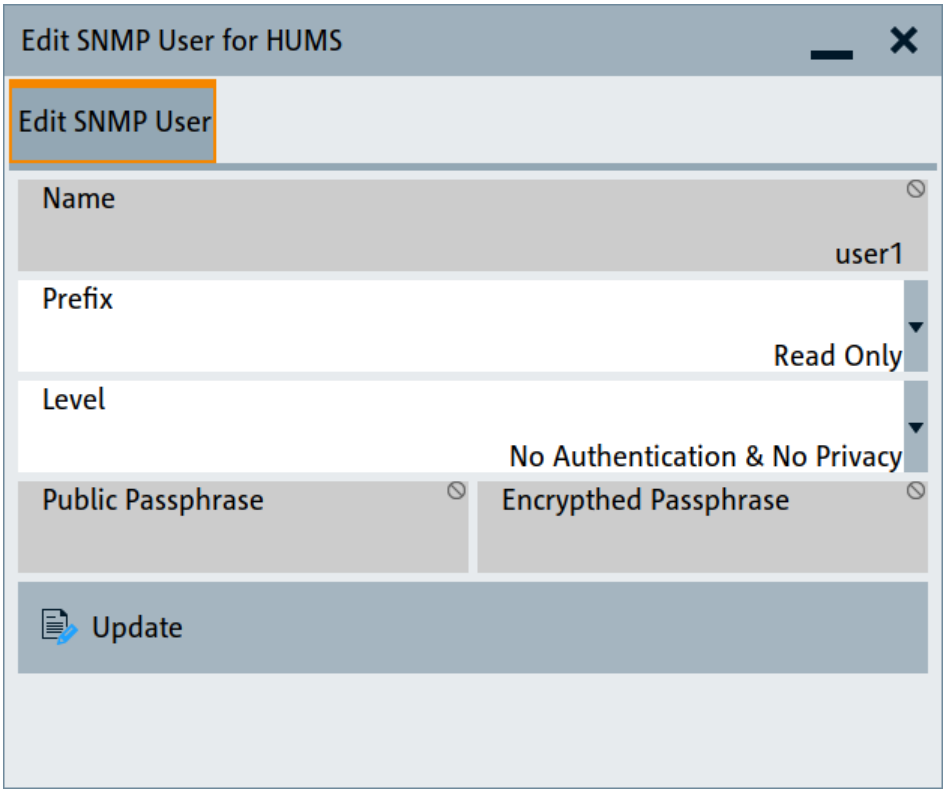
User table
Lists all defined SNMP users.



The table informs on the user name and its specified user profile.

Remote command:
`SYSTem:COMMunicate:SNMP:USM:USER:ALL?` on page 747

Edit ← User table
Accesses the "Edit SNMP Users for HUMS" dialog, where you can modify an already defined user profile.



For description on the entry fields, see Add SNMP User for HUMS.

Name ← User table
Shows the user name of the user who should have specific user rights.

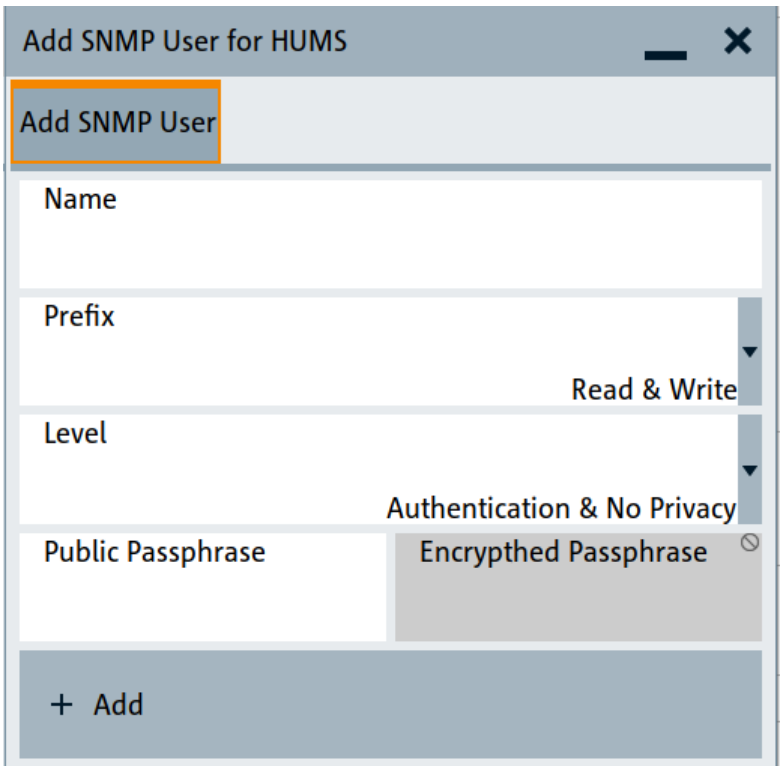
Prefix ← User table
Shows the access right of the selected user.

Level ← User table
Shows the security level of the selected user.

Delete ← User table
Removes the selected user from the list.

Remote command:
`SYSTem:COMMunicate:SNMP:USM:USER:DELete` on page 748

Add SNMP User for HUMS
Configuration dialog for defining SNMP users and their profiles.



Remote command:
`SYSTem:COMMunicate:SNMP:USM:USER` on page 747

SNMP User Name ← Add SNMP User for HUMS
Defines the name of the user for assigning specific user rights. Entering a user name is mandatory.

SNMP User Prefix ← Add SNMP User for HUMS
Defines the access right for a user.

"Read Only" Allows the user to only read information.

"Read & Write" Allows the user to read and modify information.

SNMP User Level ← Add SNMP User for HUMS
Defines the security level of the SNMP user. Depending on the security level, the service requests user name and passphrases for authentication and encryption.

"No Authentication & No Privacy"
Low security level. Using this level, the service queries the user name only. Password authentication and password for encrypted data transfer is not requested.
See "SNMP User Public Passphrase" on page 658 and "SNMP User Encrypted Passphrase" on page 658 for data transfer is not requested.

"Authentication & No Privacy"
Medium security level: Requests the user name and password authentication, but no data transfer encryption.

"Authentication & Privacy"
High security level: Requests the user name, and both, the password authentication and the password for data transfer encryption.

SNMP User Public Passphrase ← Add SNMP User for HUMS
Defines the password for authentication. The password must have of 8 to 12 characters with any combination of ASCII characters.

SNMP User Encrypted Passphrase ← Add SNMP User for HUMS
Defines the password for encryption. This password must have at least 8 characters with any combination of ASCII characters. When encryption is defined, the R&S SMM100A supports the DES (directed enhanced services) protocol.

Add / Update ← Add SNMP User for HUMS
Assigns the defined user with its profile to the list.

If you change an already defined user profile, the instrument provides the "Update" button to apply the modifications.

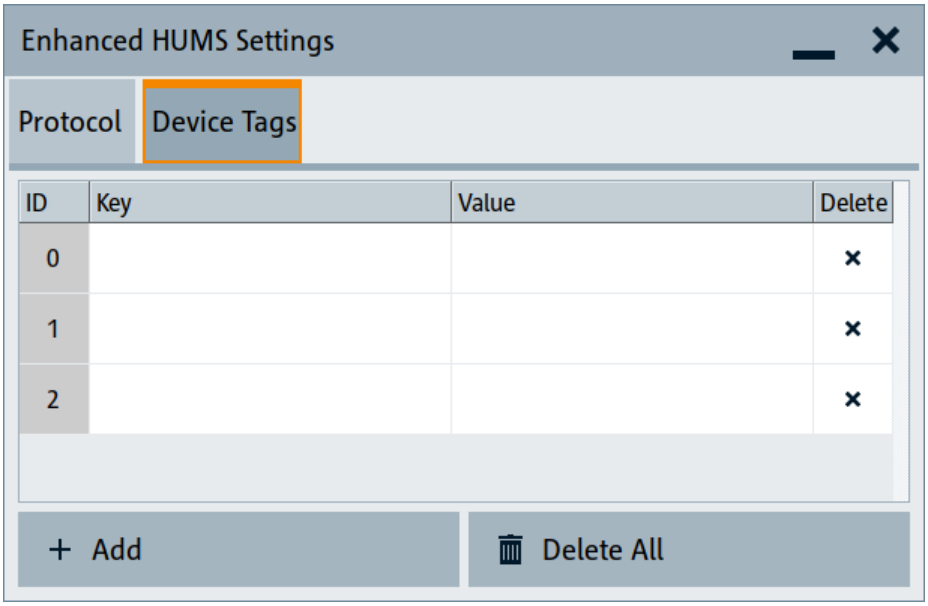
12.5.9.3 Device tag settings

The "Device Tags" tab of the "Enhanced HUMS Settings" dialogs displays the defined device tags. You can also add or delete device tags here.

A device tag is a label to assign to your instrument. You can create any device tag for your instrument and define it by a specific key and value.

Access:

1. Select "System Config > Remote Access > HUMS".
2. Select "State > ON".
3. Select "Enhanced Settings".



Configures device tags for tagging user-defined information of the instrument in a table. You can define up to 32 device tags, e.g., for HUMS history evaluation.
To add a device tag, define "Key" and "Value" of the device tag in the table. Click "Add" to add all device tags of the table to the HUMS history.

Settings:

ID....659
Key....659
Value....659
Delete....659
Add....659
Delete All....659

ID
Identification count of a device tag entry.

Key
Sets the identification key of a device tag.

Remote command:
`DIAGnostic:HUMS:TAGS[:VALue]` on page 745

Value
Sets the value of the identification key of a device tag.

Remote command:
`DIAGnostic:HUMS:TAGS[:VALue]` on page 745

Delete
Deletes the selected device tag from the HUMS history.

Remote command:
`DIAGnostic:HUMS:TAGS:DELete` on page 744

Add
Adds a new device tag to the HUMS service.

Remote command:
`DIAGnostic:HUMS:TAGS[:VALue]` on page 745
`DIAGnostic:HUMS:TAGS:ALL?` on page 744

Delete All
Removes all device tags from the HUMS history.

Remote command:
`DIAGnostic:HUMS:TAGS:DELete:ALL` on page 745

12.5.10 QR code

Access:

► Select "System Config" > "Remote Access" > "QR Code".

The "QR Code" dialog shows the current instrument address (IP address) in quick response (QR) format.

This functionality provides fast access to the instrument via VNC with, for example, a smartphone or a tablet.

See Section 12.9.2, "Using a smart device", on page 686

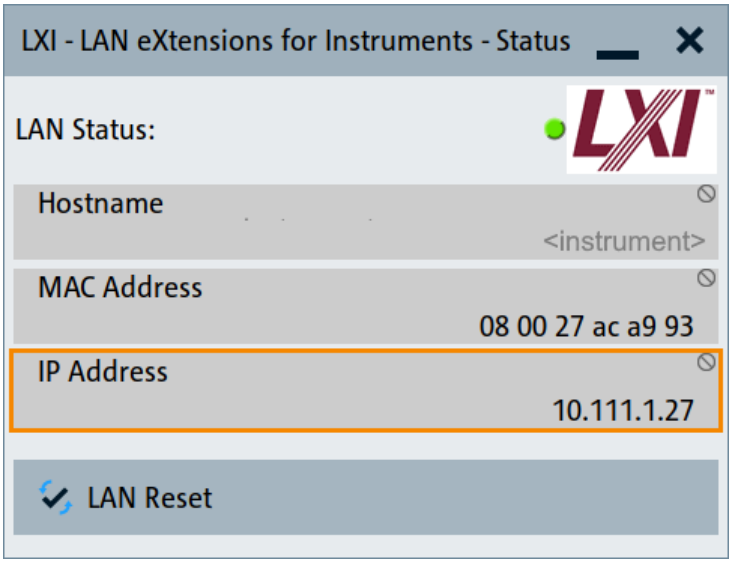
12.6 LXI status settings

On the R&S SMM100A, an LXI functionality is already installed and enabled. Thus, you can access he instrument using any web browser.

See Section 12.7, "LXI browser settings", on page 662.

Access:

► Select "System Config > Setup > Remote Access > LXI Status".



The LXI "LAN Status" dialog shows the parameters of the LAN connection.

Alternatively, you can change the LAN settings using the LXI web browser interface, see Section 12.7.1, "LAN configuration", on page 664.

Settings:

LAN Status....661
Hostname / MAC Address / IP Address....661
LAN Reset....661

LAN Status
The LED indicates the LXI status.

"green" Normal operation

"green (flashing)" Device identification

"red" LAN fault

Hostname / MAC Address / IP Address
See "Hostname" on page 640.

LAN Reset
Initiates the network configuration reset mechanism for the instrument and resets the hostname, MAC address, and IP address.

According to the LXI standard, a LAN reset must set the following network parameters to a default state:

Parameter	Value
TCP/IP mode	DHCP + Auto IP address
Dynamic DNS	Enabled

Parameter	Value
ICMP ping	Enabled
Password for LAN configuration	LxiWebIfc

The LAN reset also resets the following parameters for the R&S SMM100A:

Parameter	
Hostname	`Instrument-specific hostname`
Description	vector signal generator
Negotiation	Auto detect
VXI-11 discovery	Enabled

12.7 LXI browser settings

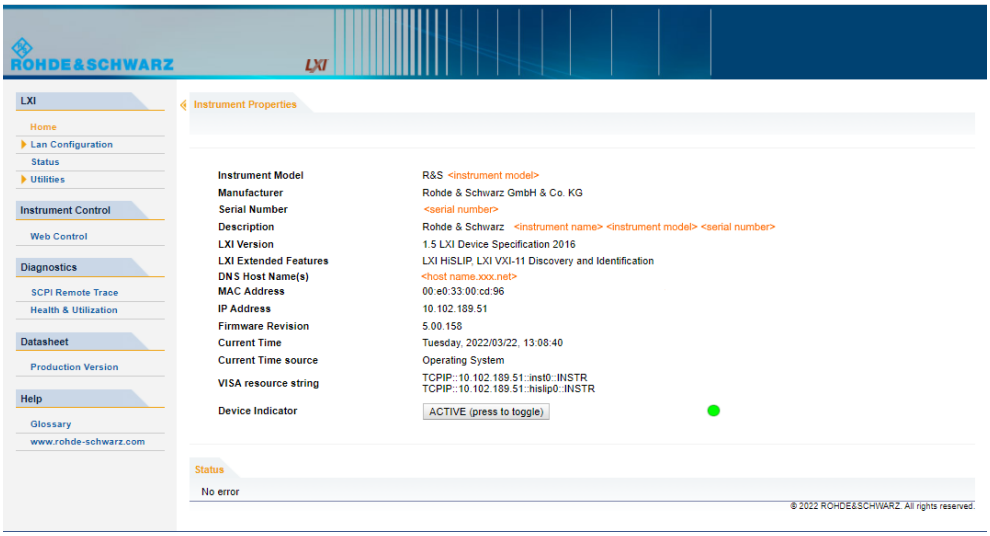
Accessing the R&S SMM100A over the LXI browser inerface, you can perform the following tasks:

- Modifying network configurations, see Section 12.7.1, "LAN configuration", on page 664.
- Accessing the instrument remotely
- Analyzing SCPI remote diagnostics
- Monitoring the use and status of the instrument
  This service requires option R&S SMM-K980 "Health and utilzation monitoring service (HUMS)".

Access:

► In the address field of the browser, enter the URL address, composed of the instrument's IP address or host name, for example *http://10.113.1.151*.
Note: Do not add the missing zeros in the IP address, while opening the instrument homepage.

The instrument homepage (welcome page) opens.



The navigation pane of the browser interface contains the following elements:

- "LXI"
  - "Home" opens the instrument homepage.
    The homepage displays the device information required by the LXI standard, including the VISA resource string in read-only format.
  - "Device Indicator" activates or deactivates the LXI status indication.
    When activated, the LXI LED flashes. A green LXI status symbol indicates that a LAN connection has been established; a red symbol indicates that no LAN cable is connected.
  - "Lan Configuration" allows you to configure LAN parameters and to initiate a ping, see Section 12.7.1.3, "Ping client", on page 666.
  - "Status" displays information about the LXI status of the instrument.
  - "Utilities" provides access to the LXI event logging functionality required by the LXI standard.
- "Instrument Control"
  "Web Control" provides remote access to the instrument.
  See "To start remote control with the LXI browser" on page 673.
- "Diagnostics"
  - "SCPI Remote Trace" records messages exchanged via the remote control interface, see Section 12.7.2, "SCPI remote trace", on page 666.
  - "Health & Utilization" (option: R&S SMM-K980) enables you to monitor the use and status of an instrument, see Section 12.7.3, "Health and utilization", on page 668.
- "Datasheet"
  Provides the Datasheet with the specification data of the instrument at the time of delivery, see Section 12.7.4, "Datasheet", on page 668.
- "Help"
  - "Glossary" explains terms related to the LXI standard.
  - www.rohde-schwarz.com opens the Rohde & Schwarz homepage.

12.7.1 LAN configuration

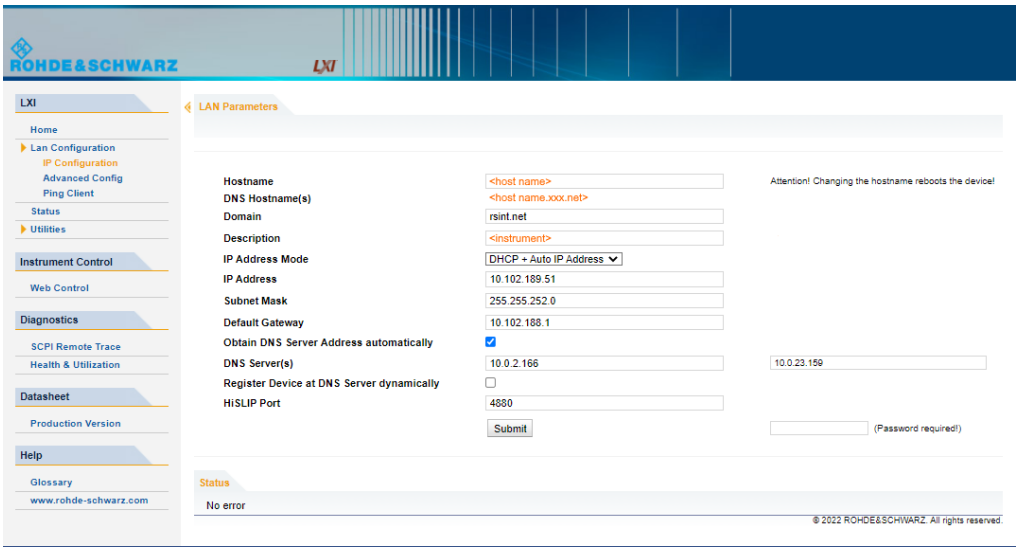
The "LAN Configuration" web page displays all mandatory LAN parameters and allows their modification.

It comprises the following navigation entries.

- IP configuration 664
- Advanced config 665
- Ping client 666

12.7.1.1 IP configuration

The "IP configuration" web page displays all mandatory LAN parameters and allows their modification.



The "IP Address Mode" selects a configuration mode for the IP address of the instrument. With static configuration, the entered IP address, subnet mask, and default gateway are used. With dynamic configuration, DHCP or dynamic link local addressing (automatic IP) is used to obtain the instrument IP address.

Changing the LAN configuration

This function is password-protected. Unlock the protection level 1 to access it.

Note: We recommend that you change the default password before connecting the instrument to a network.

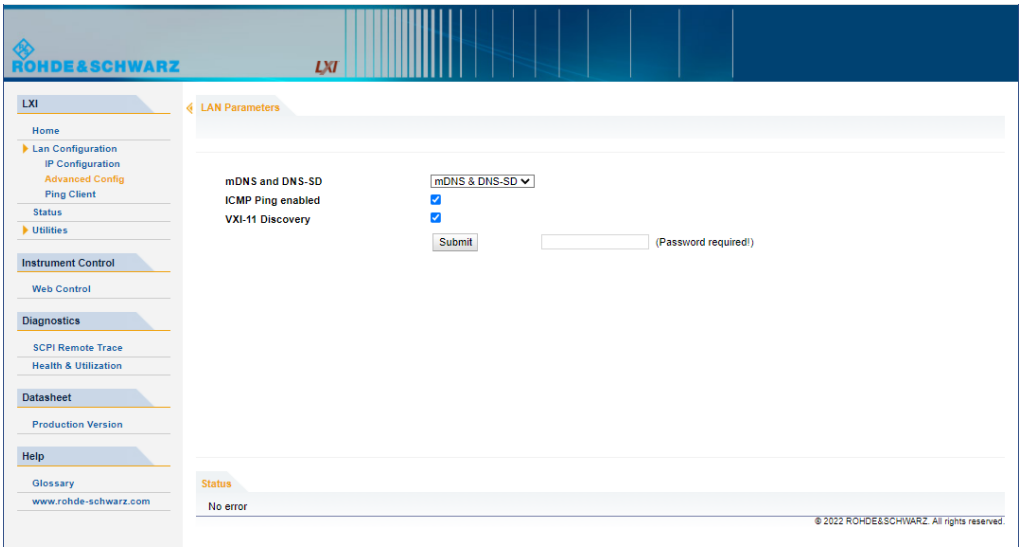
How to:

- "To change the user password of the instrument" on page 618.
- "To change the security password" on page 619.

See Section 11.6.5, "Password management", on page 615.

12.7.1.2 Advanced config

The "Advanced Config" web page provides LAN settings that are not declared mandatory by the LXI standard.



The following advanced parameters are available:

- "mDNS and DNS-SD": The additional protocols "multicast DNS" and "DNS service discovery" are used for device communication in zero configuration networks, working without DNS and DHCP.
- "ICMP Ping": Must be enabled to use the ping utility.
  If you disable this setting, the instrument does not answer ping requests. The setting does not affect the LXI ping client. You can ping other hosts from the instrument, even if the setting is disabled.
- "VXI-11 Discovery": Must be enabled to detect the instrument in the LAN.
  If you disable this setting, the instrument cannot be detected by the VXI-11 discovery protocol mechanism. The setting does not affect other detection mechanisms. Setting up a VXI-11 connection via the IP address or the host name is independent of this setting.

Changing the LAN configuration

This function is password-protected. Unlock the protection level 1 to access it.

Note: We recommend that you change the default password before connecting the instrument to a network.

How to:

- "To change the user password of the instrument" on page 618.
- "To change the security password" on page 619.

See Section 11.6.5, "Password management", on page 615.

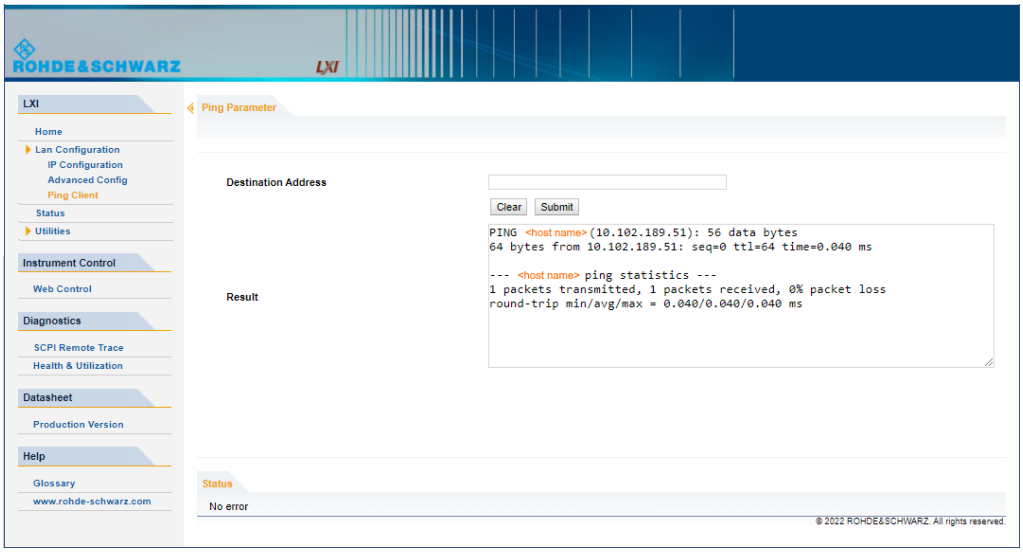
12.7.1.3 Ping client

The "Ping Client" page provides the ping utility to verify the connection between the LXI-compliant instrument and another device.

The ping is initiated from the instrument. Using the `ICMP` echo request and echo reply packets, this function checks whether the communication with a device via LAN is working. Ping is useful for the diagnosis of IP network or router failures.

To initiate a ping at the instrument:

1. On the "Ping Client" page, enter the IP address of the host in the "Destination Address" field (for example 10.113.1.151).
2. Select "Submit".



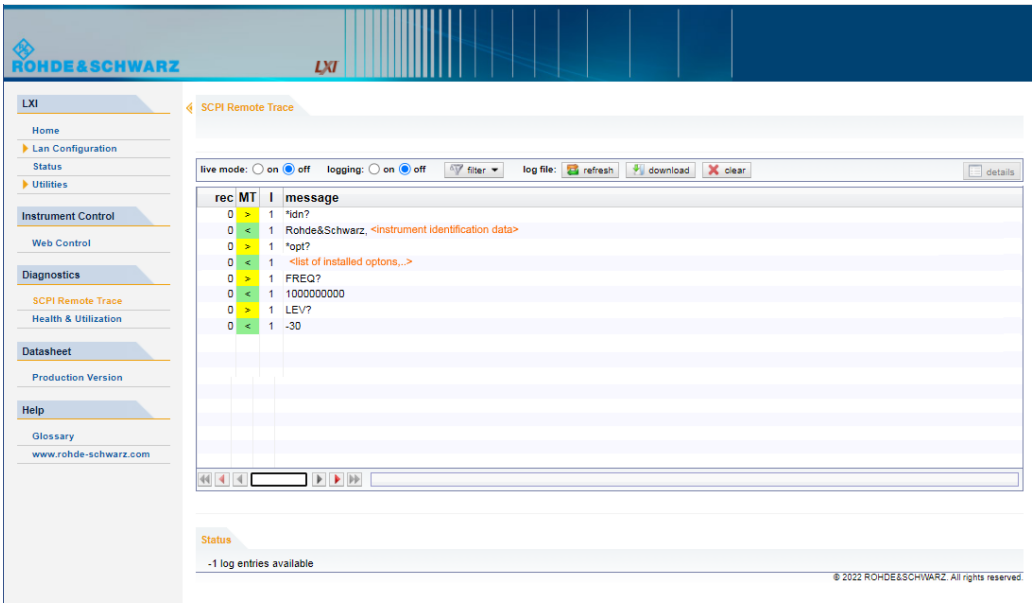
12.7.2 SCPI remote trace

The remote trace functionality allows you to trace input and output strings at the remote control interface of the R&S SMM100A.

See "To activate SCPI remote trace" on page 673

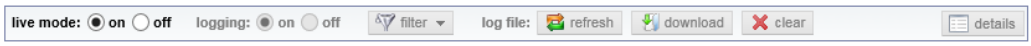
A recorded trace (message log) can be evaluated directly in the dialog. Use the highlighting and navigation functions provided by the lower toolbar to locate error messages and messages containing arbitrary search strings. You can also export the message log to a `*.csv` file and evaluate the file using a suitable program.

To trace and display messages, switch on "logging" and "live mode" in the toolbar.



Toolbars

The toolbar at the top of the dialog provides basic settings and functions.



- "Live mode" / "logging": If logging is switched on, messages are traced. They are stored in an internal database and can be displayed upon request, using the refresh button (live mode off) or they can be displayed automatically (live mode on).
- "Filter": applies a filter to columns and/or rows when working (live mode off)
- "Refresh": reads the message log from the internal database and displays it
- "Download": stores the SCPI trace log to a `*.csv` file
- "Clear": deletes all message log entries in the database and at the screen
- "Details": displays details of the selected message, for example an SCPI command in hex format (also possible by double\-clicking a message)

Columns

The following columns are available if no column filter is applied:

- "Rec": record number of the message within the message log
- "MT": indicates the type of the message. Possible values and related message contents are:
  - > = incoming command
  - < = outgoing response to a query
  - E = error message, highlighted by red color
  - T = execution time, i.e. time required by the instrument to process the command internally.
- **I**: number of the subinstrument

- "message": indicates the type of the message. Possible values and related message contents are:
  - > = incoming command
  - < = outgoing response to a query
  - E = error message, denoted in red
  - T = execution time, i.e. time required by the instrument to process the command internally

12.7.3 Health and utilization

Option: R&S SMM-K980

The health and utilization monitoring service allows you to monitor the usage and status of the instrument, it's options, including S.M.A.R.T. data of the system drive. You can retrieve information on remote accesses over SCPI commands, web browsers or protocols, as for example SNMP or REST.

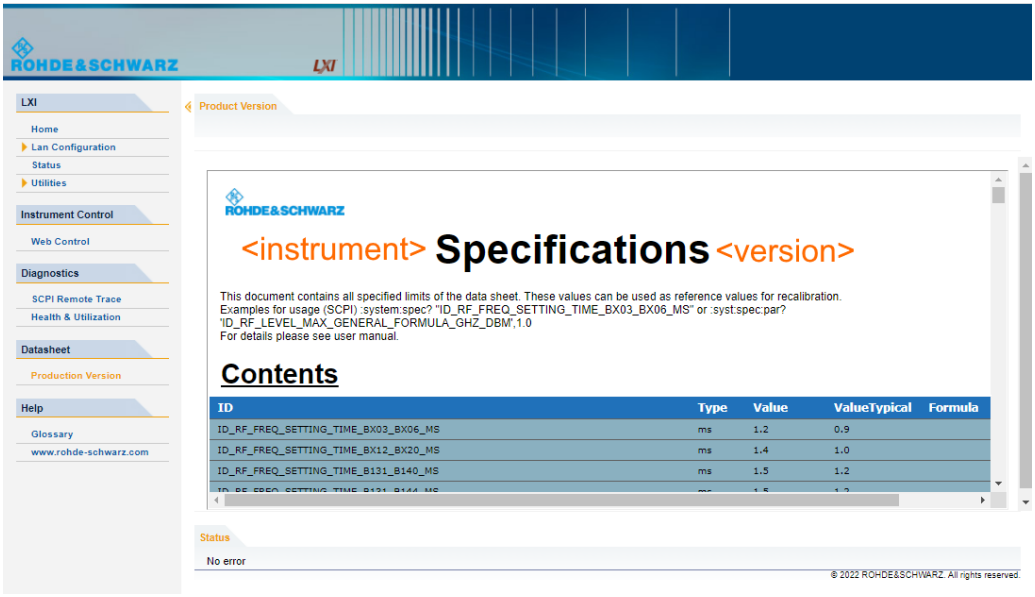
For detailed information on R&S HUMS, see the following documents, available on the Rohde & Schwarz website:

- User manual "R&S Health and Utilization Monitoring Service" , describing how to access and use the service.
- Application note GFM336, providing information on the SNMP and REST API, including a list of all SNMP variables and REST endpoints.

12.7.4 Datasheet

The datasheet functionality allows you to retrieve the specification data of the instrument at the time of delivery.

The document contains all specified value ranges and information of the datasheet, for example important as reference values for recalibration.



For more information, refer to the specifications document.

12.8 Setting up remote control

When you switch on the R&S SMM100A, it is always in manual operation state ("local" state). You can operate the instrument over the touchscreen, the front panel and an external keyboard and/or mouse.

Prerequisites

For remote control, make sure that you have fullfilled the following prerequisites:

- The instrument and the controller PC are connected for remote control.
  See Section 3.1.7, "Connecting to LAN", on page 29.
- The instrument and the controller are switched on.
- The LAN interface and SCPI over LAN are enabled.
  See Section 11.6.4, "Configuring LAN services", on page 612.
- A remote control program is running on the controller.

If security is a concern, see:

- Document Instrument Security Procedures.
- Section 11.6.6, "Preventing unauthorized access", on page 618.

The following sections describe how to start remote control over the available interface protocols.

- Configuring remote access 670
- Starting remote control with LXI 673
- Starting remote control with VXI-11 674

- Starting remote control with socket communication.....679
- Starting remote control over GPIB.....680
- Starting remote control over USB.....681
- Stopping remote control.....681

12.8.1 Configuring remote access

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 DHCP protocol, this service assigns all address information automatically (default setting).
- If the network does not support DHCP or if there is no server available, the instrument tries to obtain the IP address using the Zeroconf(Avahi) protocol.
  This protocol enables the instrument to self-configure an IP address and subnet mask. Zeroconf (Avahi) IP addresses start with the number blocks 169.254.*.*, with the subnet mask of 255.255.

The automatic address configuration establishes the physical connection to the LAN without any additional configuration.

An IP address that is assigned with the Zeroconf protocol although the network requires an IP address assigned from the DHCP server can cause network connection failures.

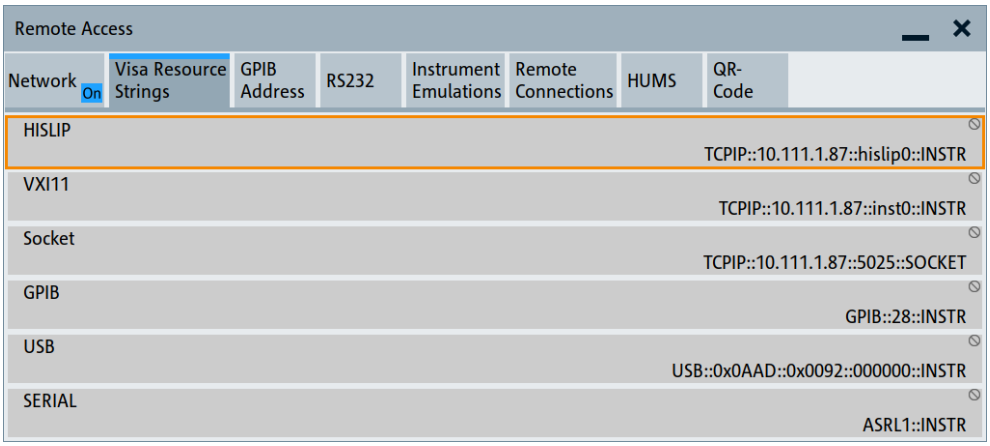
See Section 14.5, "Resolving network connection failures", on page 1104.

If both services fail to connect, you must set the address information manually.

See also "To assign the instrument address manually" on page 671.

To find the VISA resource string

► Select "System Config > Remote Access > VISA Resource Strings".



The dialog shows the VISA resource strings that enable you to access the instrument for remote control.

Note: Using the RS232 serial interface via USB requires the USB serial adapter R&S TS-USB1.

To assign the instrument address manually

It is assumed that you have connected the instrument in the LAN.

1. Obtain the instrument address information for the R&S SMM100A and the IP address for the local default gateway from your network administrator. If necessary, also obtain the name of your DNS domain and the IP addresses of the DNS server on your network.
   Obtain the IP address and subnet mask for the R&S SMM100A and the IP address for the local default gateway from your network administrator. If necessary, also obtain the name of your DNS domain and the IP addresses of the DNS server on your network.
2. On the instrument, select "System Config > Remote Access > Network".
3. Select "Address Mode > Static".
4. Select the "IP Address".
5. Enter the IP address, for example *192.168.0.1.*

   The IP address consists of four number blocks separated by dots. Each block contains 3 numbers in maximum.
6. Select the "Subnet Mask" and enter the subnet mask, for example *255.255.255.0.*

   Note: The subnet mask must be the same for both, the R&S SMM100A and the host interface, the instrument is connected to.
7. Enter the "Default Gateway", "DNS Suffix", and "DNS Server" if necessary.

Using the hostname

In a LAN that uses a DNS server, each computer or instrument connected in the LAN can be addressed with an unambiguous Hostname (also referred to as computer name) instead of the IP address. The DNS server translates the hostname to the IP address.

Using the hostname is useful in networks with dynamic TCP/IP and DHCP protocol services, that assign the address information automatically. Thus, it can be that the services assign a new IP address each time the instruments restarts, but they do not change the hostname.

Each instrument is delivered with an assigned hostname, that remains constant as long as it is not explicitly changed.

This function is password-protected. Unlock the protection level 1 to access it.

The default *hostname* name follows the syntax `<INST>-<Serial Number>`, where:

- `<INST>` is the short name of your instrument, as stated on the front panel.
- `<Serial Number>` is the individual serial number of the instrument.
  You can find the serial number at the rear panel of instrument. It is the third part of the device ID printed on the barcode sticker.

To query and change the hostname

1. Select "System Config > Remote Access > Network".

   Section "Instrument Name" displays the assigned "Hostname".

   Note: This function is password-protected. Unlock the protection level 1 to access it.

2. Select "System Config > Setup > Security > Protection".

3. Enable the "Protection Level 1".
   The default protection level 1 password is *123456*.

   The parameter "Hostname" in the "Network" tab is now enabled for configuration.

4. Change the "Hostname".

Configuring LAN access and services

By default, the LAN interface and the supported LAN interface services are enabled. For security reasons, for example to protect the instrument against unauthorized access, you can block either the LAN services individually, or the access over LAN in general.

For information on how you configure the remote access individually, see the following sections:

- Section 11.6.4, "Configuring LAN services", on page 612
- "To disable LAN access in general" on page 619
- "To disable LAN services individually" on page 619
- "To enable SMB version 1.0/2.0 client and server" on page 620

Configuring access over GPIB

To control the instrument remotely over the GPIB bus, it must be addressed using the GPIB address. The remote control address is factory-set to 28, but it can be changed 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.

To change the GPIB address

1. Select "System Config" > "Remote Access" > "GPIB Address".

2. Select "GPIB Channel Address" and enter a value between 0 and 30.

Risk of losing remote connection

If the remote access and network settings had been configured to values different to the default, executing a factory preset via remote control terminates the connection to the instrument.

12.8.2 Starting remote control with LXI

Using the LXI browser interface you can access and control the R&S SMM100A instrument remotely from a controller PC without additional installation. Remote control over LXI supports file upload and download between the instrument and the controller PC.

It is assumed that the instrument is set up in the LAN.

See "Prerequisites" on page 669.

To start remote control with the LXI browser

1. On the controller PC, start a browser that supports HTML5 (W3C compliant).
2. Enter the IP address of the R&S SMM100A in the browser's address bar.

   The browser displays the R&S SMM100A's welcome page.
3. In the navigation pane, select "Instrument Control" > "Web Control".

   Remote access to the instrument requires the password. The default password is *instrument*.
4. Enter the password.
5. Confirm with [Enter].

   The current screen of the R&S SMM100A appears in the browser window.
6. Use the mouse cursor and keyboard to access the functionality of the instrument as if you operate the instrument directly.

To activate SCPI remote trace

The remote trace functionality allows you to trace SCPI commands and messages exchanged over the LAN of the R&S SMM100A. To communicate with the instrument over SCPI, use a suitable remote control application.

1. Set up the remote control session as described under "To start remote control with the LXI browser" on page 673.
2. In the navigation pane, select "Diagnostics > SCPI Remote Trace".
3. In the toolbar bar of the "SCPI Remote Trace" page, select "live mode > on".
4. Using the remote control program, send your SCPI commands to the R&S SMM100A.

   The "SCPI Remote Trace" tab displays all sent commands and responses.
5. Select "logging > on".

(Live mode and logging exclude each other).

"logging > on" displays all commands and responses, and traces messages also.

The SCPI remote trace function records all sent commands, received responses and messages, and saves them in an internal database. If "live mode" is disabled, you can display the recent traces on request, using the "refresh" button. You can also save the log in a file.
Note: The diagnostics functionality is extended in later releases, e.g. to download or upload SCPI command files from / to the instrument.

12.8.3 Starting remote control with VXI-11

This connection uses the I/O software library R&S VISA from Rohde & Schwarz to setup a LAN remote control link to the instrument.

R&S VISA is running on a controller PC with Windows operating system. You can send commands to the instrument and receive the responses.

For information installing, operating and the utility applications the software provides, see R&S VISA product page www.rohde-schwarz.com/rsvisa.

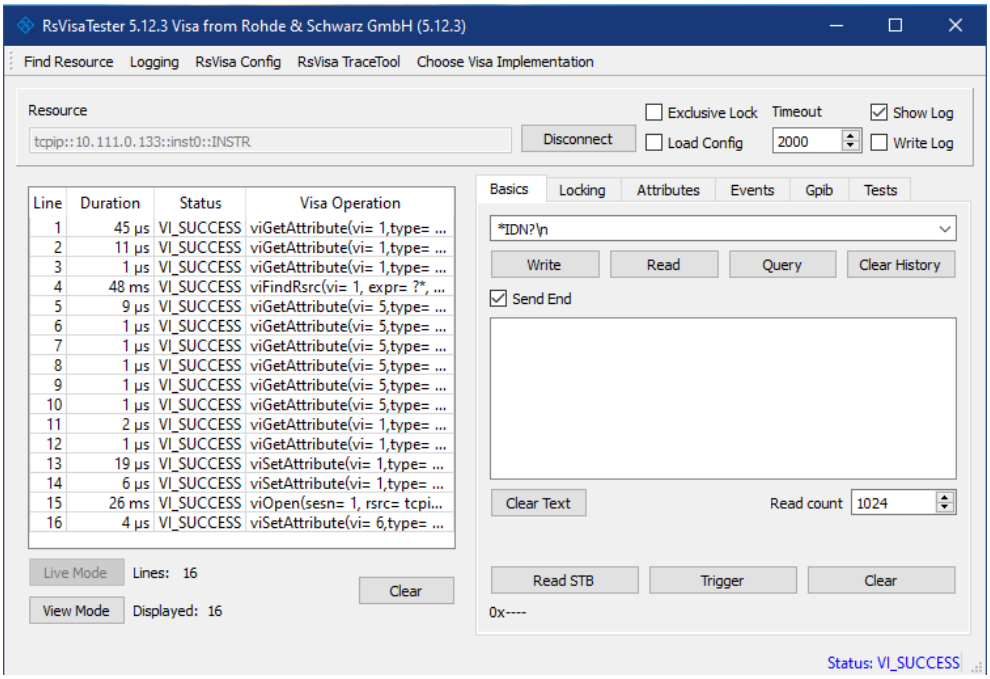
The remote control connection requires a VISA installation but no additional hardware on the controller PC. The LAN I/O channel is selected at initialization time using the VISA resource string (also referred to as "address string"). A VISA alias (short name) replaces the complete resource string. The host address is the R&S SMM100A's host-name or its IP address.

See Section 12.2.1, "LAN interface", on page 628.

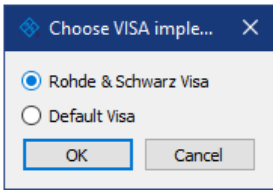
To set up the controller with R&S VISA

To remote control the R&S SMM100A, we use the R&S VISA Tester application. The application communicates over the TCP/IP protocol.

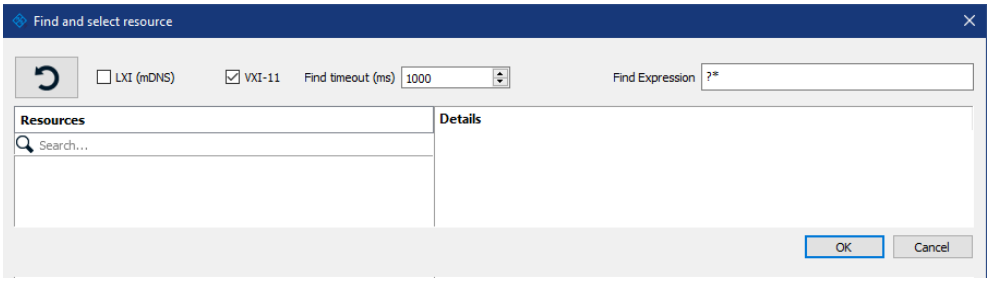
1. On the controller PC, install the R&S VISA program.
   See www.rohde-schwarz.com/rsvisa > "RS VISA release notes".
2. On the instrument, enable the LAN interface and "SCPI over LAN".
3. On the controller, start, e.g., "R&S VISA > Tester".



4. In the menu bar, select "Choose VISA Implementation > Rohde & Schwarz Visa"
5. Confirm with "OK".

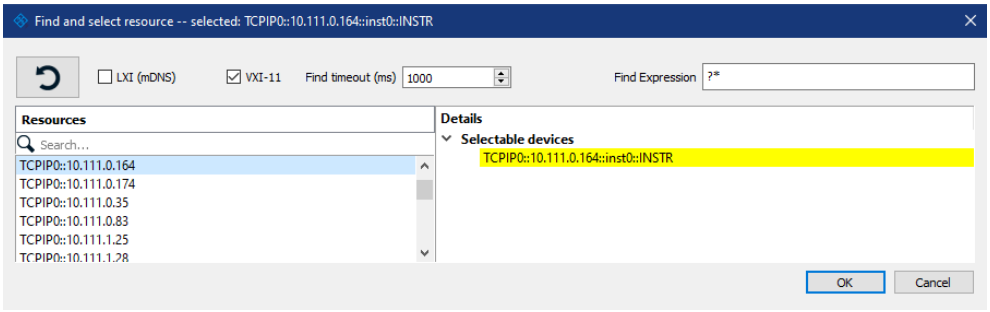


6. In the menu bar, select "Find Resource" to search for the instrument in the LAN.



7. Select "VXI-11".
8. Select the "refresh" button to start the search.

   R&S VISA scans the network for connected instruments and lists all detected instruments in the "Resource" list.
   Note: The search can take some time, particularly in large networks.
9. Select the required instrument.

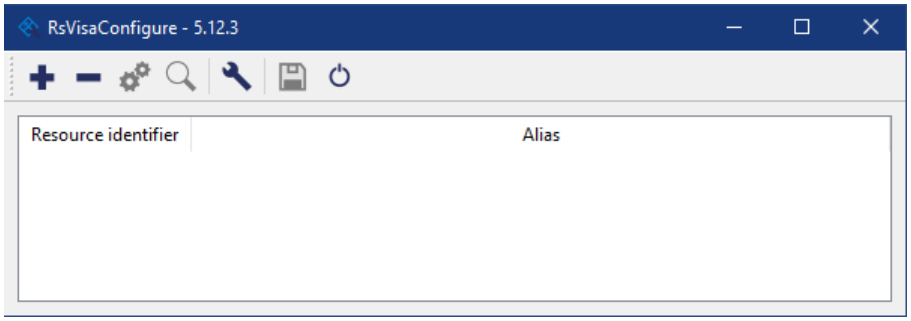


10. Confirm with "Ok".

    The "Find and select resource" dialog closes and R&S VISA indicates the IP address in the "Resource" field of the main application window.

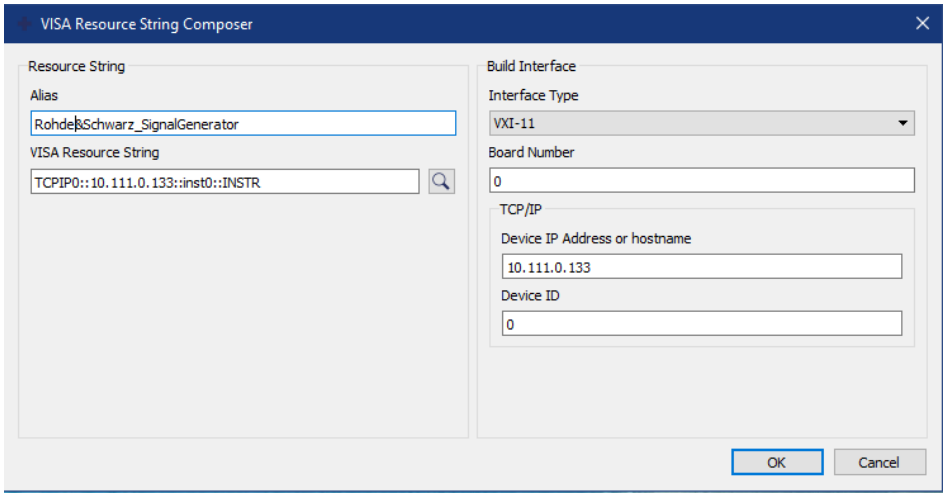
11. As an alternative to the IP address, you can assign an alias name to the R&S SMM100A:

    a) In the menu bar, select "RsVisaConfig".

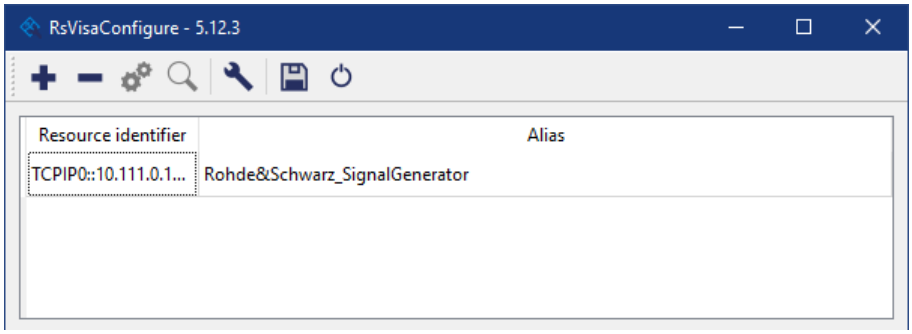


    b) In the toolbar, select "+" to access the "VISA Resource String Composer".

c) Fill in the "Alias" name, the "VISA Resource String" and the "Device IP Address or hostname" as shown in the figure.



R&S VISA indicates the assigned "Alias" name.



d) Confirm with "OK".
R&S VISA identifies the R&S SMM100A and you can address it either with the resource string or the alias name.

12. In the main window, select "Connect".

    R&S VISA establishes the connection to the R&S SMM100A.

    You can send settings to configure the instrument and receive its responses.

    Note: If the connection cannot be set up, R&S VISA displays an error in the log view.
    See also Section 14.5, "Resolving network connection failures", on page 1104.

To start remote control with R&S VISA

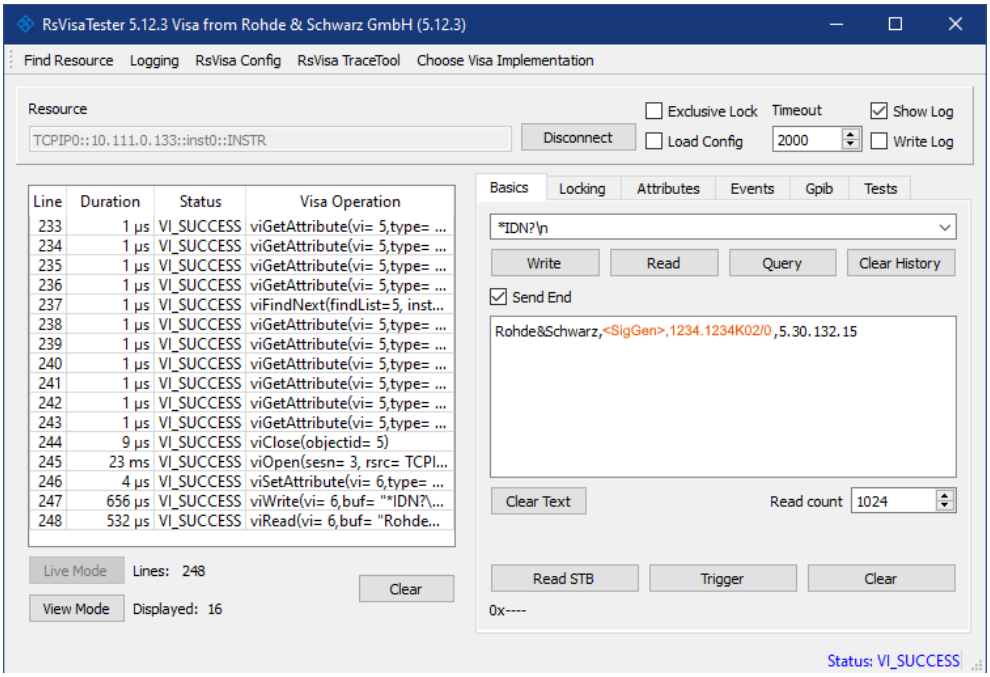
To set the instrument to remote control state, you can send any command from the controller.

1. Start the R&S VISA Tester.
   Establish the connection to the R&S SMM100A.
   See "To set up the controller with R&S VISA" on page 674.
2. In the R&S VISA "Basics" tab, enter a SCPI command, e.g. `*IDN?`.

3. Confirm with "Query".

   The instrument switches to remote control when it receives a command from the controller.

4. Select "Read" to obtain the instrument response.



   The instrument returns the response.
   Remote control over R&S VISA is enabled.

To check remote control with VISA

You can check the communication by sending a setting command and querying the response:

1. Set, e.g. the frequency with the command:
   `SOUR1:FREQ 3 GHz`.
2. Select "Write".
3. Enter the command `SOUR:FREQ?`.
4. Select "Query".

   If the R&S SMM100A responses with the frequency value xyou entered, remote control works properly.

To monitor the remote control operation

1. Check the "Show Log" checkbox on the top right.

   R&S VISA displays each VISA operation in the log-view on the left.

2. Check the "Write Log" checkbox.

R&S VISA saves all log-view entries to a log file.

You can operate the log-view in two modes:
- "Live Mode": shows only the most recent messages
- "View Mode" allows you to scroll the history

To return to manual operation, see Section 12.8.7, "Stopping remote control", on page 681.

12.8.4 Starting remote control with socket communication

This section provides an example on how to establish a remote control connection over Telnet client and a simple sockets-based program example that can be further developed.

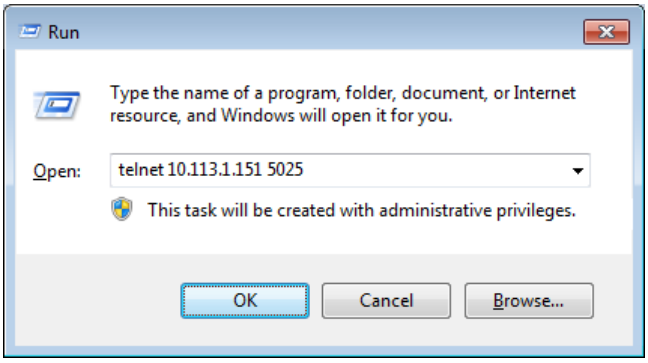
The telnet client transmits information unencrypted. Therefore, for sensitive information we recommend that you use a client which supports secure protocols, like SSH.

To set up a Telnet connection

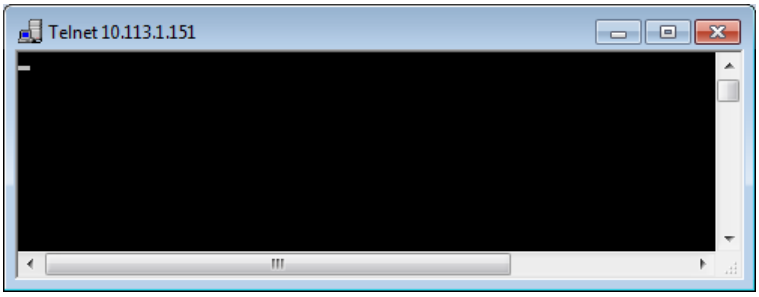
To control the software, only a Telnet program is required. The Telnet program is part of each operating system.

The controller PC and the instrument are connected in the same network.

1. On the instrument, enable the LAN interface and "SCPI over LAN".
   See Section 11.6.4, "Configuring LAN services", on page 612.
2. On the controller PC, start the Telnet program.
3. Enter the socket address.
   The socket address is a combination of the IP address or the hostname of the R&S SMM100A and the number of the port configured for remote-control via Telnet.
   Tip: The R&S SMM100A uses the port number 5025 for remote connection via Telnet.

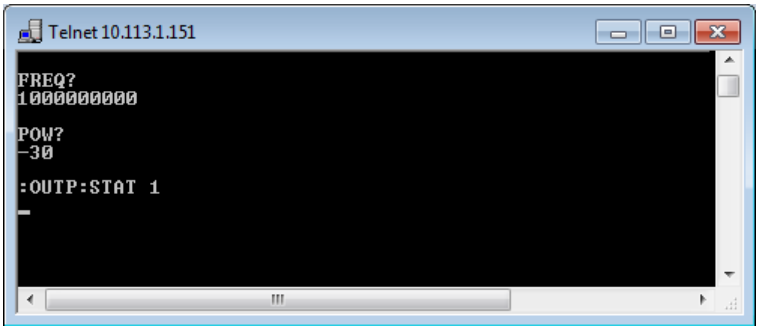


The connection to the instrument is set up and you can send remote-control commands.



4. Telnet does not reflect your first entry.
   Insert a command, e.g. `*IDN` and confirm with "Enter".
5. Observe the screen.

   A response on the query confirms that the connection is working. The client displays all subsequent inputs and responses.
6. Even if the cursor is not visible on the screen, just enter a remote-control command. Confirm with Enter.



12.8.5 Starting remote control over GPIB

The program example in this section is written in VISUAL BASIC. A condition for programming in VISUAL BASIC is that the modules NIGLOBAL (`Niglobal.bas`) and VBIB32 (`Vbib_32.bas`) are added to the projects.

Drivers for instrument, for example IVI-COM and LabVIEW drivers, are available for download area on the product page at:
https://www.rohde-schwarz.com/driver/smm100a/

To start remote control over GPIB

1. Connect instrument and controller using a GPIB cable.
   Switch them on.
2. Select "System Config > Remote Access > GPIB Address" > **"GPIB Channel Address = 28"**.
   The GPIB address of the instrument must be the default value of 28.

3. Execute the following commands on the controller:
   a) Open the port to the instrument.
      `CALL IBFIND("DEV1", generator%)`
   b) Inform the controller about instrument address.
      `CALL IBPAD(generator%, 28)`
   c) Reset the instrument.
      `CALL IBWRT(generator%, "*RST;*CLS")`
   d) Set the instrument to new address.
      `CALL IBWRT(generator%, "SYST:COMM:GPIB:ADDR 18")`
   e) Inform the controller about new address.
      `CALL IBPAD(generator%, 18)`

   The GPIB address of the instrument is changed.
4. To return to manual operation, see Section 12.8.7, "Stopping remote control", on page 681.

12.8.6 Starting remote control over USB

For remote control, the PC and the instrument must be connected over the USB type B interface. A USB connection requires the VISA library to be installed. VISA detects and configures the R&S instrument automatically when the USB connection is established. You do not have to enter an address string or install a separate driver.

To start remote control over USB

1. Connect instrument and controller using USB cable. Switch them on.
2. Execute the following commands on the controller:
   a) Open the port to the instrument.
      `viOpen (..., "USB::0x0AAD::0x0277::100001::INSTR", ...)`
   b) Reset the instrument.
      `viRST (generator%, "*RST;*CLS")`
   c) Set 2 GHz frequency
      `viPrintf (..., "SOUR:FREQ 2GHz\n")`
   d) Set 20 dBm output level
      `viPrintf (..., "SOUR:POW -20dBm\n")`

   The RF frequency and signal level of the instrument are changed.
3. To return to manual operation, see Section 12.8.7, "Stopping remote control", on page 681.

12.8.7 Stopping remote control

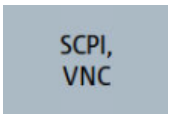
Before returning to manual control, command processing must be completed. Otherwise, the instrument switches back to remote control immediately.

You have the following options to switch from remote control to manual operation:

- Closing the remote control session
- Using remote control commands
- Selecting the remote icon in the status bar directly on the screen
- Using the "Local" key

To find out active remote connections

► Check the indication on the taskbar:



A softkey in the taskbar indicates if and what kind of remote connections are currently set up.
See also Section 12.5.6, "Active remote connection settings", on page 647

To return to manual operation

Depending on the used remote control state, the transition from remote control to manual operation requires different actions.

► Select the corresponding transition action as shown in the table.

Table 12-6: Remote control status icons

GUI symbol	Transition to remote control state...	Remote control state characteristics	Transition to manual operation...(local state)
 	`&GTR` (controller PC)	Remote control, but usable front panel keys. The parameters are in read-only mode. The green arows indicate a currently performed setting.	• `&GTL` (SCPI If `&NREN` has been set before `&GTL` is locked. Use `&GTR` instead. • `CALL IBLOC (generator%)`, (visual basic). • `viGpibControlREN()` (VISA function) • "Remote" icon in the status bar • [Local] (front panel or key emulation) The setting must be completed (white arrows) before you can return to manual operation.
	`&LLO` (controller)	Remote control with locked front panel keys to prevent user interaction. The parameters are in read-only mode. You can unlock LLO, and thus return to manual operation only via remote control.	• `&LOCS` • `&REMS` Changes from "Remote LLO" to "Remote" state. • `CALL IBLOC (generator%)` • `viGpibControlREN()`

12.9 Setting up remote operation over VNC

VNC accesses the R&S SMM100A over LAN from a remote device using a web browser or a VNC client. With the screen displayed on the controller, you can control the instrument as if you operate it directly. Establishing the access depends on the used remote device and VNC client software.

See Section 12.1, "Overview of remote access modes", on page 626.

The following examples descibe how to set up remote operation with remote devices:

- Using a controller PC
  - "To operate the instrument from a web browser over VNC" on page 684
  - "To operate the instrument from a Linux/Unix client over VNC" on page 684
  - "To operate the instrument from a Windows client over VNC" on page 685
- Using a smart device
  - "To operate the instrument using a VNC App on a smart device" on page 687
  - "To operate the instrument from a web browser over VNC" on page 684
  - "To access the instrument with QR code on a smart device" on page 688

To enable VNC service on the R&S SMM100A

1. **NOTICE!** Enabled VNC service can lead to unauthorized access.
   Change the computer name and password of the instrument.
   See Section 11.6.6, "Preventing unauthorized access", on page 618.
2. Select "System Config > Setup > Security > Security".
3. Select "LAN Services > Common Services".
4. Enable "VNC".
5. Enter the Security Password.
6. Confirm with "Accept".

- Using a controller PC 683
- Using a smart device 686
- Stopping remote operation 688

12.9.1 Using a controller PC

Prerequisites

For remote operation, make sure that you have fullfilled the following prerequisites:

- The instrument and the controller PC are connected in the same network.
  See Section 3.1.7, "Connecting to LAN", on page 29.
- The instrument and the controller are switched on.
- The LAN interface and VNC LAN service is enabled.

See Section 11.6.4, "Configuring LAN services", on page 612.

- A suitable application is running on the remote device.
  - Web browser
    The R&S SMM100A supports remote operation over VNC with any web browser, e.g., Windows Internet Explorer, Mozilla Firefox, or an HTML5 web browser.
  - VNC client software
    The software application provides remote operation of the R&S SMM100A.

VNC client software

Linux/Unix operating systems include a VNC client software by default.

For remote devices with windows operating system a VNC client software must be installed manually. Various free-of charge programs such as Ultr@VNC or similar VNC client programs are available for download on the Internet.

If security is a concern, see:

- Document Instrument Security Procedures.
- Section 11.6.6, "Preventing unauthorized access", on page 618.

To operate the instrument from a web browser over VNC

1. Install the *JRE (Java Runtime Environment)* on the remote computer.
   Note: Skip this step if you are working with an HTML5 web browser.
2. Enter the IP address of the instrument in the address field of the web browser, e.g. *http://10.113.1.151*

   The VNC authentication screen appears.
3. Enter the user password.
   The default password is *instrument*.
4. Confirm with with "OK".

   When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the remote computer.

To operate the instrument from a Linux/Unix client over VNC

1. Start a web browser on the remote computer. Enter the IP address of the instrument.
2. Enter the following address:
   `vnc://<IP-address of the instrument>`, for example *vnc://10.113.1.151*.

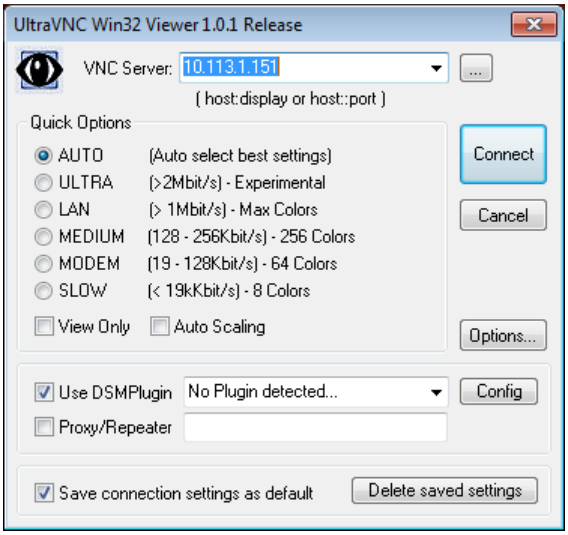
   A dialog opens requesting the password for the remote VNC connection.
3. Enter the user password.
   The default password is *instrument*.

4. Confirm with with "OK".

   When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the remote computer.

To operate the instrument from a Windows client over VNC

1. Install the VNC viewer program component on the remote computer.
   a) Download a VNC client program from the Internet.
   For example the free of charge software Ultr@VNC (`vncviewer.exe` is available, see http://www.uvnc.com/download/index.html.
   b) Execute the VNC client installation.
   c) Select the VNC viewer program component and follow the installation instructions.
2. Start VNC viewer program component on the PC.



3. Select "VNC Server"
4. Enter the IP address of the instrument.
5. Confirm with "Connect".

   An authentication dialog opens.

6. Enter the user password for authentication.
   The default password is *instrument*.

7. Confirm with "LogOn".

   When the connection is established, the screen of the signal generator appears and you can operate the instrument from the remote computer.

12.9.2 Using a smart device

The R&S SMM100A supports remote operation over VNC from a smart device (remote client), like a tablet (tablet computer) or a smartphone. The smart device accesses the instrument over WLAN, either by a suitable App, or an HTML5 web browser with embedded *javascript*.

There are several possibilities to establish a WLAN connection between the smart device and the R&S SMM100A. This section gives an example of how a network environment can be built up, and some essential configuration steps.

For more information, see:

- 1MA216: Remote Operation of Windows Based Instruments with Apple iPad
- 7BM82: Apple iPad Remote Control of Broadcasting T&M Instruments

Example:

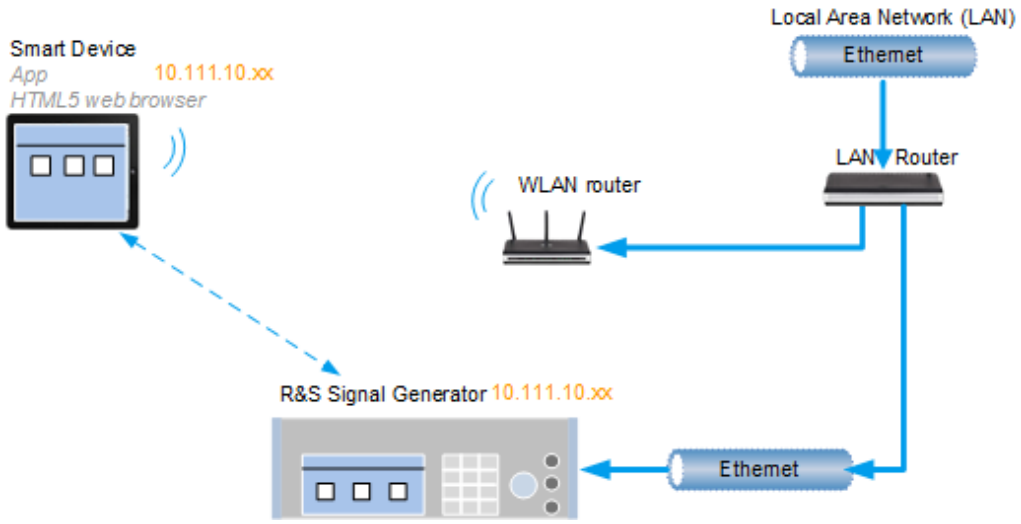


Figure 12-7: Example of a network configuration for remote operation with a smart device

As shown in the figure, the R&S SMM100A and the WLAN router are connected to the LAN router. The smart device accesses the Rohde & Schwarz instrument via the WLAN router.

The WLAN router as an additional access point enables you to operate the instrument even from a great distance.

Prerequisites

For the remote operaton, you need the following equipment and configuration:

- Equipment:

  - LAN router
  - WLAN router (hot spot) for accessing the instrument
  - Smart device
- The instrument and the smart device PC are connected in the same network.
- The instrument and the smart device are switched on.
- The LAN interface and VNC LAN service is enabled.
  See Section 11.6.4, "Configuring LAN services", on page 612.
- A suitable application is running on the smart device.
  - Web browser
    The R&S SMM100A supports remote operation over VNC with any HTML5 compliant web browser, e.g., Internet Explorer, Firefox, Google Chrome or Safari.
  - VNC app
    An application that implements the VNC functionality for remote operation. The VNC App must be suitable to the used smart device.
    Refer to the manufacturer's website to find a VNC App supported for your smart device, and how it is installed.
  - QR code
    If your smart device is equipped with a camera and a QR code reader, you can scan the instrument's IP address or access the instrument with the Safari web browser.
    Refer to the manufacturer's website to find a QR code reader supported for your smart device, and how it is installed.

We recommend that all components in the network use DHCP, which automatically assigns the relevant address information.

To operate the instrument using a VNC App on a smart device

1. Set up the network connection as shown in Figure 12-7
2. Configure the WLAN router according to the manufacturer's instructions.
3. Install the required *VNC App* on your smart device.
4. On the smart device, start the *VNC App*.
   Enter the IP address of the instrument in the address field of *VNC App*.

   The VNC authentication screen appears.
5. Enter the user password.
   The default password is *instrument*.
6. Enter the password to establish the remote access.
   The default user name and password is *instrument*.

   When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the smart device.

To operate the instrument from a web browser over VNC

1. Install the *JRE (Java Runtime Environment)* on the remote computer.

Note: Skip this step if you are working with an HTML5 web browser.

2. Enter the IP address of the instrument in the address field of the web browser, e.g. *http://10.113.1.151*

   The VNC authentication screen appears.

3. Enter the user password.
   The default password is *instrument*.

4. Confirm with with "OK".

   When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the remote computer.

To access the instrument with QR code on a smart device

1. Set up the network connection as shown in Figure 12-7
2. Configure the WLAN router according to the manufacturer's instructions.
3. Install the required QR code reader software on your smart device.
4. On the smart device, start the QR code reader.
5. On the R&S SMM100A, select "System Config > Remote Access".
6. Select the "QR-Code" tab.
7. Scan the QR code of the instrument with your smart device.
8. On the smart device, decode the scanned QR code and forward it to the web browser.

   The VNC authentication screen appears.

9. Enter the user password.
   The default password is *instrument*.

   When the VNC connection is established, the screen of the signal generator appears and you can operate the instrument from the smart device.

12.9.3 Stopping remote operation

To stop remote operation

To terminate remote operation over VNC depends on the used client:

► Select the action that applies to the used client:

a) On an external Unix/Linux PC, close the Internet browser or the signal generator window.
b) On an external Windows PC, close the VNC viewer program.

c) On a smart device, close the application.

The connection is terminated but not disabled. It can be established again anytime.

12.10 Using remote command scripts

To configue a test setup quickly, or to make complex test setups or repeating measurements reproducible, you can automate the required settings with remote command scripts. A remote command script contains a sequence of SCPIs which configure the corresponding settings. When created, it is converted to an executable format, saved in a file and can be run whenever needed.

The graph shows the main steps required to create and execute a SCPI script.

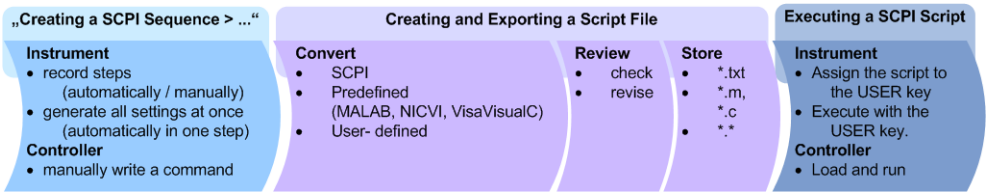


Figure 12-8: Steps for performing SCPI Scripts

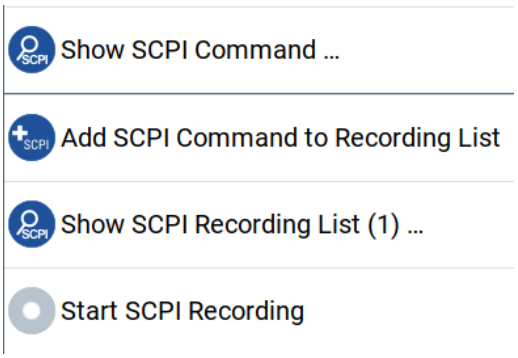
- SCPI recording settings 689
- Creating remote command lists 693
- Checking and verifying a remote command list 696
- Converting a remote command list to a script 697
- Running a remote command script 699

12.10.1 SCPI recording settings

The R&S SMM100A provides information on the required SCPI command for the available measurement settings, functions, and results in the context-sensitive menu.

Access:

1. Select a parameter.
2. Open the context-sensitive menu (tap and hold).



The context-sensitive menu provides the SCPI recording functions to help you create your script.

- Show SCPI command settings....690
- SCPI recording list settings....690
- SCPI recording export settings....691

12.10.1.1 Show SCPI command settings

Access:

1. Select the parameter.
2. Open the context-sensitive menu.
3. Select "Show SCPI Command".

This function provides the syntax of the remote command with the current setting.

Setttings:

Copy....690
Close....690

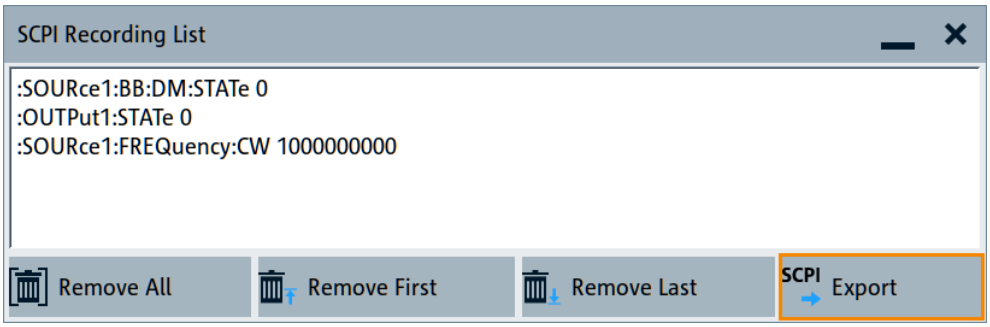
Copy
Copies the command and the current setting.

Close
Exits the "SCPI Command" dialog.

12.10.1.2 SCPI recording list settings

Access:

1. Select a parameter.
2. Open the context-sensitive menu.
3. Select "Show SCPI Recording List".



The "SCPI Recording List" shows the recorded commands.

Setttings:

SCPI Recording List....691
Remove All....691
Remove First....691
Remove Last....691
Export....691

SCPI Recording List
Lists the automatically or manually recorded SCPI commands.

Remove All
Deletes all entries in the SCPI command list.

Remove First
Deletes the first entry in the SCPI command list.

Remove Last
Deletes the last entry in the SCPI command list.

Export
Opens the "SCPI Recording Export" dialog for configuring the file parameters for the SPCI command script file.

See Section 12.10.1.3, "SCPI recording export settings", on page 691.

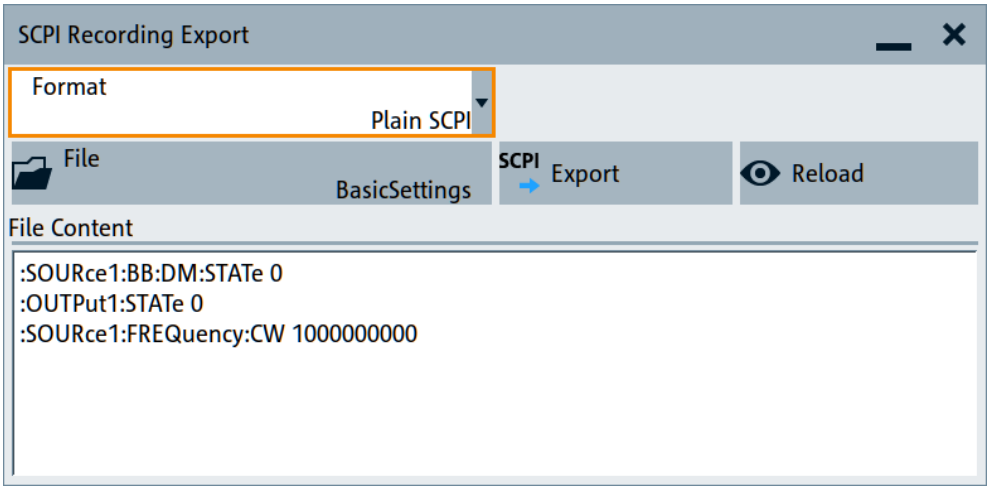
12.10.1.3 SCPI recording export settings

The R&S SMM100A displays recorded remote command lists in the "SCPI Recording Export" dialog. This dialog opens automatically, when you stop recording. To open the dialog manually, proceed as described.

Access:

1. Select a parameter.
2. Open the context-sensitive menu.
3. Select "Show SCPI Recording List".

4. Select "Export".



The "SCPI Recording Export" dialog contains all functions required for export of command lists to a file. It enables you to select the source code format, assign an individual filename and display the file content.

Setttings:

Format....692
Code Template....692
File....692
Export....693
Reload....693
File content....693

Format
Selects the source code format for the command list.

"Plain SCPI" Uses SCPI syntax.

"Predefined Code Generator"
Accesses the predefined templates for common source code generators that convert the recorded settings in the programming languages MATLAB or NICVI or Python.

"User Code Generator"
Use this setting to convert a script by a user-specific code generator.

Code Template
Opens a standard file handling dialog for saving or loading predefined or user-defined code templates.

See Section 10.6.1, "File select settings", on page 535.

File
Opens a standard file handling dialog for selecting the directory and file name for the output file.

See Section 10.6.1, "File select settings", on page 535.

Export
Saves the remote command list file in the selected directory.

Reload
Reloads a remote command list file.

File content
Displays the content of the remote command list in the selected format and code template.

12.10.2 Creating remote command lists

Using the SCPI recorder functions, you can create a SCPI command list directly on the instrument and then export the list for use on the controller PC. You can also edit or write a script manually, using a suitable editor on the controller. For manual creation, you can retrieve the command corresponding to a setting directly on the instrument.

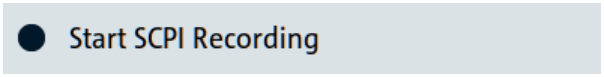
You can create a SCPI list directly on the instrument at any time of operation, in the following ways:

- Recording settings automatically
  The "Start SCPI Recording" function adds the SCPI command of each step that you perform to the SCPI list. You can start, stop and resume automatic recording, and also add individual commands manually.
  See "To record settings automatically" on page 693.
- Recording settings manually
  The "Add SCPI Command to Recording List" function adds the SCPI command and settings value of an individual step to the SCPI list.
  See "To record settings manually" on page 694.
- Generating a SCPI command list of all settings in one step
  Adds the SCPI commands of the current instrument settings in one step in a SCPI list.
  See "To generate a SCPI command list of all settings in one step" on page 695.
  Note: This function lists all commands in alphabetical order, in contrast to the recording or manual creation, which consider the order the settings are configured. If a setting cannot be set by a SCPI command, *no SCPI command found* is entered instead of a command when generate all settings at once.
  Using this function can slow down the performance or cause errors during execution.
  Therefore, always check and revise a script if necessary.
  See "To display a remote command list" on page 696 and "To review a remote command list" on page 696.
- Copying and pasting individual SCPI commands manually
  "Show SCPI command" enables you to copy the SCPI command and the current setting and paste it into any suitable editor.
  See "To copy and paste SCPI commands" on page 694.

To record settings automatically

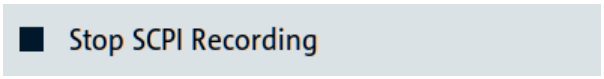
1. On the screen, open the context-sensitive menu.

2. Select "Start SCPI recording".



The R&S SMM100A now records all steps you take.

3. To stop SCPI recording, select "Stop SCPI recording" in the context-sensitive menu.

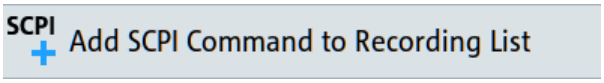


The "SCPI Recording List" dialog opens.

4. Proceed with "To review a remote command list" on page 696.

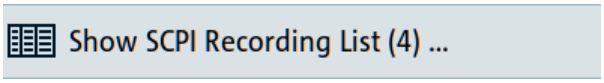
To record settings manually

1. Select the parameter or function.
2. Set the parameter.
3. Open the context-sensitive menu.
4. Select "Add SCPI Command to Recording List".



The R&S SMM100A adds the SCPI command of the setting including the value in a temporary SCPI command list.

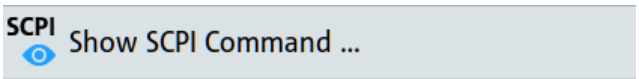
Tip: "Context-Sensitive > Show SCPI Recording List" opens the dialog with the recorded settings.



5. Continue with the next setting accordingly whenever you want to record it.
6. Proceed with "To review a remote command list" on page 696.

To copy and paste SCPI commands

1. On the instrument, select the parameter or function.
2. Set the parameter.
3. Open the context-sensitive menu.
4. Select "Show SCPI Command".



The R&S SMM100A displays the syntax and the setting value of the SCPI command.

With the "Copy" function, you can copy and paste the SCPI command and setting value, e.g., in a command script on a PC.

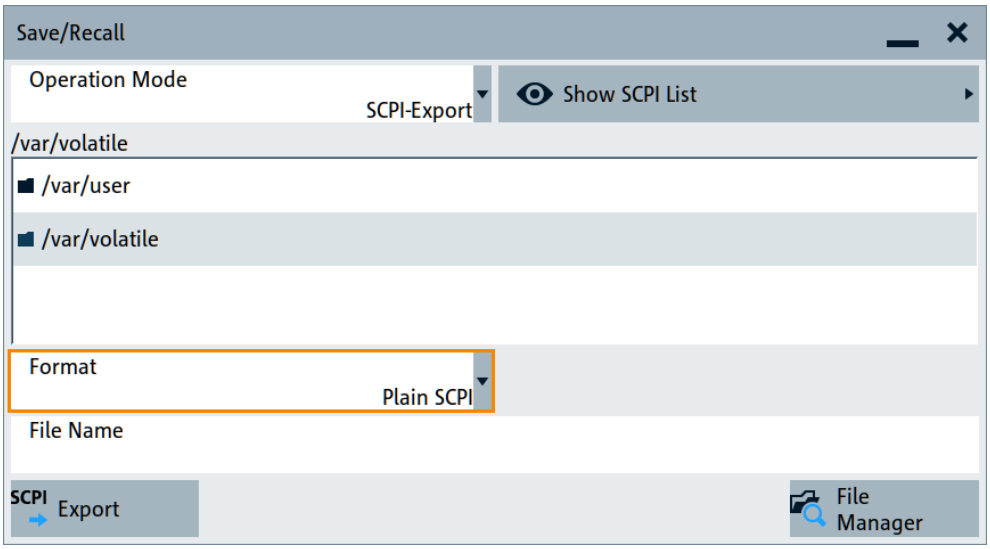
To generate a SCPI command list of all settings in one step

Using the save/recall function, you can create a SCPI command list for all settings in one step.

1. Press the [Save/Recall] key.

   The instrument opens the standard "Save/Recall" dialog.

2. Select "Operating mode" > "SCPI Export".



   The dialog adjusts the entry fields for configuring the command list file. "Show SCPI List" provides access to the list of all setttings the instrument has recorded.

3. Select the "/var/user" directory in which you want to save the SCPI command list.
4. In the "Format" entry field, select the source code format.
5. Enter a filename.
6. Select "Export".
   The R&S SMM100A saves the SCPI command list as `*.txt` file.

   Note: Exporting the SCPI list of the instrument state in one step usually requires postprocessing on an external PC, as this function lists all instrument states and commands in alphabetical order.
   In contrast, recording or manual creation of a SCPI command list considers the order the settings are configured.

12.10.3 Checking and verifying a remote command list

Before converting a command list to an executable script, we recommend that you check if the entries are correct and complete. It can be that ...

- a parameter has not assigned a SCPI command or an element of the user interface has not an assigned parameter. In these cases, `:SYST:INF:SCPI 'SCPI command not available'` is entered in the list instead.
  Such entries are also detected during execution. The instrument recognizes these incomplete commands and displays notification.
- a preset has been executed, but several standards then perform some internal settings that are also assigned to the list with "SCPI Export".
- after a preset some settings are still defined, which are then written to the list generated with "SCPI Export."

To display a remote command list

On the instrument, you have different options to access a remote command list.

1. During automatic or manual recording:
   a) Open the context-sensitive menu.
   b) Select "Show SCPI Recording List".
2. At the end of automatic recording:
   a) Open the context-sensitive menu.
   b) Select "Stop SCPI Recording".
3. After exporting a command list to a file.
   a) Select "SCPI Recording Export" > "Show file content".

   The "SCPI Recording List" opens.

To review a remote command list

To rework a remote command list, you must transfer it to a computer.

1. Export the list to a PC, using, for example, a USB flash drive.
2. Check the list, e.g. by comparing it with the modified settings in the manual mode.

   Tip: To find out your settings, you can use the "Mark all parameters changed from preset" function.
   See Section 10.3.2, "Identifying parameters with non-default values", on page 526.
3. Search for missing or incomplete command entries.
   a) Add missing commands.
   b) Complete missing parts of commands.
   c) Remove superfluous entries, e.g. `:SYST:INF:SCPI 'SCPI command not available'`.
   d) Remove unnecessary content written after a preset.

4. Rearrange the commands to a reasonable order. For example, if you set a `STATe` command to the last position in a list, you can avoid intermediate calculations of the signal.

12.10.4 Converting a remote command list to a script

For conversion of a remote command list into an executable script, a code generator translates the commands into the source code of a proprietary programming language, based on a code template. Therefore, each progamming language requires a dedicated code template.

The R&S SMM100A provides the following predefined code templates by default:

- Plain SCPI
  Represents SCPI base format, that is ASCII format, saved as text file (`*.txt`).
- MATLAB
  A programming environment, frequently used in signal processing and test and measurement applications (`*.m`).
  You can directly use this format with MATLAB(c) Toolkit. For comprehensive information on this topic, refer to the application note 1GP60.
- NICVI
  An ANSI C programming environment designed for measurements and tests (`*.c`).
  You can directly use this format with National Instruments LabWindows CVI.
- Python3
  A general-purpose and high-level programming language (`*.py`).

You can also convert a script to a user-specific format. In this case, you need a code template with the extension `*.expcodetmpl`.

When converted, you can save the script in a file with the extension corresponding to the programming language.

To configure a plain SCPI script file

1. Select "Show SCPI Recording List" in the context-sensitive menu.
2. Select "Export".
   The "SCPI Recording Export" dialog opens.
3. Select the "Format" > "Plain SCPI".
4. Select "File".
   A standard file handling dialog opens.
5. Configure filename and directory and confirm with "Ok".
6. In the "SCPI Recording Export" dialog, select "Export".
   The R&S SMM100A saves the recorded data in `*.txt` format. The "File Content" section shows the SCPI commands of the script file.

To convert the command list to a predefined code template

1. Select "Show SCPI Recording List" in the context-sensitive menu.
2. Select "Export".
   The "SCPI Recording Export" dialog opens.
3. In the "SCPI Recording Export" dialog, select "Format" > "Predefined Code Generator".

   The "CodeTemplate" button appears.
4. Select "Code Template".

   The "SCPI Recording Export - Select Predefined Code Template" dialog opens.
5. Select a predefined code template, e.g., "MATLAB".
6. Confirm with "Select".

   The R&S SMM100A returns to the "SCPI Recording Export" dialog.
7. Select "File".
   A standard file handling dialog opens.
8. Configure filename and directory and confirm with "Ok".
9. In the "SCPI Recording Export" dialog, select "Export".
   The R&S SMM100A saves the recorded data in the corresponding format. The "File Content" section shows the content of the script file in the corresponding programming language.

To convert the command list to a user-defined code template

Before creating a script in a user-specific format, make sure that you have saved the code template with the file extension `*.expcodetmpl` in the instrument.

1. Select "Show SCPI Recording List" in the context-sensitive menu.
2. In the "SCPI Recording Export" dialog, select "Format" > "Use Code Generator".

   The "CodeTemplate" button appears.
3. Select "Code Template".

   The "SCPI Recording Export - Select User Code Template" dialog opens.
4. Select your user-defined code template.
5. Confirm with "Select".

   The R&S SMM100A returns to the "SCPI Recording Export" dialog.
6. Select "File".
   A standard file handling dialog opens.
7. Configure filename and directory and confirm with "Ok".
8. In the "SCPI Recording Export" dialog, select "Export".

The R&S SMM100A saves the recorded data in the corresponding format. The "File Content" section shows the content of the script file in the corresponding programming language.

12.10.5 Running a remote command script

An executable script automates measurement tasks on the instrument. Usually controlled by a remote PC, you can also save and run a script directly in the instrument by assigning the script to the [★ (User)] key.

See Section 11.4.2, "How to assign actions to the [★ (User)] key", on page 583.

12.11 Using command macros

A macro is a sequence of remote commands that you can reference in a remote control program. Macros are kept in the RAM while a remote connection is active. Define the macros at the beginning of a remote script. In general, they remain valid until the active remote control connection is closed.

Macros are not directly transferable from one remote channel to another. But it is possible to save macros to files and to reuse them in other remote connections or sessions. It is also possible to use different macros with the same label for different connections.

Applications of command macros

Use macros to reduce long sequences of SCPI commands or to reuse repetitive command sequences. Transfer these command sequences within a few macro commands to the R&S SMM100A. The defined macros can save transfer time, for example, if the macros contain many commands and if you execute them repeatedly.

Also, you can use macros to define a simple emulation of another instrument. For example, if the other instrument that you want to emulate, is not in the list of our supported device emulations. Macros enable you to map a single SCPI command or a sequence of SCPI commands of the R&S SMM100A into a single command of the other instrument. The mapping is sufficient to emulate at least simple commands of other instruments. When you apply such a macro, the R&S SMM100A understands commands of the other instrument. For easy usage, save macro definitions within a file. Whenever you want to use these macros you can load the file and enable the loaded macros.

The following sections provide information on the contents of macro commands and programming examples. For a detailed description on the macro commands, see Section 12.11.3, "Macro commands", on page 702.

12.11.1 Macro contents and macro commands

Define macros in the RAM via the command `*DMC <Label>, <Contents>`.

The command supports two formats for macro contents:

- Strings
- IEEE 488.2 block data format with defined or indefinite length.
  "#0" introduces a data block of indefinite length.

The command `*GMC?` returns the macro contents in block data format.

If a macro is present in the RAM, you can save it to a macro file via the command `:MMEMory:STORe:MACRo <Label>, <File>`. You can load a macro file into the RAM via the command `:MMEMory:LOAD:MACRo <Label>, <File>`.

A macro file is identified via its path and filename on the instrument (`<File>`). A macro within the RAM is identified via its label (`<Label>`).

12.11.2 Macro programming examples

The following examples show you how to use macros, macro parameters, and macro files.

The examples cover the following topics:

- Example "To configure common macro commands" on page 700
- Example "To configure macros with parameters" on page 701
- Example "To use macro files and block data format" on page 701
- Example "To use macros for customized instrument emulations" on page 702

Example: To configure common macro commands

This example provides information how to work with common macro commands.

```
// Reset the instrument. Define a macro to set the RF frequency to 5 GHz.
*RST
*DMC 'SetFrequency', ':SOURce1:FREQuency:CW 5 GHz'

// Query the contents of the macro.
*GMC? 'SetFrequency'
// Response: '#248SOURce1:FREQuency:CW 5 GHz'

// Query labels of existing macros.
*LMC?
// Response: '"SetFrequency"'

// Query the RF output frequency.
:SOURce1:FREQuency:CW?
// Response is 1 GHz in unit Hz: '1000000000'
// Enable macro execution.
*EMC ON
// Execute the macro.
SetFrequency
// Check the RF output frequency again.
:SOURce1:FREQuency:CW?
// Response is 5 GHz in unit Hz: '5000000000'
```

```
// Delete the macro.
*RMC 'SetFrequency'
// Delete all macros in the active connection.
*PMC
// Check if all macros have been deleted.
*LMC?
// Response: '""'
```

Example: To configure macros with parameters

This example provides information how to configure macros with parameters.

```
// Reset the instrument.
*RST

// Define a macro to set the RF frequency and RF level to arbitrary values using
// macro parameters '$1' and '$2'.
*DMC 'RF_Settings', ':SOURce1:FREQuency:CW $1;
:SOURce1:POWer:LEVel:IMMediate:AMPLitude $2'
// Execute the macro.
*EMC ON
RF_Settings 5 GHz,-10 dBm

// Check the results.
:SOURce1:FREQuency:CW?
// Response is 5 GHz in unit Hz: '5000000000'
:SOURce1:POWer:LEVel:IMMediate:AMPLitude?
// Response in dBm: '-10'
```

Example: To use macro files and block data format

This example provides information how to configure macros with block data format.

```
// Save the macro to the file RF_Settings.txt.
:MMEMory:STORe:MACRo 'RF_Settings', '/var/user/RF_Settings.txt'
// Delete all macros in the active connection.
*PMC
// Check if all macros have been deleted.
*LMC?
// Response: '""'

// Reload the macro contents from the macro file, assigning the old label.
:MMEMory:LOAD:MACRo 'RF_Settings', '/var/user/RF_Settings.txt'
// Query the contents.
*GMC? 'RF_Settings'
*LMC?

// Redefine the macro using block data format.
*DMC 'RF_Settings', 'RF_Settings', #0:SOURce1:FREQuency:CW $1;
:SOURce1:POWer:LEVel:IMMediate:AMPLitude $2
// Check and save the macro.
*GMC? 'RF_Settings'
:MMEMory:STORe:MACRo 'RF_Settings', '/var/user/RF_Settings.txt'
```

Example: To use macros for customized instrument emulations

This example provides basic information how to use macros for customized instrument emulations. It uses a macro command with a label that has the same syntax as the command of the emulated instrument.

```
// Define the macro and its label using the command of the emulated instrument.
// For example, we use the command 'RF:FREQ'.
*DMC 'RF:FREQ', ':SOURce1:FREQuency:CW $1;

// Optionally, save the macro into the file 'RF_Settings.txt' for later reuse.
:MMEMory:SAVE:MACRo 'RF:FREQ', '/var/user/RF_Settings.txt'
// Check that the R&S SMM100A emulates no other instrument.
:SYSTem:LANGuage? SCPI
// Returns the default command set of Rohde & Schwarz generators.
// Enable macro execution.
*EMC ON
// Execute the macro.
'RF:FREQ' 1 GHz
:SOURce1:FREQuency:CW?
// Resonse in Hz: '1000000000'
// The R&S SMM100A sets an RF output frequency of 1 GHz with the
// corresponding command from another instrument.
```

For a detailed description on the macro commands, see Section 12.11.3, "Macro commands", on page 702.

12.11.3 Macro commands

The following remote control commands are related to macro files and macro execution.

R&S SMM100A-specific command properties

The following macro command properties differ from SCPI regulations:

- The `*RST` state of `*EMC` is `OFF`. To use macros, enable the macro execution for the used remote connection.
- Normal remote control execution has priority over macro execution. Macros that have the same name as a remote command supported by the R&S SMM100A are ignored.

*DMC....703
*EMC....703
*GMC?....703
*LMC?....704
*PMC....704
*RMC....704
MMEMory:LOAD:MACRo....704
MMEMory:STORe:MACRo....705

***DMC**

Creates a macro. If the label exists already, the macro contents are overwritten.

Macros are deleted when a remote connection is closed but can be saved to a macro file for later reuse via the following command:

`MMEMory:STORe:MACRo` on page 705

Avoid using labels that are identical to supported remote control commands. In contrast to SCPI stipulations, remote commands have priority over macros.

Parameters:

<MacroLabel> string

Label to be assigned to the macro.
The label is used to execute the macro and to reference it in other macro commands.

<MacroSequence> string | block

String or block data element defining the macro contents, typically a sequence of remote control commands.
#0 introduces a data block of indefinite length.

Example: See Example "To configure common macro commands" on page 700.

***EMC** <Boolean>

Enables or disables the execution of all macros that are defined for the active remote connection.

Note: In contrast to SCPI specifications, macro execution is disabled by default.

Parameters:

<Boolean> ON | OFF | 1 | 0

Boolean value to enable or disable macro execution. In the disabled state (OFF / 0), macros in a command sequence are not expanded. The R&S SMM100A issues an error message: `113, Undefined header;<MacroLabel>`.

*RST: 0

Example: See Example "To configure common macro commands" on page 700.

***GMC?** <MacroLabel>, <MacroSequence>

Returns the contents of a macro.

Parameters:

<MacroLabel> string

<MacroSequence> block

Block data element containing the macro contents.

Example: See Example "To configure common macro commands" on page 700.

Usage: Query only

***LMC?** <Label>

Returns the labels of all macros of the active connection.

Parameters:

<Label> string

Comma-separated list of strings.
An empty string indicates that no macros are defined for the active connection.

Example: See Example "To configure common macro commands" on page 700.

Usage: Query only

***PMC**

Deletes all macros of the active remote connection.

Example: See Example "To configure common macro commands" on page 700.

Usage: Setting only

***RMC** <MacroLabel>

Deletes a macro.

Parameters:

<MacroLabel> string

Example: See Example "To configure common macro commands" on page 700.

Usage: Setting only

MMEMory:LOAD:MACRo <MacroLabel>, <MacroFile>

Creates a macro, reading the macro contents from a file. If the label exists already, the macro contents are overwritten.

Avoid using labels that are identical to supported remote control commands. In contrast to SCPI stipulations, remote commands have priority over macros.

Parameters:

<MacroLabel> string

Label to be assigned to the macro.
The label is used to execute the macro and to reference it in other macro commands.

<MacroFile> string

Path and filename of the source file on the instrument

Example: See Example "To configure common macro commands" on page 700.

Usage: Event

MMEMory:STORe:MACRo <MacroLabel>, <MacroFile>

Saves the contents of a macro to a file.

If the file exists, it is overwritten. If the file does not exist, it is created.

Parameters:

<MacroLabel> string

<MacroFile> string

Path and filename of the destination file on the instrument.

Example: See Example "To configure common macro commands" on page 700.

Usage: Event

12.12 References

12.12.1 LXI functionality

LAN Extensions for Instrumentation (LXI) is an instrumentation platform for measuring instruments and test systems that is based on standard Ethernet technology.

LXI is intended to be the LAN-based successor to GPIB, combining the advantages of Ethernet with the simplicity and familiarity of GPIB. Like GPIB, LXI determines and standardizes the way the instrument behaves in a LAN.

The LXI implementation in the R&S SMM100A allows you to change certain LAN settings, to reset the LAN connection, and to identify the instrument.

For information about the LXI standard, refer to the LXI website at https://www.lxistandard.org.

See also "News from Rohde & Schwarz, article 2006/II - 190".

The LXI functionality in the R&S SMM100A is characterized by a common LAN implementation, including an ICMP ping responder for diagnostics. Using a web browser, you can configure the instrument. A LAN Configuration Initialize (LCI) mechanism resets the LAN configuration. The instrument also supports automatic detection in a LAN via the VXI-11 discovery protocol and programming by IVI drivers.

In addition, the R&S SMM100A provides the following LXI-related functionality:

- Integrated "LXI Status" dialog for LXI status indication and reset of the LAN configuration, see Section 12.6, "LXI status settings", on page 660.
- "LXI Browser Interface", as described in Section 12.7.1, "LAN configuration", on page 664.
- "SCPI Remote Trace" utility, see Section 12.7.2, "SCPI remote trace", on page 666.

Firmware update

To enable the full LXI functionality after a firmware update, shut down and restart the instrument.

12.12.2 Code generator templates

This section describes the main structure of the code generator templates, and shows the method with the NICVI template.

The code generation is controlled by templates with the following blocks:

Command	Function
`#EXTENSION_START` `#EXTENSION_END`	Defines the output file extension.
`#INIT_CODE_START` `#INIT_CODE_END`	Contains initial entries, such as included files and libraries, buffer size, commands for synchronization, or creating a VISA session. All entries between start and end are written once at the beginning of the output file.
`#COMMAND_CODE_START` `#COMMAND_CODE_END`	Frame for a SCPI command. A command is accessed with `%COMMAND`.
`#NO_COMMAND_CODE_START` `#NO_COMMAND_CODE_END`	Frame for a parameter with no SCPI command available. A parameter is accessed with `%PARAMETER`.
`#EXIT_CODE_START` `#EXIT_CODE_END`	Closes the visa session. All entries between start and end are written once at the end of the output file.

Templates are created in ASCII format with file extension `*.expcodetempl`.

Example:

Example to the code generator template `NICVI.expcodetmpl`:

```
#EXTENSION_START
.c
#EXTENSION_END

#INIT_CODE_START
#include <ansi_c.h>
#include <visa.h>
#include <cvirte.h>

#define MAX_BUFFER_SIZE 200
static ViStatus status;
static ViSession defaultRM, handle;

static void write_command(char *command)
{
  char writeBuffer[MAX_BUFFER_SIZE];
        char readBuffer[MAX_BUFFER_SIZE];
        int length;
        int readCount;

        strcpy(writeBuffer, command);
        //append "*OPC?" to sync
        strcat(writeBuffer, ";*OPC?");
        length = strlen (writeBuffer);
        writeBuffer[length]='\n';
        length = length+1;
        viWrite (handle, writeBuffer, length, VI_NULL);
        //read result
        viRead(handle, readBuffer, 100, &readCount);
}
int main (int argc, char *argv[])
{
  if (InitCVIRTE (0, argv, 0) == 0)
     return -1;    /* out of memory */
        //create a VISA session and return a handle to it
     viOpenDefaultRM (&defaultRM);
        //create a VISA session to the serial port and return a handle to it
        viOpen (defaultRM, (ViRsrc)"TCPIP::localhost::INSTR", VI_NULL, VI_NULL,
&handle);
#INIT_CODE_END

#COMMAND_CODE_START
  write_command("%COMMAND");
#COMMAND_CODE_END

#NO_COMMAND_CODE_START
  //no SCPI command available for parameter %PARAMETER !
#NO_COMMAND_CODE_END

#EXIT_CODE_START
```

```
  viClose (handle);
        viClose (defaultRM);
        return 0;
}
#EXIT_CODE_END
```

13 Remote control commands

In the following, all remote-control commands are presented in detail with their parameters and the ranges of numerical values.

For an introduction to remote control and the status registers, see Section 12, "Network operation and remote control", on page 625.

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- Programming examples 710
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- Preset commands 718
- MMEMory subsystem 720
- CALibration subsystem 732
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- FORMat subsystem 753
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- OUTPut subsystem 761
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- SOURce subsystem 797
- SYSTem subsystem 1054
- STATus subsystem 1084
- TEST subsystem 1088
- TRIGger subsystem 1095
- UNIT subsystem 1098

13.1 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 R&S SMM100A 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.
- *Factory preset values*
  Default parameter values that are reset only by factory preset.
- *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.

13.2 Programming examples

The corresponding sections of the same title provide simple programming examples for the R&S SMM100A. The purpose of these examples is to present all commands for a given task. Real applications require application-specific sets of commands and configurations.

The programming examples have been tested with a software tool which provides an environment for the development and execution of remote tests. To keep the examples as simple as possible, only the "clean" SCPI syntax elements are reported. Non-executable command lines start with two characters `//`, for example, comments.

At the beginning of the most remote control program, an instrument preset or reset is recommended to set the R&S SMM100A to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. `*CLS` also resets the status registers and clears the output buffer.

In all the examples we assume the following:

- A remote PC is connected to the instrument.
- The remote PC and the instrument are switched on.
- A connection between them is established.
- The security setting "System Config" > "Setup" > "Security" > "SCPI over LAN" is enabled.

13.3 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:

*CLS....711
*ESE....711
*ESR?....711
*IDN?....712
*IST?....712
*OPC....712
*OPT?....712
*PRE....713
*PSC....713
*RCL....713
*RST....713
*SAV....714
*SRE....714
*STB?....714
*TRG....714
*TST?....715
*WAI....715

***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>"

Usage: Query only

Manual operation: See "IDN String" on page 647
See "Hardware Options/Software Options" on page 1110

***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 options. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed.

Usage: Query only

Manual operation: See "OPT String" on page 647
See "Hardware Options/Software Options" on page 1110

***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.

***RCL** <Number>

Recall

Loads the instrument settings from an intermediate memory identified by the specified number. The instrument settings can be stored to this memory using the command `*SAV` with the associated number.

It also activates the instrument settings which are stored in a file and loaded using the `MMEMory:LOAD <number>, <file_name.extension>` command.

Manual operation: See "Quick Recall x" on page 533

***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`.

Usage: Setting only

Manual operation: See "Preset" on page 525

***SAV** <Number>

Save

Stores the current instrument settings under the specified number in an intermediate memory. The settings can be recalled using the command `*RCL` with the associated number.

To transfer the stored instrument settings in a file, use the command `:MMEM:STOR:STAT`.

Manual operation: See "Quick Save x" on page 532

***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.

Usage: Event

***TST?**

Self-test query

Initiates self-tests of the instrument and returns an error code.

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

13.4 Macro commands

The following remote control commands are related to macro files and macro execution.

R&S SMM100A-specific command properties

The following macro command properties differ from SCPI regulations:

- The `*RST` state of `*EMC` is `OFF`. To use macros, enable the macro execution for the used remote connection.
- Normal remote control execution has priority over macro execution. Macros that have the same name as a remote command supported by the R&S SMM100A are ignored.

*DMC....716
*EMC....716
*GMC?....716
*LMC?....717
*PMC....717
*RMC....717
MMEMory:LOAD:MACRo....717
MMEMory:STORe:MACRo....718

***DMC**

Creates a macro. If the label exists already, the macro contents are overwritten.

Macros are deleted when a remote connection is closed but can be saved to a macro file for later reuse via the following command:

`MMEMory:STORe:MACRo` on page 705

Avoid using labels that are identical to supported remote control commands. In contrast to SCPI stipulations, remote commands have priority over macros.

Parameters:

<MacroLabel> string

Label to be assigned to the macro.
The label is used to execute the macro and to reference it in other macro commands.

<MacroSequence> string | block

String or block data element defining the macro contents, typically a sequence of remote control commands.
#0 introduces a data block of indefinite length.

Example: See Example "To configure common macro commands" on page 700.

***EMC** <Boolean>

Enables or disables the execution of all macros that are defined for the active remote connection.

Note: In contrast to SCPI specifications, macro execution is disabled by default.

Parameters:

<Boolean> ON | OFF | 1 | 0

Boolean value to enable or disable macro execution. In the disabled state (OFF / 0), macros in a command sequence are not expanded. The R&S SMM100A issues an error message: `113, Undefined header;<MacroLabel>`.

*RST: 0

Example: See Example "To configure common macro commands" on page 700.

***GMC?** <MacroLabel>, <MacroSequence>

Returns the contents of a macro.

Parameters:

<MacroLabel> string

<MacroSequence> block

Block data element containing the macro contents.

Example: See Example "To configure common macro commands" on page 700.

Usage: Query only

***LMC?** <Label>

Returns the labels of all macros of the active connection.

Parameters:

<Label> string

Comma-separated list of strings.
An empty string indicates that no macros are defined for the active connection.

Example: See Example "To configure common macro commands" on page 700.

Usage: Query only

***PMC**

Deletes all macros of the active remote connection.

Example: See Example "To configure common macro commands" on page 700.

Usage: Setting only

***RMC** <MacroLabel>

Deletes a macro.

Parameters:

<MacroLabel> string

Example: See Example "To configure common macro commands" on page 700.

Usage: Setting only

MMEMory:LOAD:MACRo <MacroLabel>, <MacroFile>

Creates a macro, reading the macro contents from a file. If the label exists already, the macro contents are overwritten.

Avoid using labels that are identical to supported remote control commands. In contrast to SCPI stipulations, remote commands have priority over macros.

Parameters:

<MacroLabel> string

Label to be assigned to the macro.
The label is used to execute the macro and to reference it in other macro commands.

<MacroFile> string

Path and filename of the source file on the instrument

Example: See Example "To configure common macro commands" on page 700.

Usage: Event

MMEMory:STORe:MACRo <MacroLabel>, <MacroFile>

Saves the contents of a macro to a file.

If the file exists, it is overwritten. If the file does not exist, it is created.

Parameters:

<MacroLabel> string

<MacroFile> string

Path and filename of the destination file on the instrument.

Example: See Example "To configure common macro commands" on page 700.

Usage: Event

13.5 Preset commands

The preset commands are not bundled in one subsystem. Therefore, they are listed separately in this section.

In addition, a specific preset command is provided for each digital standard. These specific commands are described in the associated subsystems.

Four presetting actions are available:

- Activating the default state of all internal instrument functions (`*RST` on page 713). Functions that concern the integration of the instrument into a measurement setup are not changed, e.g. reference oscillator source settings.
- Activating the preset state of the parameters related to the selected signal path (`:SOURce<hw>:PRESet` on page 719)
- Activating the preset state of all parameters that are not related to the signal path (`:DEVice:PRESet` on page 719)
- Activating the original state of delivery (factory reset, `:SYSTem:FPReset` on page 719). Only functions that are protected by a password remain unchanged as well as the passwords themselves.

When resetting, the following deviation between remote and manual control exists:
In contrast to the [Preset] key, the SCPI commands `*RST` and `:SYSTem:PRESet` do not close open dialogs in the GUI.

:DEVice:PRESet 719
:SOURce<hw>:PRESet 719
:SYSTem:PRESet 719
:SYSTem:FPReset 719

:DEVice:PRESet

Presets all parameters which are not related to the signal path, including the LF generator.

Example: `DEV:PRES`
Presets all instruments settings that are not related to the signal path.

Usage: Event

:SOURce<hw>:PRESet

Presets all parameters which are related to the selected signal path.

Example: `SOUR:PRES`
Presets all settings that are related to signal path

Usage: Event

:SYSTem:PRESet

Triggers an instrument reset. This command has the same effect as:

- The [Preset] key.
  However, the command does not close open GUI dialogs like the key does.
- The `*RST` command

For an overview of the settings affected by the preset function, see Table 10-1

Example: `SYST:PRES`
All instrument settings (also the settings that are not currently active) are reset to their default values.

Usage: Setting only

:SYSTem:FPReset

Triggers an instrument reset to the original state of delivery.

Example: `SYST:FPR`
All instrument settings (also the settings that are not currently active) are reset to the factory values.

Usage: Event

Manual operation: See "Execute Factory Preset" on page 526

13.6 MMEMory subsystem

The `MMEMory` subsystem (Mass MEMory) contains the commands for managing files and directories as well as for loading and saving complete instrument settings in files.

Mass storage location

Without any additional measures, the R&S SMM100A stores user files on the internal memory or if connected, on a memory stick.

Both, the user directory `/var/user/` on the internal memory or the `/usb/` directory on the memory stick, can be used to **preserve** user-defined data. Any directory structure can be created.

The `/var/volatile` directory serves as a RAM drive and can be used to protect sensitive information. The data is available **temporarily**.

Default storage location

The R&S SMM100A stores user data in the user directory.

In the file system, user directory is always indicated as **`/var/user/`**.

In manual control, you access this directory via the "File Manager", see Section 10.9, "Using the file manager", on page 540. In remote control, you can query it with the command `:SYSTem:MMEMory:PATH:USER?`.

To query and change the default directory used for mass storage, use the command `:MMEMory:CDIRectory`.

13.6.1 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 and *is case-sensitive*, i.e it is distinguished between uppercase and lowercase letters.
- All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the filename).
- Avoid using special characters.
- Do not use slashes "\" and "/". These symbols are used in file paths.
- Avoid using the following filenames: `CLOCK$`, `CON`, `COM1 to COM4`, `LPT1 to LPT3`, `NUL` or `PRN`
  They are reserved by the operating system.

File extension

The file and the optional file *extension* are separated by a period sign. The R&S SMM100A distinguishes the files according to their extensions; each type of file is assigned to a specific file content and hence a specific file extension. Refer to Section A, "Available user files and file extensions", on page 1135 for an overview of the supported file extensions.

Wildcards

The two characters "*" and "?" function as "wildcards", i.e. they are used for selecting several files. The "?" character represents exactly one character, while the "*" character represents all characters up to the end of the filename. "*.*" therefore represents all files in a directory.

Filename and file path

When used in remote control commands, the parameter `<filename>` is specified as a string parameter with quotation marks. It can contain either the complete path including the root user directory `/var/user` and filename, or only the filename. The filename must include the file extension. The same applies for the directory `/var/volatile` and for the parameters `<directory_name>` and `<path>`.

Depending on how much information is provided, the values specified in the parameter or with the command `MMEM:CDIR` are used for the path and drive setting in the commands.

13.6.2 Handling files in the default or in a specified directory

For better overview and easy file handling, it is useful to save all user files in the user directory `/var/user` but rather organize them into subdirectories.

The command syntax defines two general ways to access files with user data in a *specific* directory:

- **Change the current default directory** for mass memory storage and then directly access the files in this default directory, like saved list files, files with user data or save/recall files.
  See Example "Save the user settings in a file in a specific directory" on page 722.
  The subsequent commands for file handling (select, delete, read out files in the directory, etc.) require only specification of the filename. File extension can be omitted; after syntax evaluation of the used command, the R&S SMM100A filters out the relevant files.
- Define the **complete file path**, including the user directory `/var/user`, created subdirectories and filename.
  As a rule, whenever a complete file path is determined, it overwrites a previously specified default directory.

The following example explains this rule as a principle. Exceptions of this general rule are stated in the description of the corresponding command. The programming examples in the following sections explain the general working principle with the commands for mass memory storage.

The same rule applies to the /var/volatile directory, see Example "To work with files in the volatile memory" on page 724.

Example: Save the user settings in a file in a specific directory

This example uses the commands for saving and loading files with custom digital modulation settings. We assume that the directory /var/user/DigMod is existing and contains the files SaveRecallTest.dm and dmSavRcl.dm.

```
// Set the default directory first
MMEMory:CDIRectory "/var/user/DigMod"
SOURce1:BB:DM:SETTing:CATalog?
// "SaveRecallTest","dmSavRcl"

// Specify only the file name; the extenssion *.dm is assigned automatically
SOURce1:BB:DM:SETTing:STORe "dmSettings"
SOURce1:BB:DM:SETTing:DELete "dmSavRcl"
SOURce1:BB:DM:SETTing:LOAD "SaveRecallTest"
SOURce1:BB:DM:SETTing:CATalog?
// "SaveRecallTest","dmSettings"
```

Working with the files of other subsystems or files containing the settings of a particular digital standard (e.g. SOURce1:BB:EUTRa:SETTing:...), is analogical.

Example: Load file with user data from a specific directory

This example shows how to use the custom digital modulation commands to set the data source and select a data list. We assume that the directory /var/user/lists is existing and contains the files dlist1.dm_iqd and myDList.dm_iqd.

```
// Select a data list file as data source
SOURce1:BB:DM:SOURce DLISt

// Query the data list files (*.dm_iqd) in the default directory
MMEMory:CDIRectory "/var/user/lists"
SOURce1:BB:DM:DLISt:CATalog?
// "dlist1","myDList"

// Specify the complete path to select a data list file (*.dm_iqd)
// in the specific directory
MMEMory:CDIRectory
SOURce1:BB:DM:DLISt:SELect "/var/user/lists/myDList"
SOURce1:BB:DM:DLISt:DELete "/var/user/lists/dlist1"
```

Working with other list files is analogous. These files can contain control lists (...:CLISt:...) or lists with modulation data (...:MLISt:...), or data list files of other subsystems or of a particular digital standard (like SOURce1:BB:EUTRa:...:DSELect).

13.6.3 Programming examples

To save and load current settings

Example:

This example shows two ways of how to save the current instrument setting in the file `settings.savrcltxt` in the directory `/var/user/savrcl`.

Before the instrument settings can be saved in a file, they have to be saved in an intermediate memory using common command `*SAV <number>`. The specified number is then used in the `:MMEMory:STORe:STATe` command.

Also, after loading a file with instrument settings with command `:MMEMory:LOAD:STATe`, these settings have to be activated with the common command `*RCL <number>`.

```
// Save the current settings in an intermediate memory with number 4.
*SAV 4
// To save the file into a specific directory, include the complete file path.
:MMEMory:STORe:STATe 4,"/var/user/savrcl/settings.savrcltxt"
// To save the file in the default directory, specify only the filename.
:MMEMory:CDIRectory  "/var/user/savrcl"
*SAV 4
:MMEMory:STORe:STATe 4,"settings.savrcltxt"
// Load the saved settings in the intermediate memory 4 and activate them.
:MMEMory:LOAD:STATe 4,"/var/user/settings.savrcltxt"
*RCL 4
```

To work with files and directories

Example:

This example shows how to list files in a directory, list the subdirectories, query the number of files in a directory, create directory, rename and delete files.

```
// Query the current default directory for mass storage,
// change the directory to the default user directory "/var/user"
// and read out the files in it
:MMEMory:CDIRectory?
// "/var/user/temp"
:MMEMory:CDIRectory
:MMEMory:CDIRectory?
// "/var/user/"
:MMEMory:CATalog?
// 1282630,8102817792,".,DIR,4096","..,DIR,4096","Log,DIR,4096",
// "settings.savrcltxt,BIN,16949","temp,DIR,4096","test,DIR,4096",
// "list.lsw,BIN,1245201"
// the directory "/var/user" contains the predefined directory "Log",
// the subdirectories "test" and "temp"
```

```
// as well as the files "settings.savrcltxt" and "list.lsw"

// query only the subdirectories of the current or specified directory
:MMEMory:DCATalog? "/var/user"
// ".","..","Log","temp","test"

// query only number of subdirectories in the current or specified directory
:MMEMory:DCATalog:LENGth? "/var/user"
// 5

// query number of files in the current or specified directory
:MMEMory:CATalog:LENGth? "/var/user"
// 7

// Create a new directory for mass memory storage in the specified directory
:MMEMory:MDIRectory "/var/user/new"

// Copy the file "settings.savrcltxt" into the new directory
:MMEMory:COPY "/var/user/settings.savrcltxt","/var/user/new/settings.savrcltxt"

// Rename the file "settings.savrcltxt" into the new directory
// and read out the files in this specific directory
:MMEMory:CDIRectory  "/var/user/new"
:MMEMory:MOVE "settings.savrcltxt","settings_new.savrcltxt"
:MMEMory:CATalog? "/var/user/new"
// 25141,8102789120,".,DIR,4096","..,DIR,4096","settings_new.savrcltxt,BIN,16949"

// Delete an empty directory, e.g. the "test" directory
:MMEMory:RDIRectory "/var/user/test"
// Delete the entire directory, including files and subdirectories
:MMEMory:RDIRectory:RECursive "var/user/test"
```

Example: To work with files in the volatile memory

This example shows how to work with files in the `/var/volatile` directory.

```
// Change the default directory for mass storage, read out the files, load a
// list mode file.
:MMEMory:CDIRectory "/var/volatile"
:MMEMory:CDIRectory?
// Response: "/var/volatile"
:MMEMory:CATalog?
// Response: "13928","525352960",".,DIR,60","..,DIR,4096","list.lst,BIN,9772"
:SOURce1:LIST:SELect "/var/volatile/list"
:SOURce1:FREQuency:MODE LIST
:OUTPut1:STATe 1
```

Example: To add binary and marker data to a file

This example shows how to add binary data or marker data to a file.

```
:MMEM:DATA:UNPR "NVWFM:/var/user/wave.wv",#220<I0Q0..IxQx>
// Adds the binary data <I0Q0..IxQx> in the file wave.wv and saves the file
// in the selected directory.
// The <I0Q0..IxQx> pairs result in 20 bytes or 5 I/Q samples, 2 bytes for the
// I component and the Q component each. <I0Q0..IxQx> is a placeholder; the
// actual ASCII values are not printable.
:MMEMory:DATA:UNPRotected? "NVWFM:/var/user/wave.wv"
:MMEMory:DATA:UNPR "NVMKR:/var/user/wave.wv",#15<M0M1…M5>
// Adds marker data <M0M1…M5> in the file wave.wv and saves the file in the
// selected directory. The values are printable values; these values make up
// only the 4 least significant bits of a byte.
:MMEMory:DATA:UNPRotected? "NVMKR:/var/user/wave.wv"
// Note that, the query returns binary values.
:SOURce1:BB:ARBitrary:WAVeform:CLOCk "/var/user/wave.wv",1.1E6
:SOURce1:BB:ARBitrary:WAVeform:CLOCk? "/var/user/wave.wv"
```

13.6.4 Remote control commands

:MMEMory:CATalog? 725
:MMEMory:CATalog:LENGth? 726
:MMEMory:CDIRectory 726
:MMEMory:COPY 726
:MMEMory:DATA 727
:MMEMory:DATA:UNPRotected 728
:MMEMory:DCATalog? 729
:MMEMory:DCATalog:LENGth? 729
:MMEMory:DELete 730
:MMEMory:LOAD:STATe 730
:MMEMory:MDIRectory 730
:MMEMory:MOVE 730
:MMEMory:MSIS 731
:MMEMory:RDIRectory 731
:MMEMory:RDIRectory:RECursive 731
:MMEMory:STORe:STATe 732
:MEMory:HFRee? 732

:MMEMory:CATalog?

Returns the content of a particular directory.

Return values:

<Catalog> string

String parameter to specify the directory.
If you leave out the path, the command returns the contents of the directory selected with `:MMEMory:CDIRectory`.
The path can be relative or absolute.

Example: See "To work with files and directories" on page 723.

Usage: Query only

Manual operation: See "Directory, File List and Filename" on page 531

:MMEMory:CATalog:LENGth? [<Path>]

Returns the number of files in the current or in the specified directory.

Query parameters:

<Path> string

String parameter to specify the directory. If the directory is omitted, the command queries the content of the current directory, queried with `:MMEMory:CDIRectory` command.

Return values:

<FileCount> integer

Number of files.

Example: See "To work with files and directories" on page 723.

Usage: Query only

:MMEMory:CDIRectory <Directory>

Changes the default directory for mass memory storage.

All following `MMEM` commands use the new directory, if you do not specify another directory explicitly in the command string.

Parameters:

<Directory> <directory_name>

Complete file path or relative file path of the target directory. To change to a higher directory, use two dots:
`:MMEMory:CDIRectory ".."`

Example: See "To work with files and directories" on page 723.

Manual operation: See "Directory, File List and Filename" on page 531
See "Directory and Filename" on page 541

:MMEMory:COPY <SourceFile>, <DestinationFile>

Copies an existing file to a new file. Instead of just a file, this command can also be used to copy a complete directory together with all its files.

Setting parameters:

<SourceFile> string

Complete file path or relative file path and filename of the source file.

<DestinationFile> string

Complete file path or relative file path and filename of the target file.
If `<DestinationFile>` is not specified, the `<SourceFile>` is copied to the current directory, queried with the `:MMEMory:CDIRectory` command.
Note: Existing files with the same name in the destination directory are overwritten without an error message.

Example: See "To work with files and directories" on page 723.

Usage: Setting only

Manual operation: See "Cut, Copy&Paste and Delete" on page 542

:MMEMory:DATA <Filename>, <BinaryData>
:MMEMory:DATA? <Filename>

The setting command writes the block data `<BinaryBlock>` to the file identified by `<Filename>`.

Tip: Use this command to read/transfer stored instrument settings or waveforms directly from/to the instrument.

Parameters:
<BinaryData>

Setting parameters:
<Filename> string

A string parameter to specify the name of the file.

Query parameters:
<Filename> #<number><length_entry><data>

`#`: Hash sign; always comes first in the binary block.
`<number>`: the first digit indicates how many digits the subsequent length entry has
`<length_entry>`: indicates the number of subsequent bytes
`<data>`: binary block data for the specified length.
For files with a size with more than nine digits (gigabytes), the instrument allows the syntax `#(<Length>)`, where `<Length>` is the file size in decimal format.

Example: `:MMEMory:DATA '/var/user/test.txt',#15hallo`
Writes the block data to the file `test.txt`.
The digit `1` indicates a length entry of one digit; the digit `5` indicate a length of the binary data (`hallo`) in bytes.
`:MMEMory:DATA? '/var/user/test.txt'`
Sends the data of the file `test.txt` from the instrument to the controller in the form of a binary block.
`Response: #15hallo`

:MMEMory:DATA:UNPRotected <Msus>, <Data>

The setting command sends the I/Q data and the marker data to the file defined with the `<Msus>` parameter. The required tags are created automatically so that the file content follows the waveform file format.

The query command reads out the I/Q data part or the marker information of the specified file.

Waveform files can also be created with the command `[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA`. In this case, the *complete content* of the waveform file must be specified, i.e. not only the I/Q or marker data but all required tags.

See also Section 4.6.5, "Tags for waveforms, data and control lists", on page 180.

Parameters:

<Msus> <Identifier>:<file name>

Mass Storage Unit Specifier
A string that specifies whether I/Q data (`NVWFM`) or marker data (`NVMKR`) is transferred and the filename the data is stored in.
If the file with the specified name does not exist, a file is created. Any existing content in the file is *overwritten*.
Complete file path and file extension can also be specified. If omitted, files are stored in the default directory and the extension `*.wv` is assigned to the filename.

Setting parameters:

<Data> block data

I/Q data or marker binary data, where the number of marker elements has to be equal to the number of I/Q samples.
Binary block data follows one of the following syntaxes:
`#<Digits><Length><I0Q0...IxQx...IN-1QN-1>`
`#<Digits><Length><M0M1...Mx...MN-1>`

#
Indicates the start of the data block.

<Digits>
Decimal value
Gives the number of decimal digits used for the `<Length>` value.

<Length>
Decimal value
Number of bytes the follow in the `<Binary data>` part.

I0Q0...IxQx…IN-1QN-1
Binary data in ASCII format
The expression `IxQx` represents binary data (16-bit signed integer in 2's complement notation) containing the I and Q component alternately and starting with the I component. Each I and Q component consists of 2 bytes in MSB format (the most significant byte first).
The values of the 2 bytes in an I component and a Q component are in the range: -32767 to +32767.

M0M1…Mx…MN-1
Binary data in ASCII format
The expression `Mx` represents one marker byte, where only the 4 least significant bits are used. These 4 bits are assigned to the 4 possible markers of the instrument, 1 bit per marker: Bit_0 = Marker 1 to Bit_3 = Marker 4.
One 4-bit marker element is required for every I/Q sample.

Example: See Example "To add binary and marker data to a file" on page 724.

:MMEMory:DCATalog?

Returns the subdirectories of a particular directory.

Return values:

<DCatalog> <file_entry>
Names of the subdirectories separated by colons. The first two strings are related to the parent directory.

Example: See "To work with files and directories" on page 723.

Usage: Query only

:MMEMory:DCATalog:LENGth? [<Path>]

Returns the number of subdirectories in the current or specified directory.

Query parameters:

<Path> string
String parameter to specify the directory. If the directory is omitted, the command queries the contents of the current directory, to be queried with `:MMEMory:CDIRectory` command.

Return values:

<DirectoryCount> integer
Number of the parent directory and subdirectories.

Example: See "To work with files and directories" on page 723.

Usage: Query only

:MMEMory:DELete <Filename>

Removes a file from the specified directory.

Setting parameters:

<Filename> string
Filename or complete file path

Example: See "To work with files and directories" on page 723.

Usage: Setting only

Manual operation: See "Cut, Copy&Paste and Delete" on page 542

:MMEMory:LOAD:STATe <SavRclStateNumb>, <file_name>

Loads the specified file stored under the specified name in an internal memory.

After the file has been loaded, the instrument setting must be activated using an `*RCL` command.

Setting parameters:

<SavRclStateNumb> Determines to the specific <number> to be used with the `*RCL` command, e.g. `*RCL 4`.

<filename> Filename with file extension `*.savrcltxt`.

Example: See "To save and load current settings" on page 723.

Usage: Setting only

Manual operation: See "Recall" on page 533

:MMEMory:MDIRectory <Directory>

Creates a subdirectory for mass memory storage in the specified directory. If no directory is specified, a subdirectory is created in the default directory. This command can also be used to create a directory tree.

Setting parameters:

<Directory> string
Specifies the complete file path of the new directory.

Example: See "To work with files and directories" on page 723.

Usage: Setting only

Manual operation: See "Create New Directory" on page 542

:MMEMory:MOVE <SourceFile>, <DestinationFile>

Moves an existing file to a new location or, if no path is specified, renames an existing file.

Setting parameters:

<SourceFile> string

Filename of the file that you want to move.

<DestinationFile> string

Filename of the new file.

Example: See "To work with files and directories" on page 723.

Usage: Setting only

Manual operation: See "Rename" on page 542

:MMEMory:MSIS <Path>

Defines the drive or network resource for instruments with windows operating system, using `msis` (MSIS = Mass Storage Identification String).

Note: Instruments with the Linux operating system ignore this command, since Linux does not use drive letter assignment.

Example: See "To save and load current settings" on page 723.

:MMEMory:RDIRectory <Directory>

Removes an empty directory from the mass memory storage system. If no directory is specified, the subdirectory with the specified name is deleted in the default directory.

Setting parameters:

<Directory> string

Specifies the complete file path or relative file path of the directory that you want to delete.

Example: See "To work with files and directories" on page 723.

Usage: Setting only

:MMEMory:RDIRectory:RECursive <Directory>

Removes the specified directory, including files and subdirectories from the mass memory storage system. If no directory is specified, the command removes the subdirectories of the default directory.

The command the entire directory without further prompt or notification.

Setting parameters:

<Directory> string

String parameter to specify the directory to be deleted.

Example: See "To work with files and directories" on page 723.

Usage: Setting only

:MMEMory:STORe:STATe <savrcl_state_nr>, <file_name>

Saves the current instrument setting in the specified file.

Save the instrument settings to the internal memory with the same number using the common command `*SAV`.

Setting parameters:

<savrcl_state_nr> Corresponds to the specific `<number>` defined with the `*SAV` command, e.g. `*SAV 4`.

<filename> Filename with file extension `*.savrcltxt`.

Example: See "To save and load current settings" on page 723.

Usage: Event

Manual operation: See "Save" on page 532

:MEMory:HFRee?

Returns the used and available memory in Kb.

Return values:

<TotalPhysMemKb> integer
Total physical memory.

<ApplicMemKb> integer
Application memory.

<HeapUsedKb> integer
Used heap memory.

<HeapAvailableKb> integer
Available heap memory.

Usage: Query only

13.7 CALibration subsystem

The `CALibration` subsystem contains the commands needed for performing internal adjustments. This procedure is triggered by the query commands.

Common suffixes

The following common suffixes are used in the remote commands:

Suffix	Value range	Description
`CALibration<hw>`	[1]	Optional suffix

Understanding the query response

- `0`: error-free execution of the adjustments
- `1`: indicates that an error occurred; the process has been canceled

Example: Querying the most recent internal adjustments

```
CALibration:ALL:DATE?
"2024-07-16"
CALibration:ALL:INFormation?
"" // no adjustment info available
CALibration:ALL:TEMP?
"-2.0 K"
CALibration:ALL:TIME?
"17 days"
```

:CALibration:ALL[:MEASure]?..... 733
:CALibration<hw>:ALL:DATE?..... 734
:CALibration<hw>:ALL:INFormation?..... 734
:CALibration<hw>:ALL:TEMP?..... 734
:CALibration<hw>:ALL:TIME?..... 734
:CALibration<hw>:CONTinueonerror..... 735
:CALibration:DATA:EXPort..... 735
:CALibration:DATA:FACTory:DATE?..... 735
:CALibration:DELay:MINutes..... 735
:CALibration:DELay:SHUTdown[:STATe]..... 736
:CALibration:DELay[:MEASure]?..... 736
:CALibration<hw>:DEBug..... 736
:CALibration<hw>:IQModulator:LOCal?..... 737
:CALibration<hw>:FREQuency:CONVerter:EXTernal?..... 737
:CALibration<hw>:LOSCillator:COUPling:LOCal?..... 737

:CALibration:ALL[:MEASure]? [<Force>]

Starts all internal adjustments that do not need external measuring equipment.

Note: If an external frequency converter R&S SZU is connected, the internal adjustments are blocked, and the R&S SMM100A generates an error message.

Query parameters:

<Force> string

Return values:

<Measure> 1 | ON | 0 | OFF

Example:

```
CAL:ALL:MEAS?
// Response: "0"
// Executes the adjustments of all instrument functions.
// When completed, it indicates that the adjustment
// has been performed successfully.
```

Usage: Query only

Manual operation: See "Adjust All" on page 1126

:CALibration<hw>:ALL:DATE?

Queries the date of the most recently executed full adjustment.

Suffix:
<hw> [1]
Optional suffix

Return values:
<Date> string

Example: See Example "Querying the most recent internal adjustments" on page 733.

Usage: Query only

Manual operation: See "Last Full Adjustment" on page 1126

:CALibration<hw>:ALL:INFormation?

Queries the current state of the internal adjustment.

Return values:
<CalInfoText> string

Example: See Example "Querying the most recent internal adjustments" on page 733.

Usage: Query only

Manual operation: See "Information" on page 1127

:CALibration<hw>:ALL:TEMP?

Queries the temperature deviation compared to the calibration temperature.

Suffix:
<hw> [1]
Optional suffix

Return values:
<Temperature> string

Example: See Example "Querying the most recent internal adjustments" on page 733.

Usage: Query only

Manual operation: See "Temperature Offset" on page 1127

:CALibration<hw>:ALL:TIME?

Queries the time elapsed since the last full adjustment.

Return values:
<Time> string

Example: See Example "Querying the most recent internal adjustments" on page 733.

Usage: Query only

Manual operation: See "Time" on page 1126

:CALibration<hw>:CONTinueonerror <State>

Continues the calibration even though an error was detected. By default adjustments are aborted on error.

Suffix:
<hw> [1]
Optional suffix

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example:
```
CAL:CONT ON
// Continues calibration after an error
```

Manual operation: See "Continue Adjustment on Error" on page 1127

:CALibration:DATA:EXPort

Collects the internal adjustment data and provides the data for export in a zip file. You can export the data for service and evaluation purposes.

Example:
```
:CALibration:DATA:EXPort
```

Usage: Event

:CALibration:DATA:FACTory:DATE?

Queries the date of the last factory calibration.

Return values:
<Date> string

Example:
```
CAL:DATA:FACT:DATE?
// "2016-01-01"
```

Usage: Query only

Manual operation: See "Last Full Factory Adjustment" on page 1109

:CALibration:DELay:MINutes <Minutes>

Sets the warm-up time to wait before internal adjustment starts automatically.

Automatic execution starts only, if you have enabled the calibration with command `:CALibration:DELay[:MEASure]? ON`.

Parameters:
<Minutes> integer
Range: 30 to 120
*RST: n.a. (no preset. default: 60)

Example:
```
:CALibration:DELay:MINutes 30
// sets the time delay for warm-up of the instrument.
```

Manual operation: See "Warm Up Time" on page 1128

:CALibration:DELay:SHUTdown[:STATe] <Shutdown>

Enables the instrument to shut down automatically after calibration.

Parameters:
<Shutdown> 1 | ON | 0 | OFF
*RST: 0

Example:
```
:CALibration:DELay:SHUTdown[:STATe] ON|1
// inititates that the instrument shuts down when the adjustments are com
```

Manual operation: See "Shutdown After Adjustment" on page 1128

:CALibration:DELay[:MEASure]?

Starts the delayed adjustment process. When the warm-up time has elapsed (see `:CALibration:DELay:MINutes`, it executes the internal adjustments.

If you have enabled automatic shutdown, `:CALibration:DELay:SHUTdown[:STATe] ON`, the instrument shuts down when the adjustments are completed.

Return values:
<Error> 1 | ON | 0 | OFF
*RST: n.a. (no preset. default: 0)

Example:
```
:CALibration:DELay[:MEASure] ON|1
// enables the adjustment processs to start after the warm-up time automa
```

Usage: Query only

Manual operation: See "Adjust All Delayed" on page 1128

:CALibration<hw>:DEBug <State>

Activates logging of the internal adjustments.

Suffix:
<hw> [1]
Optional suffix

Setting parameters:
<State> 0 | 1 | OFF | ON
*RST: 0

Example: `CALibration:DEBug 1`

Usage: Setting only

Manual operation: See "Log Debug Info" on page 1127

:CALibration<hw>:IQModulator:LOCal?

Starts adjustment of the I/Q modulator for the currently set frequency and baseband gain. The I/Q modulator is adjusted with respect to carrier leakage, I/Q imbalance and quadrature.

Return values:

<Local> 1 | ON | 0 | OFF

*RST: 0

Example:

```
// Start adjustment for the I/Q modulator
// for the currently set frequency
CALibration:IQModulator:LOCal?
// 0
// Adjustments are performed successfully
```

Usage: Query only

Manual operation: See "Adjust I/Q Modulator Current Frequency" on page 1127

:CALibration<hw>:FREQuency:CONVerter:EXTernal?

Queries the calibration state of the connected external instrument.

External instrument can be for example an external frontend.

Return values:

<Success> 1 | ON | 0 | OFF

*RST: 0

Example:

```
// Query calibration state of a connected external frontend.
CAL1:FREQ:CONV:EXT?
// 1
// The external frontend connected in path A is calibrated.
```

Usage: Query only

Manual operation: See "Adjust External Frequency Converter" on page 1127

:CALibration<hw>:LOSCillator:COUPling:LOCal?

Adjusts the internal LO level at the I/Q modulator automatically, when an external LO signal is fed.

Return values:

<CouplingLevel> 1 | ON | 0 | OFF

*RST: 1

Example: CALibration:LOSCillator:COUPling:LOCal 1

Usage: Query only

Manual operation: See "Adjust LO Level at Current Frequency" on page 331

13.8 DIAGnostic subsystem

The DIAGnostic subsystem contains the commands used for instrument diagnosis and servicing. SCPI does not define any DIAGnostic commands; the commands listed here are all device-specific. All DIAGnostic commands are query commands which are not affected by *RST.

The test functions are intended for services purposes.
They are thus password-protected functions. Unlock the corresponding protection level to access them, see :SYSTem:PROTect<ch>[:STATe].
For more information, see R&S SMM100A Service Manual.

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
DIAGnostic<hw>	[1]	Optional suffix

Example: Programming example

The example lists the commands required to query assemblies and test points for diagnosis purposes.

```
// Query the modules available in the instrument
// and variant and revision state of a certain assembly
DIAGnostic1:BGINfo:CATalog?
// IEC_BOARD,BNC_BOARD,BBMB,FPNL,SSYN,SYNEX,RFMB,...

DIAGnostic1:BGINfo? "SSYN"
// SSYN 1412.6667.02 05.02 100000

// Query the test points available in the instrument
// and trigger the measurement in a selected test point

DIAGnostic1:POINt:CATalog?
// ASATT6HP_M5V7,ASATT6HP_OFFSET,...

// Select the test point to be measured
DIAGnostic1:POINt:CONFiguration  "BGU","POINT","DATA"

DIAGnostic1:MEASure:POINt? "BBB_CODER_BBB_US"
// -1.000000V/°C

// Query the operating hours and number of power-on so far.
DIAGnostic:INFO:OTIMe?
// 112 h
DIAGnostic:INFO:POCount?
// 14
```

Commands

:DIAGnostic<hw>:BGINfo:CATalog?....739
:DIAGnostic<hw>:BGINfo?....740
:DIAGnostic:INFO:OTIMe?....740
:DIAGnostic:INFO:POCount?....740
:DIAGnostic<hw>:POINt:CATalog?....741
:DIAGnostic<hw>[:MEASure]:POINt?....741

:DIAGnostic<hw>:BGINfo:CATalog?

Queries the names of the assemblies available in the instrument.

Return values:

<Catalog> string

List of all assemblies; the values are separated by commas
The length of the list is variable and depends on the instrument equipment configuration.

Example: See Example "Programming example" on page 739.

Usage: Query only

:DIAGnostic<hw>:BGINfo? [<Board>]

Queries information on the modules available in the instrument, using the variant and revision state.

Query parameters:

<Board> string

Module name, as queried with the command `:DIAGnostic<hw>:BGINfo:CATalog?`.
To retrieve a complete list of all modules, omit the parameter.
The length of the list is variable and depends on the instrument equipment configuration.

Return values:

<BgInfo> <Module name> <Module stock number incl. variant> <Module revision> <Module serial number>

List of comma-separated entries, one entry per module.
Each entry for one module consists of four parts that are separated by space characters.

Example: See Example "Programming example" on page 739.

Usage: Query only

Manual operation: See "Assembly" on page 1109

:DIAGnostic:INFO:OTIMe?

Queries the operating hours of the instrument so far.

Return values:

<OperationTime> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Programming example" on page 739.

Usage: Query only

Manual operation: See "Operation Time / h" on page 1109

:DIAGnostic:INFO:POCount?

Queris how often the instrument has been turned on so far.

Return values:

<PowerOnCount> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Programming example" on page 739.

Usage: Query only

Manual operation: See "Power On Count" on page 1109

:DIAGnostic<hw>:POINt:CATalog?

Queries the test points available in the instrument.

For more information, see R&S SMM100A Service Manual.

Return values:

<Catalog> string
List of comma-separated values, each representing a test point

Example: See Example "Programming example" on page 739.

Usage: Query only

:DIAGnostic<hw>[:MEASure]:POINt? <Name>

Triggers the voltage measurement at the specified test point and returns the measured voltage.

For more information, see R&S SMM100A Service Manual.

Query parameters:

<Name> <test point identifier>
Test point name, as queried with the command `:DIAGnostic<hw>:POINt:CATalog?` on page 741

Return values:

<Value> <value><unit>

Example: See Example "Programming example" on page 739.

Usage: Query only

13.9 HUMS remote control commands

The remote control commands for the health and utilizations monitoring system (HUMS) comprise commands of the `DIAGnostic` subsystem and the commands of the `SYSTem:COMMunicate:REST` and `SYSTem:COMMunicate:REST` subsystems.

For all HUMS-related remote control commands, see refer to the "R&S®HUMS Health and Utilization Monitoring Service" User Manual on the Internet.

Commands

DIAGnostic:HUMS:DELete:ALL 742
DIAGnostic:HUMS:DEVice:HISTory? 742
DIAGnostic:HUMS:DEVice:HISTory:DELete:ALL 743
DIAGnostic:HUMS:FORMat 743
DIAGnostic:HUMS:SAVE 743
DIAGnostic:HUMS:STATe 744

DIAGnostic:HUMS:TAGS:ALL? 744
DIAGnostic:HUMS:TAGS:DELete 744
DIAGnostic:HUMS:TAGS:DELete:ALL 745
DIAGnostic:HUMS:TAGS[:VALue] 745
SYSTem:COMMunicate:REST:ENABle 745
SYSTem:COMMunicate:SNMP:COMMunity:RO 746
SYSTem:COMMunicate:SNMP:COMMunity:RW 746
SYSTem:COMMunicate:SNMP:CONTact 746
SYSTem:COMMunicate:SNMP:LOCation 747
SYSTem:COMMunicate:SNMP:USM:USER 747
SYSTem:COMMunicate:SNMP:USM:USER:ALL? 747
SYSTem:COMMunicate:SNMP:USM:USER:DELete 748
SYSTem:COMMunicate:SNMP:USM:USER:DELete:ALL 748
SYSTem:COMMunicate:SNMP:VERSion 748

DIAGnostic:HUMS:DELete:ALL

Deletes the complete HUMS data. This includes device history, device tags, SCPI connections, utilization history and utilizations.

Example: //Delete HUMS data
`DIAG:HUMS:DEL:ALL`

Usage: Event

DIAGnostic:HUMS:DEVice:HISTory?

Queries the device history information of the connected instrument. Depending on the set data format, the queried data is either displayed in `XML` or `JSON` format. For more information about setting the data format, see `DIAGnostic:HUMS:FORMat` on page 743.

Return values:

<HistoryInfo> <block_data>

Device history information of the connected instrument as block data in a comma-separated list:
`#blockdata[{event1},{event2},{event3}...]`
With the following parameters:
`<eventID>,<eventTimestamp>,<eventMessage>,<eventDetails>,<eventSeverity>`
Binary block data with the following syntax:
`#<Digits><Length><Binarydata>`
#
Indicates the start of the binary block
<Digits>
Decimal value
Gives the number of decimal digits used for the `<Length>` value
<Length>
Decimal value

Number of bytes the follow in the <Binary data> part
<Binary data>
Binary data in ASCII format

Example: //Return device history
DIAG:HUMS:DEV:HIST?
Returns for example:
#44715[{"eventId":32,"eventTimestamp":
"2021-02-02T17:25:39Z","eventMessage":
"Deviation from Self Alignment Temperature",
"eventDetails":
"Deviations resolved","eventSeverity":0}

Usage: Query only

Manual operation: See "Export History" on page 651

DIAGnostic:HUMS:DEVice:HISTory:DELete:ALL

Deletes the complete device history information of the connected instrument.

Example: //Delete complete device history
DIAG:HUMS:DEV:HIST:DEL:ALL

Usage: Event

Manual operation: See "Delete History" on page 651

DIAGnostic:HUMS:FORMat <DataFormat>

Selects the format for the queried HUMS data. You can query the HUMS data either in JSON format or XML format.

The defined format affects all other commands that return block data.

Parameters:
<DataFormat> JSON | XML

JSON
Returns the HUMS data in JSON format.

XML
Returns the HUMS data in XML format.

*RST: JSON

Example: //Return data in JSON format
DIAG:HUMS:FORM JSON

DIAGnostic:HUMS:SAVE <path>

Saves the HUMS history as a ZIP file to your preferred path.

Setting parameters:
<path>

Example: //Save HUMS history data
```
DIAG:HUMS:SAVE 'C:\HUMS\hums_2021.zip'
```

Usage: Setting only

Manual operation: See "Export History" on page 651

DIAGnostic:HUMS:STATe <State>

Turns the HUMS service and data collection on and off.

Parameters:

<State> ON | OFF | 1 | 0
*RST: ON

Example: //Turn on HUMS service
```
DIAG:HUMS:STAT ON
```

Manual operation: See "State" on page 651

DIAGnostic:HUMS:TAGS:ALL?

Queries all key-value tags that you have assigend to the instrument. Depending on the set data format, the queried data is either displayed in `XML` or `JSON` format. For more information about setting the data format, see `DIAGnostic:HUMS:FORMat` on page 743.

Return values:

<ID> ID number of the defined tag.

<Key> String containing key name of the defined tag.

<Value> String containing value of the defined tag.

Example: //Return all tags
```
DIAG:HUMS:TAGS:ALL?
1,"location","building_11",2,"time zone","CET"
```

Usage: Query only

Manual operation: See "Add" on page 659

DIAGnostic:HUMS:TAGS:DELete <ID>

Deletes a certain tag you assigned to your instrument, including its key and value.

Setting parameters:

<ID> ID number of the tag you want to delete.
To identify the ID number, query all device tags from the system first. For more information, see `DIAGnostic:HUMS:TAGS:ALL?` on page 744.

Example: //Delete tag
```
DIAG:HUMS:TAGS:DEL 0
```

Usage: Setting only

Manual operation: See "Delete" on page 659

DIAGnostic:HUMS:TAGS:DELete:ALL

Deletes all key-value tags you have assigned to the instrument.

Example: //Delete all tags
```
DIAG:HUMS:TAGS:DEL:ALL
```

Usage: Event

Manual operation: See "Delete All" on page 659

DIAGnostic:HUMS:TAGS[:VALue] <ID>, <Key>, <Value>
DIAGnostic:HUMS:TAGS[:VALue]? <ID>

Adds or modifies a key-value pair (device tag).

The query returns the key-value pair for a given ID or an empty string if the ID is unknown.

Parameters:

<Key> String containing key name of the queried tag.

<Value> String containing value of the queried tag.

Parameters for setting and query:

<ID> 0 - 31
ID number of the tag you want to modify or query.
To identify the ID number, query all device tags from the system first. For more information, read here `DIAGnostic:HUMS:TAGS:ALL?` on page 744.

Example: //Add or modify a tag (tag 1)
```
DIAG:HUMS:TAGS 1,'location','building_11'
```

Manual operation: See "Key" on page 659
See "Value" on page 659
See "Add" on page 659

SYSTem:COMMunicate:REST:ENABle <RestState>

Turns communication via the REST API on and off.

Parameters:

<RestState> ON | OFF | 0 | 1

Example: //Return REST state
```
SYST:COMM:REST:ENAB?
```

Manual operation: See "REST" on page 653

SYSTem:COMMunicate:SNMP:COMMunity:RO <CommunityString>

Defines the SNMP community string for read-only access.

Prerequisites for this command:

- Select an SNMP version that supports communities (`SYSTem:COMMunicate:SNMP:VERSion` on page 748).

Setting parameters:

<CommunityString> String containing the community name.

Example:

```
//Set community name
SYST:COMM:SNMP:VERS V12
SYST:COMM:SNMP:COMM:RO 'ABC'
```

Usage: Setting only

Manual operation: See "Read Only Community" on page 654

SYSTem:COMMunicate:SNMP:COMMunity:RW <CommunityString>

Defines the SNMP community string for read-write access.

Prerequisites for this command:

- Select an SNMP version that supports communities (`SYSTem:COMMunicate:SNMP:VERSion` on page 748).

Setting parameters:

<CommunityString> String containing the community name.

Example:

```
//Set read-write access
SYST:COMM:SNMP:VERS V12
SYST:COMM:SNMP:COMM:RW 'ABC'
```

Usage: Setting only

Manual operation: See "Read&Write Community" on page 654

SYSTem:COMMunicate:SNMP:CONTact <SnmpContact>

Defines the SNMP contact information for the administrator.

You can also set the contact information via SNMP if you do not set it via SCPI.

Parameters for setting and query:

<SnmpContact> String containing SNMP contact.

*RST: "" (empty string)

Example:

```
//Set SNMP contact
SYST:COMM:SNMP:CONT 'ABC'
```

Manual operation: See "Contact" on page 653

SYSTem:COMMunicate:SNMP:LOCation <SnmpLocation>

Defines the SNMP location information for the administrator.

You can also set the location information via SNMP if you do not set it via SCPI.

Parameters for setting and query:

<SnmpLocation> String containing SNMP location.
*RST: "" (empty string)

Example: //Return SNMP location
`SYST:COMM:SNMP:LOC?`

Manual operation: See "Location" on page 653

SYSTem:COMMunicate:SNMP:USM:USER <Name>, <Access>, <Level>[, <Auth_pwd>[, <Priv_pwd>]]

Defines an SNMP user profile.

Prerequisites for this command:

- Select SNMPv3 (`SYSTem:COMMunicate:SNMP:VERSion` on page 748).

Setting parameters:

<Name> String containing name of the user.

<Access> RO | RW
Defines the access right a user can have.

<Level> NOAuth | AUTH | PRIVacy
Defines the security level.

<Auth_pwd> String containing the authentication password.

<Priv_pwd> String containing the privacy password.

Example: //Create user profile
```
SYST:COMM:SNMP:VERS V123
SYST:COMM:SNMP:USM:USER 'Peter','RO','PRIV',
'1234','XYZ'
```

Usage: Setting only

Manual operation: See "Add SNMP User for HUMS" on page 656

SYSTem:COMMunicate:SNMP:USM:USER:ALL?

Queries the number of users and a list of all SNMP users for SNMPv3.

Prerequisites for this command:

- Select SNMPv3 (`SYSTem:COMMunicate:SNMP:VERSion` on page 748).

Return values:

<Count> Total number of registered SNMP users.

<Name> List of all user names as a comma-separated list.

Example: //Return all SNMP users
```
SYST:COMM:SNMP:USM:USER:ALL?
```

Usage: Query only

Manual operation: See "User table" on page 655

SYSTem:COMMunicate:SNMP:USM:USER:DELete <UserName>

Deletes a specific SNMP user profile.

Setting parameters:

<UserName> String containing name of SNMP user profile to be deleted.

Example: //Delete SNMP user profile
```
SYST:COMM:SNMP:USM:USER:DEL "Peter"
```

Usage: Setting only

Manual operation: See "Delete" on page 656

SYSTem:COMMunicate:SNMP:USM:USER:DELete:ALL

Deletes all SNMP user profiles.

Example: //Delete all SNMP user profiles
```
SYST:COMM:SNMP:USM:USER:DEL:ALL
```

Usage: Event

Manual operation: See "Delete All" on page 655

SYSTem:COMMunicate:SNMP:VERSion <SnmpVersion>

Selects the SNMP version.

Parameters for setting and query:

<SnmpVersion> OFF | V12 | V123 | V3 | DEFault

OFF
SNMP communication is off.

V12
SNMP communication with SNMPv2 or lower.

V123
SNMP communication with SNMPv2 and SNMPv3.

V3
SNMP communication with SNMPv3.

*RST: V123

Example: //Select the SNMP version
```
SYST:COMM:SNMP:VERS V12
```

Manual operation: See "SNMP" on page 653

13.10 DISPlay subsystem

The DISPlay system contains the commands to set the power-save mode of the instrument.

Example: To use the screen saver and display update

Use the following commands to switch on the screen saver of your instrument or to automatic display. These settings are particularly useful when you control the instrument remotely.

```
// Set the wait time interval and activate the screen saver.
:DISPlay:PSAVe:HOLDoff 10
:DISPlay:PSAVe:STATe ON

// Disable the display of the frequency and level values in remote control.
:DISPlay:ANNotation:ALL "<SecPassWord>", ON
// DISPlay:ANNotation:FREQuency "<SecPassWord>", ON
// DISPlay:ANNotation:AMPLitude "<SecPassWord>", ON

// Enable automatic update of the display at defined time intervals.
:DISPlay:UPDate ON
```

Example: To work with dialogs

Use the following commands to query the dialog IDs of all currently open dialogs. The dialog ID is a prerequisite for opening and closing dialogs via the remote control.

The dialog ID is also required to define user key actions.

See Section 11.4.2, "How to assign actions to the [★ (User)] key", on page 583.

```
// Query the dialog IDs of all open dialogs.
:DISPlay:DIALog:ID?
// CEUtraDLGenSetDlg,_,$A DlgKeyRf_Rosc
// Open and close dialogs via remote control
:DISPlay:DIALog:OPEN "CEUtraDLGenSetDlg,_,$A"
:DISPlay:DIALog:OPEN "DlgKeyRf_Rosc"
:DISPlay:DIALog:CLOSe "DlgKeyRf_Rosc"
:DISPlay:DIALog:CLOSe:ALL
```

Commands:

:DISPlay:PSAVe:HOLDoff 750
:DISPlay:PSAVe[:STATe] 750
:DISPlay:UPDate[:STATe] 750
:DISPlay:ANNotation:AMPLitude 750
:DISPlay:ANNotation:FREQuency 751
:DISPlay:ANNotation[:ALL] 751
:DISPlay:DIALog:ID? 751

:DISPlay:DIALog:OPEN....752
:DISPlay:DIALog:CLOSe....752
:DISPlay:DIALog:CLOSe:ALL....753

:DISPlay:PSAVe:HOLDoff <HoldoffTimeMin>

Sets the wait time for the screen saver mode of the display.

Parameters:

<HoldoffTimeMin> integer

Range: 1 to 60
*RST: n.a. (factory preset: 10)
Default unit: minute

Example: see Example "To use the screen saver and display update" on page 749

Manual operation: See "Wait Time" on page 559

:DISPlay:PSAVe[:STATe] <State>

Activates the screen saver mode of the display.

We recommend that you use this mode to protect the display, if you operate the instrument in remote control.

To define the wait time, use the command `:DISPlay:PSAVe:HOLDoff`.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 0)

Example: See Example "To use the screen saver and display update" on page 749

Manual operation: See "Screen Saver" on page 559

:DISPlay:UPDate[:STATe] <Update>

Activates the refresh mode of the display.

Parameters:

<Update> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 1)

Example: See Example "To use the screen saver and display update" on page 749

Manual operation: See "Display Update is" on page 561

:DISPlay:ANNotation:AMPLitude <SecPassword>, <State>

Indicates asterisks instead of the level values in the status bar.

Parameters:

<SecPassword> string
Optional string to enter the security password.

<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 1)

Example: See Example "To use the screen saver and display update" on page 749.

Manual operation: See "Annotation Amplitude" on page 609

:DISPlay:ANNotation:FREQuency <SecPassWord>, <State>

Indicates asterisks instead of the frequency values in the status bar.

Parameters:

<SecPassWord> string
Optional string to enter the security password.

<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 1)

Example: See Example "To use the screen saver and display update" on page 749.

Manual operation: See "Annotation Frequency" on page 609

:DISPlay:ANNotation[:ALL] <SecPassword>, <State>

Displays asterisks instead of the level and frequency values in the status bar of the instrument.

Use this mode, if you operate the instrument in remote control.

Parameters:

<SecPassword> string
Optional string to enter the security password.

<State> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "To use the screen saver and display update" on page 749.

:DISPlay:DIALog:ID?

Returns the dialog identifiers of the open dialogs in a string separated by blanks.

Return values:

<DialogIdList> <DialogID#1>< ><DialogID#2>< > ... < ><DialogID#n>

Dialog identifiers are string without blanks. Blanks are represented as `$$`.
Dialog identifiers `<DialogID>` are composed of two main parts: `<DialogName>[<OptionalParts>]`

<DialogName>
Meaningful information, mandatory input parameter for the commands:
`:DISPlay:DIALog:OPEN` on page 752
`:DISPlay:DIALog:CLOSe` on page 752

<Optional parts>
String of `$<X>` values, where `<X>` is a character, interpreted as follows:
`$q<DialogQualifier>`: optional dialog qualifier, usually the letter `A` or `B`, as displayed in the dialog title.
`$i<Instances>`: comma-separated list of instance indexes, given in the order `h,c,s,d,g,u,0`. Default is zero; the terminating `",0"` can be omitted.
`$t<TabIds>`: comma-separated indexes or tab names; required, if a dialog is composed of several tabs.
`$x<Left>$y<Top>$h<Left>$w<Top>`: position and size; superfluous information.

Example: See Example "To work with dialogs" on page 749

Usage: Query only

Manual operation: See "SCPI" on page 586

:DISPlay:DIALog:OPEN <DialogId>

Opens the specified dialog.

Setting parameters:

<DialogId> string

To find out the dialog identifier, use the query `:DISPlay:DIALog:ID?`.
The `<DialogName>` part of the query result is mandatory.

Example: See Example "To work with dialogs" on page 749

Usage: Setting only

Manual operation: See "SCPI" on page 586

:DISPlay:DIALog:CLOSe <DialogId>

Closes the specified dialog.

Setting parameters:

<DialogId> string

To find out the dialog identifier, use the query `:DISPlay:DIALog:ID?`.

The `<DialogName>` part of the query result is sufficient.

Example: See Example "To work with dialogs" on page 749

Usage: Setting only

:DISPlay:DIALog:CLOSe:ALL

Closes all open dialogs.

Example: See Example "To work with dialogs" on page 749

Usage: Event

13.11 FORMat subsystem

The commands in the `FORMat` subsystem determine the format of data returned by the R&S SMM100A to the controller. This affects all query commands that return a list of numerical data or block data, noted in the descriptions of the commands. The set data format applies to both paths.

Example: Configuring the format of data returned to a controller

```
// Select the format o be returned by the instrument
//
FORMat:BORDer SWAPped
// returns the most significant byte of each floating point
// number first and the least significant byte last

FORMat:SREGister: HEXadecimal
// returns the content of the status register
// as a hexadecimal number

FORMat:DATA ASCii
//  transfers the data in ASCII format
```

:FORMat:BORDer....754
:FORMat:SREGister....754
:FORMat[:DATA]....754

:FORMat:BORDer <Border>

Determines the sequence of bytes within a binary block. This only affects blocks which use the IEEE754 format internally.

Parameters:

<Border> NORMal | SWAPped

NORMal
Expects/sends the *least* significant byte of each IEEE754 floating-point number first and the *most* significant byte last.

SWAPped
Expects/sends the *most* significant byte of each IEEE754 floating-point number first and the *least* significant byte last.

*RST: NORMal

Example: `:FORM:BORD SWAP`
transfers the data with the most significant bit first.

:FORMat:SREGister <Format>

Determines the numeric format for responses of the status register.

Parameters:

<Format> ASCii | BINary | HEXadecimal | OCTal

ASCii
Returns the register content as a decimal number.

BINary|HEXadecimal|OCTal
Returns the register content either as a binary, hexadecimal or octal number. According to the selected format, the number starts with #B (binary), #H (hexadecimal) or #O (octal).

*RST: ASCii

Example: `:FORM:SREG HEX`
returns the register content as a hexadecimal number.

:FORMat[:DATA] <Data>

Determines the data format the instrument uses to return data via the IEC/IEEE bus.

The instrument automatically detects the data format used by the controller, and assigns it accordingly. Data format determined by this SCPI command is in this case irrelevant.

Parameters:

<Data> ASCii | PACKed

ASCii
Transfers numerical data as plain text separated by commas.

PACKed
Transfers numerical data as binary block data.
The format within the binary data depends on the command.
The various binary data formats are explained in the description of the parameter types.
*RST: ASCii

Example: `:FORM ASC`
transfers the data as ASCII data.

13.12 HCOPy subsystem

The `HCOPy` subsystem contains the commands to generate and save a hard copy of the display.

To access a stored hard copy file, use the commands of the `MEMM` subsystem.

Example: Store a hard copy of the display
The following example lists commands to configure and execute a hard copy to an automatic named file.

```
:HCOPy:DEVice:LANGuage PNG
:HCOPy:FILE:NAME:AUTO:STATe 1
// defines the output format
// sets the instrument to automatically create output file names

// ****************************************************************
// Configure hard copy options, set automatic naming rules
// An automatically generated file name consists of:
// <Prefix><YYYY><MM><DD><Number>.<Format>
// ****************************************************************
:HCOPy:DEVice:LANGuage BMP
// defines output format *.bmp
:HCOPy:REGion DIALog
// selects the region to be copied
:HCOPy:FILE:AUTO:DIR "/usb/HCopy"
// sets destination directory of automatic named file
:HCOPy:FILE:NAME:AUTO:FILE:PREFix:STATe 1
:HCOPy:FILE:NAME:AUTO:FILE:PREFix:"hardcopy"
:HCOPy:FILE:NAME:AUTO:FILE:YEAR:STATe 1
:HCOPy:FILE:NAME:AUTO:FILE:MONTh:STATe 1
// uses automatic naming prefix
// sets automatic naming prefix to "hardcopy"
// uses automatic naming date parameters year and month

// ****************************************************************
```

```
// Execute and transfer the hard copy
// ****************************************************************
:HCOPy:EXECute
:HCOPy:DATA
// generates a hard copy
// transfers the hard copy to the remote client
:HCOPy:FILE:AUTO:FILE?
// queries the automatic file name
// "hardcopy1607001.bmp"
:HCOPy:FILE:AUTO:NUMBer?
// queries the number in the automatic file name
// "001"
:HCOPy:FILE:AUTO?
// queries the path and file name of the automatically generated file
// "/usb/HCopy/hardcopy1607001.bmp"
```

13.12.1 Hard copy settings

With the following commands, you can configure the settings of a hard copy.

:HCOPy:DATA?....756
:HCOPy:IMAGe:FORMat....756
:HCOPy:DEVice:LANGuage....756
:HCOPy:REGion....757
:HCOPy:FILE[:NAME]....757
:HCOPy[:EXECute]....757

:HCOPy:DATA?

Transfers the hard copy data directly as a NByte stream to the remote client.

Return values:
<Data> block data

Example: See Example "Store a hard copy of the display" on page 755

Usage: Query only

:HCOPy:IMAGe:FORMat <Format>
:HCOPy:DEVice:LANGuage <Language>

Selects the graphic format for the hard copy. You can use both commands alternatively.

Parameters:
<Language> BMP | JPG | XPM | PNG
*RST: PNG

Example: See Example "Store a hard copy of the display" on page 755

Manual operation: See "Format" on page 553

:HCOPy:REGion <Region>

Selects the area to be copied.

You can create a snapshot of the screen or an active dialog.

Parameters:
<Region> ALL | DIALog
*RST: ALL

Example: See Example "Store a hard copy of the display" on page 755

Manual operation: See "Region" on page 554

:HCOPy:FILE[:NAME] <Name>

Determines the file name and path to save the hard copy, provided automatic naming is disabled.

Note: If you have enabled automatic naming, the instrument automatically generates the file name and directory, see Section 13.12.2, "Automatic naming", on page 757.

Parameters:
<Name> string

Example: See Example "Store a hard copy of the display" on page 755

Manual operation: See "File..." on page 553

:HCOPy[:EXECute]

Generates a hard copy of the current display. The output destination is a file.

Example: See Example "Store a hard copy of the display" on page 755

Usage: Event

Manual operation: See "Save" on page 553

13.12.2 Automatic naming

Use the following commands to automatically assign a file name.

:HCOPy:FILE[:NAME]:AUTO? 758
:HCOPy:FILE[:NAME]:AUTO:DIRectory 758
:HCOPy:FILE[:NAME]:AUTO:DIRectory:CLEar 758
:HCOPy:FILE[:NAME]:AUTO:FILE? 758
:HCOPy:FILE[:NAME]:AUTO:STATe 759
:HCOPy:FILE[:NAME]:AUTO[:FILE]:DAY:STATe 759
:HCOPy:FILE[:NAME]:AUTO[:FILE]:MONTh:STATe 759
:HCOPy:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe 759
:HCOPy:FILE[:NAME]:AUTO[:FILE]:NUMBer? 759
:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix 760
:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix:STATe 760

:HCOPy:FILE[:NAME]:AUTO?

Queries path and file name of the hardcopy file, if you have enabled *Automatic Naming*.

Return values:
<Auto> string

Example: See Example "Store a hard copy of the display" on page 755

Usage: Query only

:HCOPy:FILE[:NAME]:AUTO:DIRectory <Directory>

Determines the path to save the hard copy, if you have enabled *Automatic Naming*.

If the directory does not yet exist, the instrument automatically creates a new directory, using the instrument name and `/var/user/` by default.

Parameters:
<Directory> string
*RST: /var/user/

Example: See Example "Store a hard copy of the display" on page 755

Manual operation: See "Path..." on page 554

:HCOPy:FILE[:NAME]:AUTO:DIRectory:CLEar

Deletes all files with extensions `*.bmp`, `*.jpg`, `*.png` and `*.xpm` in the directory set for automatic naming.

Example: See Example "Store a hard copy of the display" on page 755

Usage: Event

Manual operation: See "Clear Path" on page 554

:HCOPy:FILE[:NAME]:AUTO:FILE?

Queries the name of the automatically named hard copy file.

An automatically generated file name consists of:

<Prefix><YYYY><MM><DD><Number>.<Format>.

You can activate each component separately, to individually design the file name.

Return values:
<File> string

Example: See Example "Store a hard copy of the display" on page 755.

Usage: Query only

:HCOPy:FILE[:NAME]:AUTO:STATe <State>

Activates automatic naming of the hard copy files.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "Store a hard copy of the display" on page 755

Manual operation: See "Automatic Naming" on page 553

:HCOPy:FILE[:NAME]:AUTO[:FILE]:DAY:STATe <State>
:HCOPy:FILE[:NAME]:AUTO[:FILE]:MONTh:STATe <State>
:HCOPy:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe <State>

Uses the date parameters (year, month or day) for the automatic naming. You can activate each of the date parameters separately.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "Store a hard copy of the display" on page 755

Manual operation: See "Prefix, Year, Month, Day" on page 555

:HCOPy:FILE[:NAME]:AUTO[:FILE]:NUMBer?

Queries the number that is used as part of the file name for the next hard copy in automatic mode.

At the beginning, the count starts at 0. The R&S SMM100A searches the specified output directory for the highest number in the stored files. It increases this number by one to achieve a unique name for the new file.

The resulting auto number is appended to the resulting file name with at least three digits.

Return values:
<Number> integer
Range: 0 to 999999
*RST: 0

Example: See Example "Store a hard copy of the display" on page 755

Usage: Query only

Manual operation: See "Current Auto Number" on page 555

:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix <Prefix>
:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix:STATe <State>

Uses the prefix for the automatic generation of the file name, provided `PREF:STAT` is activated.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "Store a hard copy of the display" on page 755

Manual operation: See "Prefix, Year, Month, Day" on page 555

13.13 KBOard subsystem

The `KBOard` subsystem contains the commands to set a connected keyboard.

Example: Configuring the keypad

```
KBOard:LAYout US
// sets the American keyboard assignment

FPANel:KEYBoard:LAYout LETTers
// enables the alphanumerical and the
// numerical assignment of the front panel keys.
```

:FPANel:KEYBoard:LAYout 760
:KBOard:LAYout 761

:FPANel:KEYBoard:LAYout <Layout>

Selects the layout of the front panel keypad.

Parameters:

<Layout> DIGits | LETTers

DIGits
Enables numerical keys only.

LETTers
Enables numerical and alphanumerical keys.

*RST: n.a. (factory preset: DIGits)

Example:

```
:FPANel:KEYBoard:LAYout LETTers
// enables the alphanumerical additional
// and the numerical assignment of the keys.
```

Manual operation: See "Alphanumeric Keys" on page 560

:KBOard:LAYout <Layout>

Selects the language for an external keyboard and assigns the keys acccordingly.

Parameters:

<Layout> CHINese | DANish | DUTCh | ENGLish | ENGUK | FINNish | FRENch | FREBe | FRECa | GERMan | ITALian | JAPanese | KOREan | NORWegian | PORTuguese | RUSSian | SPANish | SWEDish | ENGUS

*RST: n.a. (factory preset: ENGLish)

Example:

```
:KBOard:LAYout US
// activates American keyboard
```

Manual operation: See "Layout" on page 559

13.14 OUTPut subsystem

In the `OUTPut` subsystem, you can configure the output signals.

The LF output signal is defined with the commands of the Section 13.17.12, "SOURce:LFOutput subsystem", on page 991 system.

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
`OUTPut<hw>`	[1]	Optional suffix

:OUTPut:ALL[:STATe] 761
:OUTPut<hw>[:STATe] 762
:OUTPut<hw>[:STATe]:PON 762
:OUTPut<hw>:AMODe 762
:OUTPut<hw>:BLANk:LIST:STATe 763
:OUTPut<hw>:IMPedance? 763
:OUTPut<hw>:AFIXed:RANGe:LOWer? 763
:OUTPut<hw>:AFIXed:RANGe:UPPer? 763
:OUTPut<hw>:PROTection:CLEar 763
:OUTPut<hw>:PROTection:TRIPped? 764

:OUTPut:ALL[:STATe] <State>

Enables the RF output signal of the instrument.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 0)

Example: `OUTPut:ALL:STATe 0`
Disables the RF output signal.

:OUTPut<hw>[:STATe] <State>

Activates the RF output signal.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: `:OUTPut1 ON`
Activates the RF output.

Manual operation: See "RF State/RF ON" on page 310

:OUTPut<hw>[:STATe]:PON <Pon>

Defines the state of the RF output signal when the instrument is switched on.

Parameters:
<Pon> OFF | UNCHanged
*RST: n.a. (factory preset: UNCHanged)

Example: `:OUTPut1:PON OFF`
The RF output is deactivated when the instrument is switched on.

Manual operation: See "Power-On State" on page 561

:OUTPut<hw>:AMODe <AMode>

Sets the step attenuator mode at the RF output.

Parameters:
<AMode> FIXed | MANual | AUTO

AUTO
The step attenuator adjusts the level settings automatically, within the full variation range.

FIXed
The step attenuator and amplifier stages are fixed at the current position, providing level settings with constant output VSWR. The resulting variation range is calculated according to the position.

*RST: AUTO

Example:
```
:SOURce1:POWer:ALC:STATe 1
:OUTPut1:AMODe FIXed
```

Manual operation: See "Mode" on page 401

:OUTPut<hw>:BLANk:LIST:STATe <State>

Activates RF output blanking.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 1

Example: `:OUTPut1:BLAN:LIST:STAT ON`
Activates the RF output blanking.

:OUTPut<hw>:IMPedance?

Queries the impedance of the RF outputs.

Return values:

<Impedance> G1K | G50 | G10K
*RST: G50

Example: `:OUTPut1:IMP?`
queries the impedance of RF output.
`Response: 50`
the impedance is 50 ohms

Usage: Query only

Manual operation: See "RF output impedance" on page 310

:OUTPut<hw>:AFIXed:RANGe:LOWer?
:OUTPut<hw>:AFIXed:RANGe:UPPer?

Queries the settable minimum/maximum value in mode `:OUTPut:AMODe FIXed`, i.e. when the attenuator is not being adjusted.

Return values:

<Upper> float
Increment: 0.01
Default unit: dBm

Example:

```
:OUTPut1:AMODe FIXed
:OUTPut1:AFIXed:RANGe:UPPer?
// -27
:OUTPut1:AFIXed:RANGe:LOW?
// -50
```

Usage: Query only

Manual operation: See "Level Range" on page 318

:OUTPut<hw>:PROTection:CLEar

Resets the protective circuit after it has been tripped.

To define the output state, use the command `:OUTPut<hw>[:STATe]`.

Example: `:OUTPut1:PROT:CLE`
Resets the protective circuit of the RF output.

Usage: Event

Manual operation: See "Overload" on page 402

:OUTPut<hw>:PROTection:TRIPped?

Queries the state of the protective circuit.

Return values:
<Tripped> 1 | ON | 0 | OFF
*RST: 0

Example: `:OUTPut1:PROT:TRIP`
queries the state of the protective circuit of the RF output.
`Response: 0`
the protective circuit has not tripped.

Usage: Query only

Manual operation: See "Overload" on page 402

13.15 SENSe, READ, INITiate and SLISt subsystems

These subsystems contain the commands for configuring the power measurements with R&S NRP power sensor connected to the R&S SMM100A.

The local state is set with the `INIT` command. Switching off the local state enhances the measurement performance. Measurements results can be retrieved in local state on or off.

Sensor parameters are set with the `SENSe` commands.

To start the measurement and retrieve the result, use the `:READ<ch>[:POWer]?` command.

Suffix	Value range	Description
`SENSe<ch>`	[1] to 4	Indicates the sensor Use the `:SLISt` commands to change the sensor mapping
`READ<ch>`	[1] to 4	Sensor assignment
`INIate<hw>`	[1] to 4	Sensor assignment
`ELEMent<ch>`	[1] to 25	Sensor-mapping list

Programming examples

Example: Detecting and assigning a power sensor

```
SLISt:LIST?
// Response: "NRP33SN-V-900007-USB Legacy","NRP-Z211-900001-USB Legacy"
// Lists all automatically detected sensors.

SLISt:SCAN:STATe 1
// Searches for sensors connected in the LAN or via the USBTMC protocol.

SLISt:SCAN:LSENsor 'NRQ6',101624 // sensor name, serial number
SLISt:SCAN:LSENsor 11.123.1.123, 101624 // IP address, serial number
// Adds sensors to the list, that are connected to LAN.


SLISt:SCAN:USENsor 'NRQ6',101624 //sensor name, serial number
SLISt:SCAN:USENsor #H15b,101624  //device ID (hexadecimal), serial number
SLISt:SCAN:USENsor 347,101624    //device ID (decimal), serial number
// Adds a sensor to the list, that is connected to the USB interface.


SLISt:LIST?
// Response: "NRP33SN-V-900007-USB Legacy","NRP-Z211-900001-USB Legacy",
// "NRP33SN-V-900005-USBTMC","NRP33SN-V-900011-LAN"
// Lists all automatically detected sensors.

SLISt:ELEMent3:MAPPing SENS1
// Maps the third sensor from the list to the first sensor channel.

SLISt:SENSor:MAP "NRPS18S-100654-USB Legacy", SENS3
// Maps the sensor to channel 3.


SLISt:CLEar[ALL]
// Remove all sensors that use VISA communication protocol
// from the sensor mapping list.
SLISt:CLEar:LAN
// Remove all sensors from the list, that use VISA and are connected over LAN.
SLISt:CLEar:USB
// Remove all sensors from the list, that use VISA and are connected over USB.
```

Example: Performing a simple power measurement

Prerequisite: The sensor is connected to the instrument and mapped to the first sensor channel.

```
INITiate1:CONTinuous ON
// Switches the continous power measurement on.

READ1?
// Triggers the measurement and displays the results.
```

Example: Performing a power measurement with a fixed filter

Prerequisite: The sensor is connected to the instrument and mapped to the first sensor channel.

```
SENSe1:SOURce RF
// Sensor measures the power of the RF signal.

SENSe1:FILTer:TYPE NSRatio
// Selects fixed noise filter mode.

SENSe1:FILTer:NSRatio 0.02 DB
// Sets the maximum noise component in the result to 0.02 DB.

SENSe1:FILTer:NSRatio:MTIMe 10
//Limits the settling time to 10 seconds.

SENSe1:APERture:DEFault:STATe 0
// Deactivates the default aperture time of the sensor.

SENSe1:APERture:TIMe 10e-6
// Sets the aperture time to 10 us.

SENSe1:UNIT DBM
// Selects unit dBm for the measured value.

INITiate:CONTinuous ON
// Switches the continous power measurement on.

READ?
// Triggers the measurement and displays the results.
```

:SLISt[:LIST]? 767
:SLISt:SCAN[:STATe] 767
:SLISt:SCAN:LSENsor 767
:SLISt:SCAN:USENsor 768
:SLISt:CLEar:LAN 768
:SLISt:CLEar:USB 768
:SLISt:CLEar[:ALL] 769
:SLISt:ELEMent<ch>:MAPPing 769
:SLISt:SENSor:MAP 769
:INITiate<hw>[:POWer]:CONTinuous 770
:READ<ch>[:POWer]? 770
:SENSe<ch>:UNIT[:POWer] 771
:SENSe<ch>[:POWer]:APERture:DEFault:STATe 771
:SENSe<ch>[:POWer]:APERture:TIMe 771
:SENSe<ch>[:POWer]:CORRection:SPDevice:SELect 772
:SENSe<ch>[:POWer]:CORRection:SPDevice:STATe 772
:SENSe<ch>[:POWer]:CORRection:SPDevice:LIST? 772
:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority 772
:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe 773
:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO? 773

:SENSe<ch>[:POWer]:FILTer:LENGth[:USER] 773
:SENSe<ch>[:POWer]:FILTer:NSRatio 774
:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe 774
:SENSe<ch>[:POWer]:FILTer:SONCe 774
:SENSe<ch>[:POWer]:FILTer:TYPE 775
:SENSe<ch>[:POWer]:FREQuency 775
:SENSe<ch>[:POWer]:LOGGing:STATe 776
:SENSe<ch>[:POWer]:OFFSet 776
:SENSe<ch>[:POWer]:OFFSet:STATe 776
:SENSe<ch>[:POWer]:SNUMber? 777
:SENSe<ch>[:POWer]:SOURce 777
:SENSe<ch>[:POWer]:STATus[:DEVice]? 777
:SENSe<ch>[:POWer]:SVERsion? 778
:SENSe<ch>[:POWer]:TYPE? 778
:SENSe<ch>[:POWer]:ZERO 778

:SLISt[:LIST]?

Returns a list of all detected sensors in a comma-separated string.

Return values:

<SensorList> String of comma-separated entries

Each entry contains information on the sensor type, serial number and interface.
The order of the entries does not correspond to the order the sensors are displayed in the "NRP Sensor Mapping" dialog.

Example: See Example "Detecting and assigning a power sensor" on page 765.

Usage: Query only

Manual operation: See "Sensor Mapping List" on page 433

:SLISt:SCAN[:STATe] <State>

Starts the search for R&S NRP power sensors, connected in the LAN or via the USBTMC protocol.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Detecting and assigning a power sensor" on page 765.

Manual operation: See "Scan" on page 434

:SLISt:SCAN:LSENsor <IP>

Scans for R&S NRP power sensors connected in the LAN.

Setting parameters:
<IP> string
*RST: 0

Example: See Example "Detecting and assigning a power sensor" on page 765.

Usage: Setting only

Manual operation: See "Add LAN Sensor" on page 434

:SLISt:SCAN:USENsor <DeviceID>, <Serial>

Scans for R&S NRP power sensors connected over a USB interface.

Parameters:
<Serial> integer
Range: 0 to 999999

Setting parameters:
<DeviceID> String or Integer
Range: 0 to 999999
*RST: 0

Example: See Example "Detecting and assigning a power sensor" on page 765.

Usage: Setting only

Manual operation: See "Add USBTMC Sensor" on page 435

:SLISt:CLEar:LAN

Removes all entries of R&S NRP power sensors connected in the LAN from the sensor mapping list.

Example: See Example "Detecting and assigning a power sensor" on page 765.

Usage: Event

Manual operation: See "Clear" on page 434

:SLISt:CLEar:USB

Removes all entries of R&S NRP power sensors connected over USB and using the VISA communication protocol from the sensor mapping list.

Does not affect entries for sensors communicating over the USB legacy protocol.

Example: See Example "Detecting and assigning a power sensor" on page 765.

Usage: Event

Manual operation: See "Clear" on page 434

:SLISt:CLEar[:ALL]

Removes all entries of R&S NRP power sensors using the VISA communication protocol (USB or LAN) from the sensor mapping list.

Does not affect sensors communicating over USB legacy protocol.

Example: See Example "Detecting and assigning a power sensor" on page 765.

Usage: Event

Manual operation: See "Clear" on page 434

:SLISt:ELEMent<ch>:MAPPing <Mapping>

Assigns an entry from the `:SLISt[:LIST]?` to one of the four sensor channels.

Parameters:

<Mapping> SENS1 | SENSor1 | SENS2 | SENSor2 | SENS3 | SENSor3 | SENS4 | SENSor4 | UNMapped

Sensor channel.

*RST: UNMapped

Example: See Example "Detecting and assigning a power sensor" on page 765.

Manual operation: See "Sensor Mapping List" on page 433

:SLISt:SENSor:MAP <SensorId>, <Mapping>

Assigns a sensor directly to one of the sensor channels, using the sensor name and serial number.

To find out the the sensor name and ID, you can get it from the label of the R&S NRP, or using the command `:SLISt:SCAN[:STATe]`. This command detects all R&S NRP power sensors connected in the LAN or via 'USBTMC protocol.

Setting parameters:

<SensorId> string

<Mapping> enum

Example: See Example "Detecting and assigning a power sensor" on page 765.

Usage: Setting only

Manual operation: See "Sensor Mapping List" on page 433

:INITiate<hw>[:POWer]:CONTinuous <Continuous>

Switches the local state of the continuous power measurement by R&S NRP power sensors on and off. Switching off local state enhances the measurement performance during remote control.

The remote measurement is triggered with `:READ<ch>[:POWer]?`). This command also returns the measurement results. The local state is not affected, measurement results can be retrieved with local state on or off.

Parameters:

<Continuous> 1 | ON | 0 | OFF

*RST: 0

Example: `INIT1:CONT ON`
Switches on the local state of continuous power measurement.

Manual operation: See "State" on page 429

:READ<ch>[:POWer]?

Triggers power measurement and displays the results.

Note: This command does not affect the local state, i.e. you can get results with local state on or off. For long measurement times, we recommend that you use an SRQ for command synchronization (MAV bit).

Suffix:

<ch> 1 to 3

Return values:

<Power> float or float,float

The sensor returns the result in the unit set with command `:SENSe<ch>:UNIT[:POWer]`
Certain power sensors, such as the R&S NRP-Z81, return two values, first the value of the average level and - separated by a comma - the peak value.

Example:
```
:SENS1:UNIT DBM
```
Selects unit dBm for presentation of measurement result.
```
:READ1?
```
Queries the measurement result of the sensor.
```
-45.6246576745440230
```
-45.6 dBm were measured at the given frequency.

Example: R&S NRP-Z81
```
:READ1?
-55.62403263352178,-22.419472478812476
```
-55.6 dBm is the measured average level, -22. 4 dBm is the measured peak level at the given frequency.

Usage: Query only

Manual operation: See "Measured Level" on page 425
See "Level (Peak) / Level (Average)" on page 429

:SENSe<ch>:UNIT[:POWer] <Power>

Selects the unit (Watt, dBm or dBµV) of measurement result display, queried with `:READ<ch>[:POWer]?`.

Parameters:
<Power> DBM | DBUV | WATT
*RST: DBM

Example: `:SENS2:UNIT DBM`
Selects dBm as unit for the measured value returned by command `READ`.
`:READ2?`
`Response: 7.34`
7.34 dBm are measured by sensor 2.

Manual operation: See "Measured Level" on page 425
See "Level (Peak) / Level (Average)" on page 429

:SENSe<ch>[:POWer]:APERture:DEFault:STATe <UseDefAp>

Deactivates the default aperture time of the respective sensor.

To specify a user-defined value, use the command `:SENSe<ch>[:POWer]:APERture:TIMe` on page 771.

Parameters:
<UseDefAp> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "Performing a power measurement with a fixed filter" on page 766.

Manual operation: See "Default Aperture Time" on page 431

:SENSe<ch>[:POWer]:APERture:TIMe <ApTime>

Defines the aperture time (size of the acquisition interval) for the corresponding sensor.

Parameters:
<ApTime> float
Range: depends on connected power sensor
Increment: 1E-9
*RST: depends on connected power sensor

Example: See Example "Performing a power measurement with a fixed filter" on page 766.

Manual operation: See "Aperture Time" on page 431

:SENSe<ch>[:POWer]:CORRection:SPDevice:SELect <Select>

Several S-parameter tables can be stored in a sensor. The command selects a loaded data set for S-parameter correction for the corresponding sensor.

Parameters:
<Select> float
*RST: 0

Manual operation: See "S-Parameter" on page 432

:SENSe<ch>[:POWer]:CORRection:SPDevice:STATe <State>

Activates the use of the S-parameter correction data.

Note: If you use power sensors with attenuator, the instrument automatically activates the use of S-parameter data.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: `:SENSe1:POWer:CORRection:SPDevice:STATe 1`
Activates the use of the S-parameters correction data.

Manual operation: See "S-Parameter" on page 432

:SENSe<ch>[:POWer]:CORRection:SPDevice:LIST?

Queries the list of the S-parameter data sets that have been loaded to the power sensor.

Return values:
<List> string list
*RST: 0

Usage: Query only

Manual operation: See "S-Parameter" on page 432

:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority <Priority>

Selects average or peak power for permanent display.

Parameters:
<Priority> AVERage | PEAK
*RST: AVERage

Example: `:SENS1:DISP:PERM:STAT ON`
Turns on the permanent view.
`:SENS1:DISP:PERM:PRI AVER`
Sets the average power for display.

Manual operation: See "Display" on page 429

:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe <State>

Activates the permanent display of the measured power level results. The instrument also indicates the sensor type, the connection, the measurement source and the offset if set.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example: `:SENS1:POW:DISP:PERM:STAT ON`
Turns on the permanent view.

Manual operation: See "Display Permanent" on page 429

:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO?

Queries the current filter length in filter mode `AUTO` (`:SENSe<ch>[:POWer]:FILTer:TYPE`)

Return values:

<Auto> float
Range: 1 to depends on R&S NRP power sensor type

Example: `:SENS1:FILT:TYPE AUTO`
Selects auto filter.
`:SENS1:FILT:LENG:AUTO?`
Queries the automatically set filter length.
`Response: 1024`

Usage: Query only

Manual operation: See "Filter Length" on page 431

:SENSe<ch>[:POWer]:FILTer:LENGth[:USER] <User>

Selects the filter length for `SENS:POW:FILT:TYPE USER`. As the filter length works as a multiplier for the time window, a constant filter length results in a constant measurement time (see also "About the measuring principle, averaging filter, filter length, and achieving stable results" on page 420).

The R&S NRP power sensors provide different resolutions for setting the filter length, depending on the used sensor type.

For more information, refer to the specifications document.

Parameters:

<User> float
Range: 1 to depends on R&S NRP power sensor type
*RST: 1

Example: `:SENS1:FILT:TYPE USER`
Selects user filter mode.
`:SENS1:FILT:LENG 16`
Sets a filter length of 16. E.g. using a sensor with 20 ms time window, the resulting measurement time is 640 ms (2x16x20 ms)

Manual operation: See "Filter Length" on page 431

:SENSe<ch>[:POWer]:FILTer:NSRatio <NSRatio>

Sets an upper limit for the relative noise content in fixed noise filter mode (`:SENSe<ch>[:POWer]:FILTer:TYPE`). This value determines the proportion of intrinsic noise in the measurement results.

Parameters:
<NSRatio> float

Range: 0.001 to 1
Increment: 0.001
*RST: 0.01

Example: See Example "Performing a power measurement with a fixed filter" on page 766.

Manual operation: See "Noise/Signal Ratio" on page 431

:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe <MTime>

Sets an upper limit for the settling time of the auto-averaging filter and thus limits the length of the filter.

Parameters:
<MTime> float

Range: 1 to 999.99
Increment: 0.01
*RST: 8

Example: See Example "Performing a power measurement with a fixed filter" on page 766.

Manual operation: See "Timeout" on page 431

:SENSe<ch>[:POWer]:FILTer:SONCe

Starts searching the optimum filter length for the current measurement conditions. You can check the result with command `:SENS1:POW:FILT:LENG:USER?` in filter mode `USER` (`:SENSe<ch>[:POWer]:FILTer:TYPE`).

Example: `SENS1:FILT:TYPE USER`
Selects user filter mode.
`:SENS1:FILT:SONC`
Activates the search for the optimum filter length.
`:SENS1:FILT:LENG?`
Returns the found optimum filter length.
`Response: 128`

Usage: Event

Manual operation: See "Auto Once" on page 431

:SENSe<ch>[:POWer]:FILTer:TYPE <Type>

Selects the filter mode. The filter length is the multiplier for the time window and thus directly affects the measurement time.

Parameters:

<Type> AUTO | USER | NSRatio

AUTO
Automatically selects the filter length, depending on the measured value. The higher the power, the shorter the filter length, and vice versa.
Note: To avoid long settling times when the power is low, you can limit the averaging factor limited with the "timeout" parameter (`:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe`).

USER
Allows you to set the filter length manually. As the filter-length takes effect as a multiplier of the measurement time, you can achieve constant measurement times.

NSRatio
Selects the filter length (averaging factor) according to the criterion that the intrinsic noise of the sensor (2 standard deviations) does not exceed the specified noise content. You can define the noise content with command `:SENSe<ch>[:POWer]:FILTer:NSRatio`.

*RST: AUTO

Example: See Example "Performing a power measurement with a fixed filter" on page 766.

Manual operation: See "Filter" on page 430

:SENSe<ch>[:POWer]:FREQuency <Frequency>

Sets the RF frequency of the signal, if signal source `:SENSe<ch>[:POWer]:SOURce USER` is selected.

Parameters:
<Frequency> float
*RST: 1 GHz

Example: `:SENS1:SOUR USER`
Selects user-defined source.
`:SENS1:FREQ 2.44GHz`
Sets the RF frequency of the source which is 2.44 GHz.

Manual operation: See "Frequency" on page 430

:SENSe<ch>[:POWer]:LOGGing:STATe <State>

Activates the recording of the power values, measured by a connected R&S NRP power sensor.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: `:SENS:LOGG:STAT ON`
Activates recording of the power measurement of the first sensor.

Manual operation: See "Enable Logging" on page 432

:SENSe<ch>[:POWer]:OFFSet <Offset>

Sets a level offset which is added to the measured level value after activation with command `:SENSe<ch>[:POWer]:OFFSet:STATe`. The level offset allows, e.g. to consider an attenuator in the signal path.

Parameters:
<Offset> float
Range: -100.0 to 100.0
*RST: 0
Default unit: dB

Example: `:SENS1:POW:OFFS 10.0`
Sets a level offset of 10 dB

Manual operation: See "Level Offset State,Level Offset" on page 430

:SENSe<ch>[:POWer]:OFFSet:STATe <State>

Activates the addition of the level offset to the measured value. The level offset value is set with command `:SENSe<ch>[:POWer]:OFFSet`.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: `:SENS1:POW:OFFS 0.4dB`
Sets a level offset of 0.4 dB
`:SENS1:POW:OFFS:STAT ON`
A level offset of 0.4 dB is added to the measured value.

Manual operation: See "Level Offset State,Level Offset" on page 430

:SENSe<ch>[:POWer]:SNUMber?

Queries the serial number of the sensor.

Return values:
<SNumber> string

Example: `:SENS1:SNUM?`
Queries the serial number.

Usage: Query only

Manual operation: See "Sensor type and serial number" on page 428

:SENSe<ch>[:POWer]:SOURce <Source>

Determines the signal to be measured.

Note: When measuring the RF signal, the sensor considers the corresponding correction factor at that frequency, and uses the level setting of the instrument as reference level.

Parameters:
<Source> A | USER | RF
*RST: A

Example: See Example "Performing a power measurement with a fixed filter" on page 766.

Manual operation: See "Use Frequency Of" on page 429

:SENSe<ch>[:POWer]:STATus[:DEVice]?

Queries if a sensor is connected to the instrument.

Return values:
<Status> 1 | ON | 0 | OFF
*RST: 0

Example: `:SENS1:STAT?`
`Response: 1`
A sensor is connected.

Usage: Query only

Manual operation: See "State" on page 429

:SENSe<ch>[:POWer]:SVERsion?

Queries the software version of the connected R&S NRP power sensor.

Return values:
<SVersion> string

Example: `:SENS1:POW:SVER?`
Queries the software version of the power sensor.

Usage: Query only

:SENSe<ch>[:POWer]:TYPE?

Queries the sensor type. The type is automatically detected.

Return values:
<Type> string

Example: `:SENS1:TYPE?`
Queries the type of sensor.
`Response: NRP-Z21`
The R&S NRP-Z21 sensor is used.

Usage: Query only

Manual operation: See "Sensor type and serial number" on page 428

:SENSe<ch>[:POWer]:ZERO

Performs zeroing of the sensor.

Zeroing is required after warm-up, i.e. after connecting the sensor.

Note: Switch off or disconnect the RF power source from the sensor before zeroing.

We recommend that you zero in regular intervals (at least once a day), if:

- The temperature has varied more than about 5 °C.
- The sensor has been replaced.
- You want to measure very low power.

Example: `:SENS1:ZERO`
Executes zeroing.

Usage: Event

Manual operation: See "Zero" on page 429

13.16 SCONfiguration subsystem

The `SCONfiguration` subsystem contains the commands to define the system configuration, stream mapping and baseband configuration.

Required options

See "Required options" on page 491.

Common suffixes

The commands in this section use the following common suffixes:

Suffix	Suffix range	Description	Required option
CODer<ch>	[1]	Dig I/Q input connector, optional suffix HS Dig I/Q input connector, optional suffix	R&S SMM-B9
IQOutput<ch>	[1]	Dig I/Q output connector, optional suffix	R&S SMM-K19
RF<ch>	[1]	RF connector, optional suffix	Frequency option, for example, R&S SMM-B1003
STReam<st>	[1]	One I/Q stream, optional suffix	-

Example: Distributing the streams to the output connectors

The following example lists the commands necessary to fulfill this task.

```
// ******************************************************************************
// Map the I/Q streams to the output connectors.
// ******************************************************************************
SCONfiguration:OUTPut:MAPPing:RF1:STReam1:STATe ON
SCONfiguration:OUTPut:MAPPing:IQOutput1:STReam3:STATe ON
```

Example: Connecting and configuring external instruments

The following example lists commands to connect and configure external instruments.

```
// ******************************************************************************
// Scan interfaces and your network for connected instruments.
// ******************************************************************************
SCONfiguration:EXTernal:DISPlay ALL
SCONfiguration:EXTernal:REMote:CLEan
SCONfiguration:EXTernal:REMote:SCAN
SCONfiguration:EXTernal:REMote:SCAN:STATe?
// Response: "0"
// The scanning procedure is finished.


// ******************************************************************************
// Specify characteristics at the input and output interfaces.
// ******************************************************************************
SCONfiguration:EXTernal:CODer1:DIRection?
// Response: "IN"
SCONfiguration:EXTernal:BBMM1:DIRection?
```

```
// Response: "OUT"
SCONfiguration:EXTernal:IQOutput1:DIRection?
// Query the IQ connection state.
SCONfiguration:EXTernal:CODer1:IQConnection:STATe?
// Response: 1
SCONfiguration:EXTernal:BBMM1:IQConnection:STATe?
// Response: 1

// ***************************************************************************
// Manage external instruments.
// ***************************************************************************
SCONfiguration:EXTernal:REMote:LIST?
// Response: "SMBV100B,SGS_2,SGT100A,SMBVB_1,SMBVB_2,SMW200A (100010)"
// Add instruments to selection.
SCONfiguration:EXTernal:REMote:ADD "SGS_1","USB","100007"
SCONfiguration:EXTernal:REMote:ADD "SMW200A (100001)","LAN","10.112.11.125","2"
SCONfiguration:EXTernal:REMote:LIST?
// Response: "SMBV100B,SGS_2,SGT100A,SMBVB_1,SMBVB_2,SMW200A (100010),SGS_1,
// SMW200A (100001)"
SCONfiguration:EXTernal:REMote:REName "SGS_2","SGS (102030)"
SCONfiguration:EXTernal:REMote:LIST?
// Response: "SMBV100B,SGS (102030),SGT100A,SMBVB_1,SMBVB_2,SMW200A (100010),SGS_1,
// SMW200A (100001)"

// ***************************************************************************
// Detect external instruments and connect them to the R&S SMM100A.
// ***************************************************************************
SCONfiguration:EXTernal:BBMM1:REMote:DETect?
// Response: "SGT100A"
SCONfiguration:EXTernal:BBMM1:REMote:ISELect?
// Response: "SGT100A","A"
SCONfiguration:EXTernal:BBMM1:REMote:CONNect
// Alternatively, combine instrument select and connect.
SCONfiguration:EXTernal:BBMM1:REMote:ICONnect "SGT100A","A"
SCONfiguration:EXTernal:IQOutput1:REMote:ISELect "SGS_1","A"
SCONfiguration:EXTernal:IQOutput1:REMote:CONNect
// Alternatively, combine instrument select and connect.
SCONfiguration:EXTernal:IQOutput1:REMote:ICONnect "SGS_1","A"
// Query the connection state.
SCONfiguration:EXTernal:IQOutput1:RCONnection:STATe?
// Response: 1
SCONfiguration:EXTernal:BBMM1:RCONnection:STATe?
// Response: 1
// Query instrument names.
SCONfiguration:EXTernal:CODer1:INAMe?
SCONfiguration:EXTernal:BBMM1:INAMe?
// Response: "SGT100A [A]"
SCONfiguration:EXTernal:IQOutput1:INAMe?
// Response: "SGS_1 [A]"
```

```
// ********************************************************************************
// Specify characteristics of the IQ output signal.
// ********************************************************************************
SCONfiguration:EXTernal:BBMM1:RF:COUPling ON
SCONfiguration:EXTernal:BBMM1:RF:FREQuency:OFFSet 0
SCONfiguration:EXTernal:BBMM1:RF:POWer:OFFSet -10
OUTPut1:STATe ON
SCONfiguration:EXTernal:BBMM1:RF:STATe?
// Response: 1
SCONfiguration:EXTernal:IQOutput1:RF:COUPling OFF
SCONfiguration:EXTernal:IQOutput1:RF:FREQuency 2143000000
SCONfiguration:EXTernal:IQOutput1:RF:POWer -20
SCONfiguration:EXTernal:IQOutput1:RF:STATe ON

// ********************************************************************************
// Specify the intialization sequence with a user-defined initialization file.
// ********************************************************************************
MMEMory:CDIRectory "/var/user/RcExtInstr"
SCONfiguration:EXTernal:REMote:INITialization:CATalog?
// Response: "init_seq_sgs"
SCONfiguration:EXTernal:IQOutput1:REMote:INITialization:FILE "init_seq_sgs.iec"

SCONfiguration:EXTernal:ACONnect 1
*RST
SCONfiguration:EXTernal:BBMM1:INAMe?
// Response: timeout
SCONfiguration:EXTernal:REMote:PURGe
// Disconnect and disable remote control of the external instruments.
SCONfiguration:EXTernal:REMote:DISConnect[:ALL]
```

Example: Configuring primary-secondary mode

```
// For the primary instrument:
:SOURce1:ROSCillator:SOURce INT
:SCONfiguration:MULTiinstrument:MODe PRIMary
:SCONfiguration:MULTiinstrument:STATe 1
:SCONfiguration:APPLy

SOURce1:INPut:USER6:DIRection OUTP
OUTPut1:USER6:SIGNal INSinc

SOURce1:INPut:USER5:DIRection OUTP
OUTPut1:USER5:SIGNal INSinc

// For the secondary instrument:
SOURce1:ROSCillator:SOURce EXT
SOURce1:ROSCillator:EXTernal:FREQuency 10MHZ
:SCONfiguration:MULTiinstrument:MODe SECondary
:SCONfiguration:MULTiinstrument:STATe 1

SOURce1:INPut:USER5:DIRection INP
SOURce1:INPut:USER5:SIGNal OUTSinc
SOURce1:INPut:USER6:DIRection OUTP
OUTPut1:USER6:SIGNal INSinc
:SCONfiguration:MULTiinstrument:TRIGger:SYNChronization?
// SYNC
```


- Multi-instrument configuration commands 782
- I/Q stream mapper commands 783
- External RF and I/Q instruments commands 784

13.16.1 Multi-instrument configuration commands

The following commands configure multi-instrument settings.

Commands:

:SCONfiguration:MULTiinstrument:MODE 782
:SCONfiguration:MULTiinstrument:STATe 783
:SCONfiguration:MULTiinstrument:TRIGger:SYNChronization? 783

:SCONfiguration:MULTiinstrument:MODE <MSMode>

Sets if the instrument works as a primary or as a secondary instrument.

Parameters:

<MSMode> PRIMary | SECondary
*RST: PRIMary

Example: See Example "Configuring primary-secondary mode" on page 782.

Manual operation: See "Multi Instrument Trigger" on page 477

:SCONfiguration:MULTiinstrument:STATe <TriggerState>

Activates the selected mode.

Parameters:
<TriggerState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configuring primary-secondary mode" on page 782.

Manual operation: See "State" on page 477

:SCONfiguration:MULTiinstrument:TRIGger:SYNChronization?

Queries if synchronization is achieved.

Return values:
<SyncSTate> SYNC | NOSYnc
*RST: NOSYnc

Example: See Example "Configuring primary-secondary mode" on page 782.

Usage: Query only

Manual operation: See "Synchronisation State" on page 477

13.16.2 I/Q stream mapper commands

The following commands configure the I/Q stream mapper.

:SCONfiguration:OUTPut:MAPPing:RF<ch>:STReam<st>:STATe 783
:SCONfiguration:OUTPut:MAPPing:IQOutput<ch>:STReam<st>:STATe 783
:SCONfiguration:OUTPut:MAPPing:STReam<st>:FOFFset 784
:SCONfiguration:OUTPut:MAPPing:STReam<st>:POFFset 784

:SCONfiguration:OUTPut:MAPPing:RF<ch>:STReam<st>:STATe <State>
:SCONfiguration:OUTPut:MAPPing:IQOutput<ch>:STReam<st>:STATe <State>

Maps the I/Q output streams to the output connectors.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Distributing the streams to the output connectors" on page 779.

Manual operation: See "Map Stream X to Connector" on page 492

:SCONfiguration:OUTPut:MAPPing:STReam<st>:FOFFset <SmFreqOffset>

Sets the frequency offset per stream.

This offset implies a shift in the frequency domain for all signals that the stream routes to a specific output connector. For example, RF or I/Q output connectors. Value ranges depend on installed options.

For more information, refer to the specifications document.

Parameters:

<SmFreqOffset> float

Range: depends on options
Increment: 0.01
*RST: 0

Example: See Example "Distributing the streams to the output connectors" on page 779.

Manual operation: See "Frequency Offset" on page 492

:SCONfiguration:OUTPut:MAPPing:STReam<st>:POFFset <SmPhasOffset>

Sets the phase offset per stream.

Parameters:

<SmPhasOffset> float

Range: -999.99 to 999.99
Increment: 0.01
*RST: 0

Example: See Example "Distributing the streams to the output connectors" on page 779.

Manual operation: See "Phase Offset" on page 492

13.16.3 External RF and I/Q instruments commands

The following commands configure external RF and I/Q instruments.

Commands:

:SCONfiguration:EXTernal:DISPlay....786
:SCONfiguration:EXTernal:ACONnect....786
:SCONfiguration:EXTernal:REMote:CONNect[:ALL]....786
:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]....786
:SCONfiguration:EXTernal:PBEHaviour....787
:SCONfiguration:EXTernal:CODer<ch>:DIRection?....787
:SCONfiguration:EXTernal:FADer<ch>:DIRection?....787
:SCONfiguration:EXTernal:RF<ch>:DIRection?....787
:SCONfiguration:EXTernal:IQOutput<ch>:DIRection?....787
:SCONfiguration:EXTernal:CODer<ch>:IQConnection:STATe?....788

:SCONfiguration:EXTernal:FADer<ch>:IQConnection:STATe?....788
:SCONfiguration:EXTernal:CODer<ch>:RCONnection:STATe?....788
:SCONfiguration:EXTernal:FADer<ch>:RCONnection:STATe?....788
:SCONfiguration:EXTernal:RF<ch>:RCONnection:STATe?....788
:SCONfiguration:EXTernal:IQOutput<ch>:RCONnection:STATe?....788
:SCONfiguration:EXTernal:CODer<ch>:INAMe?....788
:SCONfiguration:EXTernal:FADer<ch>:INAMe?....788
:SCONfiguration:EXTernal:RF<ch>:INAMe?....788
:SCONfiguration:EXTernal:IQOutput<ch>:INAMe?....788
:SCONfiguration:EXTernal:FADer<ch>:RF:COUPling....789
:SCONfiguration:EXTernal:RF<ch>:RF:COUPling....789
:SCONfiguration:EXTernal:IQOutput<ch>:RF:COUPling....789
:SCONfiguration:EXTernal:FADer<ch>:RF:FREQuency....789
:SCONfiguration:EXTernal:RF<ch>:RF:FREQuency....789
:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency....789
:SCONfiguration:EXTernal:FADer<ch>:RF:FREQuency:OFFSet....789
:SCONfiguration:EXTernal:RF<ch>:RF:FREQuency:OFFSet....789
:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency:OFFSet....789
:SCONfiguration:EXTernal:FADer<ch>:RF:POWer....790
:SCONfiguration:EXTernal:RF<ch>:RF:POWer....790
:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer....790
:SCONfiguration:EXTernal:FADer<ch>:RF:POWer:OFFSet....790
:SCONfiguration:EXTernal:RF<ch>:RF:POWer:OFFSet....790
:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer:OFFSet....790
:SCONfiguration:EXTernal:FADer<ch>:RF:STATe....791
:SCONfiguration:EXTernal:RF<ch>:RF:STATe....791
:SCONfiguration:EXTernal:IQOutput<ch>:RF:STATe....791
:SCONfiguration:EXTernal:REMote:SCAN....791
:SCONfiguration:EXTernal:REMote:SCAN:STATe?....791
:SCONfiguration:EXTernal:REMote:LIST?....792
:SCONfiguration:EXTernal:REMote:ADD....792
:SCONfiguration:EXTernal:REMote:REName....793
:SCONfiguration:EXTernal:CODer<ch>:REMote:DETect?....793
:SCONfiguration:EXTernal:FADer<ch>:REMote:DETect?....793
:SCONfiguration:EXTernal:CODer<ch>:REMote:ISELect....793
:SCONfiguration:EXTernal:FADer<ch>:REMote:ISELect....793
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ISELect....793
:SCONfiguration:EXTernal:RF<ch>:REMote:ISELect....793
:SCONfiguration:EXTernal:CODer<ch>:REMote:CONNect....793
:SCONfiguration:EXTernal:FADer<ch>:REMote:CONNect....793
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:CONNect....793
:SCONfiguration:EXTernal:RF<ch>:REMote:CONNect....793
:SCONfiguration:EXTernal:CODer<ch>:REMote:ICONnect....794
:SCONfiguration:EXTernal:FADer<ch>:REMote:ICONnect....794
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ICONnect....794
:SCONfiguration:EXTernal:RF<ch>:REMote:ICONnect....794
:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO?....794
:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO?....794
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO?....794
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO?....794

:SCONfiguration:EXTernal:CODer<ch>:REMote:DISConnect 794
:SCONfiguration:EXTernal:FADer<ch>:REMote:DISConnect 794
:SCONfiguration:EXTernal:RF<ch>:REMote:DISConnect 794
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:DISConnect 794
:SCONfiguration:EXTernal:REMote:INITialization:CATalog? 795
:SCONfiguration:EXTernal:CODer<ch>:REMote:INITialization:FILE 795
:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:FILE 795
:SCONfiguration:EXTernal:RF<ch>:REMote:INITialization:FILE 795
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:FILE 795
:SCONfiguration:EXTernal:REMote:PURGe 795
:SCONfiguration:EXTernal:REMote:CLEan 796
:SCONfiguration:EXTernal:CODer<ch>:REMote:SEND 796
:SCONfiguration:EXTernal:FADer<ch>:REMote:SEND 796
:SCONfiguration:EXTernal:RF<ch>:REMote:SEND 796
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:SEND 796
:SCONfiguration:EXTernal:IQOutput<ch>:CONNections:CHECk? 796

:SCONfiguration:EXTernal:DISPlay <DisplayMode>

Filters the displayed connectors upon the selected criteria.

Parameters:

<DisplayMode> ALL | MAPPed | INPut | OUTPut

*RST: MAPPed

Example: See Example "Connecting and configuring external instruments" on page 779.

Manual operation: See "Display" on page 493

:SCONfiguration:EXTernal:ACONnect <State>

Enables automatic detection and connection setup of connected external instruments.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Distributing the streams to the output connectors" on page 779.

Manual operation: See "Auto Connect" on page 494

:SCONfiguration:EXTernal:REMote:CONNect[:ALL]
:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]

Triggers the instrument to establish the connections to all configured external instruments or to disconnect all existing connections.

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Event

Manual operation: See "Connect All Remote/Disconnect All Remote" on page 494

:SCONfiguration:EXTernal:PBEHaviour <State>

If enabled, the connection to the external instruments is retained after preset (`*RST`) of the instrument.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 0)

Example:

```
SCONfiguration:EXTernal:IQOutput1:RCONnection:STATe?
// 1
SOURce:FREQuency:CW?
// 60000000000
SOURce1:IQ:OUTPup:ANALog:TYPE DIFFerential

SCONfiguration:EXTernal:PBEHaviour 1
*RST
SOURce:FREQuency:CW?
// 60000000000
SCONfiguration:EXTernal:IQOutput1:RCONnection:STATe?
// 1
SOURce1:IQ:OUTPup:ANALog:TYPE?
// DIFF

SCONfiguration:EXTernal:PBEHaviour 0
*RST
SOURce:FREQuency:CW?
// 1000000000
SCONfiguration:EXTernal:IQOutput1:RCONnection:STATe?
// 0
SOURce1:IQ:OUTPut:ANALog:TYPE?
// SING
```

Manual operation: See "Preset behavior: Keep connections to external instruments" on page 494

:SCONfiguration:EXTernal:CODer<ch>:DIRection?
:SCONfiguration:EXTernal:FADer<ch>:DIRection?
:SCONfiguration:EXTernal:RF<ch>:DIRection?
:SCONfiguration:EXTernal:IQOutput<ch>:DIRection?

Queries the connector direction.

Return values:

<Direction> NONE | IN | OUT

*RST: IN

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Query only

Manual operation: See "Direction" on page 495

:SCONfiguration:EXTernal:CODer<ch>:IQConnection:STATe?
:SCONfiguration:EXTernal:FADer<ch>:IQConnection:STATe?
Return values:
<IQConnState> 1 | ON | 0 | OFF

Usage: Query only

:SCONfiguration:EXTernal:CODer<ch>:RCONnection:STATe?
:SCONfiguration:EXTernal:FADer<ch>:RCONnection:STATe?
:SCONfiguration:EXTernal:RF<ch>:RCONnection:STATe?
:SCONfiguration:EXTernal:IQOutput<ch>:RCONnection:STATe?

Queries the status of the remote connection.

Return values:
<State> 1 | ON | 0 | OFF

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Query only

Manual operation: See "Remote Connection Status" on page 496

:SCONfiguration:EXTernal:CODer<ch>:INAMe?
:SCONfiguration:EXTernal:FADer<ch>:INAMe?
:SCONfiguration:EXTernal:RF<ch>:INAMe?
:SCONfiguration:EXTernal:IQOutput<ch>:INAMe?

Queries the name of the connected external instrument.

Return values:
<InstrName> string

Returns the name of the connected external instrument.

<InstrmentName> (SerialNumber) <Path>
the instrument name, as retrieved via the DIG I/Q interface

<InstrmentName>[, <RfPath>] or <InstrmentName> (SerialNumber)
the instrument name, as defined in with the "Remote Config" settings or as defined by the command `:SCONfiguration:EXTernal:REMote:ADD`

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Query only

Manual operation: See "Instrument Name" on page 496

:SCONfiguration:EXTernal:FADer<ch>:RF:COUPling <RfCouplingState>
:SCONfiguration:EXTernal:RF<ch>:RF:COUPling <RfCouplingState>
:SCONfiguration:EXTernal:IQOutput<ch>:RF:COUPling <RfCouplingState>

Enables/disables coupling all major RF setting (like the frequency, level and RF state) of the external instrument to the R&S SMM100A.

Parameters:
<RfCouplingState> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "Connecting and configuring external instruments" on page 779.

Manual operation: See "RF Couple" on page 497

:SCONfiguration:EXTernal:FADer<ch>:RF:FREQuency <Frequency>
:SCONfiguration:EXTernal:RF<ch>:RF:FREQuency <Frequency>
:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency <Frequency>

In uncoupled mode, sets the RF frequency of the external instrument.

Parameters:
<Frequency> float
Range: 100E3 to 3E9
Increment: 0.01
*RST: 1E9

Example:
```
SCONfiguration:EXTernal:IQOutput1:RF:COUPling OFF
SCONfiguration:EXTernal:IQOutput1:RF:FREQuency 2143E6
// RF frequency of the external instrument is RF = 2.143 GHz
```

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 497

:SCONfiguration:EXTernal:FADer<ch>:RF:FREQuency:OFFSet <FreqOffset>
:SCONfiguration:EXTernal:RF<ch>:RF:FREQuency:OFFSet <FreqOffset>
:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency:OFFSet <FreqOffset>

In coupled mode, offsets the RF frequency of the external instrument with the selected delta value.

Parameters:
<FreqOffset> float
Range: -3E9 to 3E9
Increment: 0.01
*RST: 0

Example:
```
SOURce1:FREQuency:CW 2143E6
SCONfiguration:EXTernal:IQOutput1:RF:COUPling ON
SCONfiguration:EXTernal:IQOutput1:RF:FREQuency:OFFSet 20E6
// The resulting RF frequency of the external instrument is
// RF = 2143E6 + 20E6 = 2.163 GHz
// Where both the RF frequency and the frequency offset
// are applied at the external instrument
```

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 497

:SCONfiguration:EXTernal:FADer<ch>:RF:POWer <Power>
:SCONfiguration:EXTernal:RF<ch>:RF:POWer <Power>
:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer <Power>

In uncoupled mode, sets the RF level of the external instrument.

Parameters:

<Power> float

Range: -130 to 20
Increment: 0.01
*RST: -30

Example:
```
SOURce1:POWer:LEVel:IMMediate:AMPLitude -30
SCONfiguration:EXTernal:IQOutput1:RF:COUPling OFF
SCONfiguration:EXTernal:IQOutput1:RF:POWer -20
// RF level of the external instrument is -20 dB
```

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 497

:SCONfiguration:EXTernal:FADer<ch>:RF:POWer:OFFSet <PowerOffset>
:SCONfiguration:EXTernal:RF<ch>:RF:POWer:OFFSet <PowerOffset>
:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer:OFFSet <PowerOffset>

In coupled mode, offsets the RF level of the external instrument with the selected delta value.

Parameters:

<PowerOffset> float

Range: -100 to 100
Increment: 0.01
*RST: 0

Example:
```
SOURce1:POWer:LEVel:IMMediate:AMPLitude -30
SCONfiguration:EXTernal:IQOutput1:RF:COUPling ON
SCONfiguration:EXTernal:IQOutput1:RF:POWer:OFFSet -20
// RF level of the external instrument is -50 dB
// Where both the RF level and the level offset
// are applied at the external instrument
```

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 497

:SCONfiguration:EXTernal:FADer<ch>:RF:STATe <RemConnState>
:SCONfiguration:EXTernal:RF<ch>:RF:STATe <RemConnState>
:SCONfiguration:EXTernal:IQOutput<ch>:RF:STATe <RemConnState>

Sets the RF output state of the connected external instrument.

Parameters:
<RemConnState> 1 | ON | 0 | OFF

Example:
```
SCONfiguration:EXTernal:IQOutput1:RF:COUPling ON
OUTput1:STATe ON
SCONfiguration:EXTernal:IQOutput1:RF:STATe?
// Response: "1"
```

Example:
```
SCONfiguration:EXTernal:BBMM1:RF:COUPling OFF
SCONfiguration:EXTernal:BBMM1:RF:STATe ON
```

Example: See Example "Connecting and configuring external instruments" on page 779.

Manual operation: See "RF State" on page 497

:SCONfiguration:EXTernal:REMote:SCAN

Scans the network for connected instruments.

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Event

Manual operation: See "Scan" on page 499

:SCONfiguration:EXTernal:REMote:SCAN:STATe?

Queries if scanning is performed or not.

To start the scanning process, use the command `:SCONfiguration:EXTernal:REMote:SCAN` on page 791.

Return values:
<ScanState> 1 | ON | 0 | OFF

1
Scanning process running

0
Not scanning

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Query only

Manual operation: See "Scan" on page 499

:SCONfiguration:EXTernal:REMote:LIST?

Lists all available instruments.

Instruments found, e.g. by the `:SCONfiguration:EXTernal:REMote:SCAN` command.

Return values:

<InstrNames> String

String with symbolic names and/or alias names

Example: See Example "Connecting and configuring external instruments" on page 779

Usage: Query only

Manual operation: See "External Instrument" on page 500

:SCONfiguration:EXTernal:REMote:ADD <InstrName>, <HwChan>, <TcpIporUsbAddr>[, <RfPathNumber>]

Adds manually an external instrument to the list of available instruments.

Parameters:

<HwChan> String

Hardware channel (USB or LAN) used by the remote channel to the external instrument

Range: "LAN" to "USB"
*RST: "LAN"

<TcpIporUsbAddr> String

IP address or hostname of the connected external instrument

<RfPathNumber> String

Determines the number of RF paths the external instrument is equipped with

Range: "1" to "2"
*RST: "1"

Setting parameters:

<InstrName> String

Alias name of the instrument

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Setting only

Manual operation: See "External Instrument" on page 500
See "Set Symbolic Name" on page 500
See "Remote Channel" on page 500
See "Hostname or IP Address" on page 501
See "Device ID" on page 501
See "RF Path" on page 501

:SCONfiguration:EXTernal:REMote:REName

Changes the symbolic name of the instrument.

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Setting only

:SCONfiguration:EXTernal:CODer<ch>:REMote:DETect?
:SCONfiguration:EXTernal:FADer<ch>:REMote:DETect?
Return values:
<DetectedInstr> string

Usage: Query only

:SCONfiguration:EXTernal:CODer<ch>:REMote:ISELect <InstrName>[, <RfPath>]
:SCONfiguration:EXTernal:FADer<ch>:REMote:ISELect <InstrName>[, <RfPath>]
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ISELect <InstrName>[, <RfPath>]
:SCONfiguration:EXTernal:RF<ch>:REMote:ISELect <InstrName>[, <RfPath>]

Selects an external instrument for the selected connector.

Parameters:
<InstrName> String

Instrument alias name, as retrieved with the command : SCONfiguration:EXTernal:REMote:LIST?.
The name can also be defined with the command : SCONfiguration:EXTernal:REMote:ADD.

<RfPath> String

Determines the used RF output of the external instrument.
For a one-path instrument, the output path is fixed.

Manual operation: See "External Instrument" on page 500
See "Apply" on page 502
See "Apply and Connect" on page 502

:SCONfiguration:EXTernal:CODer<ch>:REMote:CONNect
:SCONfiguration:EXTernal:FADer<ch>:REMote:CONNect
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:CONNect
:SCONfiguration:EXTernal:RF<ch>:REMote:CONNect

Triggers the connection to the external instrument at the selected connector.

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Event

Manual operation: See "Apply and Connect" on page 502

:SCONfiguration:EXTernal:CODer<ch>:REMote:ICONnect <InstrName>, <RfPath>
:SCONfiguration:EXTernal:FADer<ch>:REMote:ICONnect <InstrName>, <RfPath>
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ICONnect <InstrName>, <RfPath>
:SCONfiguration:EXTernal:RF<ch>:REMote:ICONnect <InstrName>, <RfPath>

Selects an external instrument for the selected connector and triggers connection.

Parameters:

<InstrName> string

Instrument alias name, as retrieved with the command `:SCONfiguration:EXTernal:REMote:LIST?`.
The name can also be defined with the command `:SCONfiguration:EXTernal:REMote:ADD`.

<RfPath> string

Determines the used RF output of the external instrument.
For a one-path instrument, the output path is fixed to RF1.

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Setting only

:SCONfiguration:EXTernal:CODer<ch>:REMote:INFO?
:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO?
:SCONfiguration:EXTernal:RF<ch>:REMote:INFO?
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO?

Queries information on the external instrument.

Example:

```
SCONfiguration:EXTernal:BBMM1:REMote:INFO?
"SGT (101676)","LAN","rssgt100a101676","A",
"Rohde&Schwarz,SGT100A,1419.4501k02/101676,3.1.19.4-3.18.251.99"
```

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Query only

Manual operation: See "Remote Connection Status" on page 496
See "Instrument Name" on page 496
See "Set Symbolic Name" on page 500
See "Remote Channel" on page 500
See "Hostname or IP Address" on page 501
See "RF Path" on page 501

:SCONfiguration:EXTernal:CODer<ch>:REMote:DISConnect
:SCONfiguration:EXTernal:FADer<ch>:REMote:DISConnect
:SCONfiguration:EXTernal:RF<ch>:REMote:DISConnect
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:DISConnect

Disconnects the selected remote connection.

To disconnect all remote connections at once, use the command `:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]`.

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Event

Manual operation: See "Remote Connection Status" on page 496

:SCONfiguration:EXTernal:REMote:INITialization:CATalog?

Queries the names of the existing initialization files in the default directory.

Per default, the instrument saves user-defined files in the `/var/user/` directory. Use the command `:MMEM:CDIRectory` to change the default directory to the currently used one.

Only files with extension `*.iec` are listed.

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Query only

Manual operation: See "Initialization Sequence" on page 502

:SCONfiguration:EXTernal:CODer<ch>:REMote:INITialization:FILE <Filename>
:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:FILE <Filename>
:SCONfiguration:EXTernal:RF<ch>:REMote:INITialization:FILE <Filename>
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:FILE <Filename>

Queries the currently selected initialization file.

Parameters:

<Filename> string

filename with file extension (`*.iec`)

Example: See Example "Connecting and configuring external instruments" on page 779.

Manual operation: See "Initialization Sequence" on page 502

:SCONfiguration:EXTernal:REMote:PURGe

Removes unused instruments from the pool of external instruments.

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Event

Manual operation: See "Clean Unused/Clean All" on page 499

:SCONfiguration:EXTernal:REMote:CLEan

Removes all instruments from the pool of external instruments.

Example: See Example "Connecting and configuring external instruments" on page 779.

Usage: Event

Manual operation: See "Clean Unused/Clean All" on page 499

:SCONfiguration:EXTernal:CODer<ch>:REMote:SEND <SendScpiCommand>
:SCONfiguration:EXTernal:FADer<ch>:REMote:SEND <SendScpiCommand>
:SCONfiguration:EXTernal:RF<ch>:REMote:SEND <SendScpiCommand>
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:SEND <SendScpiCommand>

Allows you to send SCPI commands to the RF instruments connected to the R&S SMM100A.

Setting parameters:
<SendScpiCommand>"<SCPI syntax>"

String containing an SCPI command (query or setting)

Example: See Section 13.16, "SCONfiguration subsystem", on page 778.

Usage: Setting only

Manual operation: See "Command/Send Command" on page 504

:SCONfiguration:EXTernal:IQOutput<ch>:CONNections:CHECk?

Queries the status of the required connections between the R&S SMM100A and the R&S SZU.

R&S SZU is connected to the R&S SMM100A via USB.

Example:

```
SCONfiguration:EXTernal:IQOutput1:REMote:ISELect "SZU (999991) B1066"
SOURce1:IQ:OUTPut:ANALog:TYPE SING
SCONfiguration:EXTernal:IQOutput1:REMote:CONNect
SCONfiguration:EXTernal:ACONnect 1
SCONfiguration:EXTernal:PBEHaviour 1

SCONfiguration:EXTernal:IQOutput1:REMote:INFO?
// "SZU (999991) B1066","USB (vendor specific)","999991","A"

SOURce1:FREQuency:CONVerter:EXTernal:CHECk:CONNections?
// Passed,Failed,Unused,Failed,Unused,Passed
// The R&S SZU is connected to the R&S SMW
// The USB and the RF A to LO In connections are correct
// There is a failure in the single-ended I/Q connection
// (between the I/Q OUT and the I/Q IN connectors)
```

Usage: Query only

13.17 SOURce subsystem

The SOURce subsystem contains the commands for configuring signals.

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
SOURce<hw>	[1]	• SOURce[1] = RF output (optional keyword) • LF output = SOURce:LFOutput (SOURce is optional keyword)

- Connector settings 797
- SOURce:AWGN subsystem 806
- SOURce:BBIN subsystem 814
- Analog modulation subsystems 822
- SOURce:BB subsystem 843
- SOURce:CORRection subsystem 954
- SOURce:EFRontend subsystem 967
- SOURce:FREQuency subsystem 973
- SOURce:INPut subsystem 981
- SOURce:IQ subsystem 982
- SOURce:IQ:OUTPut subsystem 985
- SOURce:LFOutput subsystem 991
- SOURce:LIST subsystem 1004
- SOURce:NOISe subsystem 1017
- SOURce:OCCupy subsystem 1019
- SOURce:PGEN subsystem 1020
- SOURce:PHASe subsystem 1022
- SOURce:POWer subsystem 1022
- SOURce:ROSCillator subsystem 1040
- SOURce:SWEep subsystem 1046

13.17.1 Connector settings

This section summarizes the commands of the OUTPut and INPut subsystems, necessary to configure the connectors settings. Listed are the commands for configuring the output signals and the inputs for trigger, data, and control signals.

The ...:USER<ch>:... commands determine the global trigger threshold and input impedance values, that affect all trigger and control signal inputs. The connector settings concern to all digital modulations, the generation of waveforms or multi carrier signals, and all digital standards.

See Section 13.17.9, "SOURce:INPut subsystem", on page 981 for a description of the commands for configuring the inputs for external modulation signals.

See also Section 11.2, "Configuring local and global connectors", on page 563.

Example: Configuring global connectors

```
// ****************************************************************************
// Check the signal routing for a global connector, for example connector User 1.
// ****************************************************************************
SOURce1:INPut:USER1:DIRection?
// Response: "UNUS"
// User 1 connector is not in use.
SOURce1:INPut:USER1:SIGnal?
// Response: "NONE"
OUTPut1:USER1:SIGnal?
// Response: "NONE"
// User 1 connector expects no input signal and no output signal.

// ****************************************************************************
// Set signal direction and signal type.
// ****************************************************************************
SOURce1:INPut:USER1:DIRection INP
SOURce1:INPut:USER1:SIGNal TRIG1
SOURce1:INPut:USER2:DIRection OUTP
SOURce1:INPut:USER2:SIGNal MARKA2
SOURce1:INPut:USER3:DIRection INP
SOURce1:INPut:USER3:SIGNal NSEGM1

SOURce1:INPut:USER5:DIRection INP
SOURce1:INPut:USER5:SIGNal TRIG2

// ****************************************************************************
// Set input signal charateristics.
// ****************************************************************************
SOURce1:INPut:USER:TRIGger:LEVel 1.5
SOURce1:INPut:USER:PULM:LEVel 2

// Sets a common threshold of 1.5 V for USER 1 to User 3 connectors. This
// threshold applies to all input signals, in this example, TRIG1 and NSEGM1.
// Sets a common threshold of 2 V for USER 4 to User 6 connectors. This
// threshold applies to all input signals, in this example, IPULSA and TRIG2.

SOURce1:INPut:USER:IMPedance G1K
// Sets the impedance of 1 kOhm/GND for the trigger or clock input signals.
SOURce1:INPut:CLOCk:SLOPe POS
// Sets a positive polarity of the active slope for clock input signals.
SOURce1:INPut:TRIGger:SLOPe POS
// Sets a positive polarity of the active slope for trigger input signals.

// ****************************************************************************
// Set signal direction and signal type.
// ****************************************************************************
SOURce1:INPut:USER1:DIRection INP
SOURce1:INPut:USER1:SIGNal TRIG1
// The input signal at User 1 connector is a global trigger.
SOURce1:INPut:USER2:DIRection OUTP
OUTput1:USER2:SIGNal?
```

```
// Response: "MARKA1"
// The output signal at User 2 connector is the baseband marker 1.

// ***************************************************************************
// Set input signal charateristics.
// ***************************************************************************
SOURce1:INPut:USER:TRIGger:LEVel 1.5
// Sets a common threshold of 1.5 V for User 1 to User 2 connectors. This
// threshold applies to all input signals, in this example, TRIG1.
SOURce1:INPut:USER:TRIGger:IMPedance G1K
// Sets the impedance of 1 kOhm/GND for the trigger or clock input signals.
SOURce1:INPut:CLOCk:SLOPe POS
// Sets a positive polarity of the active slope for clock input signals.
SOURce1:INPut:TRIGger:SLOPe POS
// Sets a positive polarity of the active slope for trigger input signals.
```

Commands:

[:SOURce<hw>]:INPut:TM<ch>:DIRection....799
:OUTPut<hw>:TM<ch>:DIRection....799
[:SOURce]:INPut:USER<ch>:DIRection....800
:OUTPut:USER<ch>:DIRection....800
[:SOURce<hw>]:INPut:TM<ch>:SIGNal....800
:OUTPut<hw>:TM<ch>:SIGNal....801
[:SOURce]:INPut:USER<ch>:SIGNal....802
:OUTPut:USER<ch>:SIGNal....802
:OUTPut:USER<ch>:TRIGger[:IMMediate]....803
[:SOURce]:INPut:USER:CLOCk:LEVel....803
[:SOURce]:INPut:USER:TRIGger:LEVel....803
[:SOURce]:INPut:USER:PULM:LEVel....804
[:SOURce]:INPut:USER:CLOCk:IMPedance....804
[:SOURce]:INPut:USER:TRIGger:IMPedance....804
[:SOURce]:INPut:USER:CLOCk:SLOPe....804
[:SOURce]:INPut:USER:TRIGger:SLOPe....804
[:SOURce<hw>]:INPut:TM:CLOCk:LEVel....805
[:SOURce<hw>]:INPut:TM:TRIGger:LEVel....805
[:SOURce<hw>]:INPut:TM:CLOCk:IMPedance....805
[:SOURce<hw>]:INPut:TM:TRIGger:IMPedance....805
[:SOURce<hw>]:INPut:TM:CLOCk:SLOPe....805
[:SOURce<hw>]:INPut:TM:TRIGger:SLOPe....806

[:SOURce<hw>]:INPut:TM<ch>:DIRection <Direction>
:OUTPut<hw>:TM<ch>:DIRection <Direction>

Determines whether the connector is used as an input or an output.

Suffix:

OUTPut<hw> | SOURce<hw>
1 | 2
Determines the baseband the connectors belong to, where:
`OUTPut1|SOURce1` = Baseband A/C and
`OUTPut2|SOURce2` = Baseband B/D

TM<ch> 1|2|3
Determines the local connector, where:
`OUTPut1:TM1|2|3` and `SOURce1:INPut:TM1|2|3` define TMC1/2/3 of Baseband A/C and
`OUTPut2:TM1|2|3` and `SOURce2:INPut:TM1|2|3` define TMC4/5/6 of Baseband B/D

Parameters:
<Direction> INPut | OUTPut
*RST: OUTPut

Manual operation: See "Direction" on page 575

[:SOURce]:INPut:USER<ch>:DIRection <Direction>
:OUTPut:USER<ch>:DIRection <Direction>

Sets the direction of the signal at the connector that can be an input or an output.

Suffix:
USER<ch> 1 to 6
"User" connector number

Parameters:
<Direction> INPut | OUTPut | UNUSed

INPut|OUTPut
Input signal or output signal

UNUSed
No signals present at the connector.

Example: See Example "Configuring global connectors" on page 798.

Manual operation: See "Direction" on page 572

[:SOURce<hw>]:INPut:TM<ch>:SIGNal <Signal>

Determines the control signal that is input at the selected connector.

To define the connector direction, use the command `[:SOURce<hw>]:INPut:TM<ch>:DIRection`.

Suffix:
SOURce<hw> 1 | 2
Determines the baseband the connectors belong to, where:
`SOURce1` = Baseband A/C and
`SOURce2` = Baseband B/D

TM<ch> 1|2|3
Determines the local connector, where:
`SOURce1:INPut:TM1|2|3` = TMC1/2/3 of Baseband A/C and
`SOURce2:INPut:TM1|2|3` = TMC4/5/6 of Baseband B/D

Parameters:

<Signal> TRIGger | CLOCk | FEEDback | DATA

`CLOCk` is available only for `TM1`
`DATA` is available only for `TM2`
`FEEDback` is available only for `TM2`

Manual operation: See "Signal" on page 575

:OUTPut<hw>:TM<ch>:SIGNal <Signal>

Determines the control signal that is output at the selected connector.

To define the connector direction, use the command `:OUTPut<hw>:TM<ch>:DIRection`.

Suffix:

OUTPut<hw> 1 | 2
Determines the baseband the connectors belong to, where:
`OUTPut1` = Baseband A/C or Baseband 1/3
`OUTPut2` = Baseband B/D or Baseband 2/4

TM<ch> 1|2|3
Determines the local connector, where:
`OUTPut1:TM1|2|3` = TMC1/2/3 of Baseband A/C or 1/3 and
`OUTPut2:TM1|2|3` = TMC4/5/6 of Baseband B/D or 2/4

Parameters:

<Signal> MARKA1 | MARKA2 | MARKA3 | SCLA | LATTA | BGATA | HOPA | CWMODA | TRIGA | MARKB1 | MARKB2 | MARKB3 | SCLB | LATTB | BGATB | HOPB | CWMODB | TRIGB | MARKC1 | MARKC2 | MARKC3 | SCLC | LATTC | BGATC | HOPC | CWMODC | TRIGC | MARKD1 | MARKD2 | MARKD3 | SCLD | LATTD | BGATD | HOPD | CWMODD | TRIGD

`MARKA1|MARKC1|MARKA2|MARKC2|(MARKA3|MARKC3)` = Baseband A/C Marker 1/2/(3)
`SCLA|SCLB|SCLC|SCLD` = Symbol Clock A/B/C/D
`LATTA|LATTB|LATTC|LATTD` = Lev Att A/B/C/D
`BGATA|BGATB|BGATC|BGATD` = Burst Gate A/B/C/D
`HOPA|HOPB|HOPC|HOPD` = HOP A/B/C/D
`CWMODA|CWMODB|CWMODC|CWMODD` = CW/Mod A/B/C/D
`TRIGA|TRIGB|TRIGC|TRIGD` = Triggered A
The character A/B/C/D in the parameter value indicates the baseband the signal is related to.

*RST: depends on TM suffix

Example:

```
:SOURce1:INPut:TM2:DIRection OUTPut
:OUTPut1:TM2:DIRection?
// OUTPut
:OUTPut1:TM2:SIGNal MARKA2
```

Manual operation: See "Signal" on page 575

[:SOURce]:INPut:USER<ch>:SIGNal <Signal>

Determines the control signal that is input at the selected connector.

To define the connector direction, use the command `[:SOURce]:INPut:USER<ch>:DIRection`.

Suffix:
USER<ch> 1 to 6

Parameters:
<Signal> TRIG1 | TRIG2 | CLOCK1 | CLOCK2 | NSEGM1 | NSEGM2 | NONE | FEEDback | IPULSA | IPULSB | ERRTA | ERRTB | BERDATIN | BERCLKIN | BERDATENIN | BERRESTIN

`TRIG1|TRIG2` = Global Trigger 1/2
`CLOCK1|CLOCK2` = Global Clock 1/2
`NSEGM1|NSEGM2` = Global Next Segment 1/2
`IPULSA|IPULSB` = Pulse In A/B, available for `USER4|5|6`
`FEEDback` = Baseband Feedback, available for `USER6`
`BERDATIN|BERCLKIN|BERDATENIN|BERRESTIN` = BER Data, Clock, Data Enable and Restart
`ERRTA|ERRTB` = External restart trigger signals for REG

Example: See Example "Configuring global connectors" on page 798.

Options: BERDATIN|BERCLKIN|BERDATENIN|BERRESTIN require R&S SMM-K80
ERRTA|ERRTB require R&S SMM-K78

Manual operation: See "Signal" on page 572

:OUTPut:USER<ch>:SIGNal <Signal>

Sets the control signal that is output at the selected connector.

To define the connector direction, use the command `:OUTPut:USER<ch>:DIRection`.

Suffix:
USER<ch> 1 to 6

Parameters:
<Signal> MARKA1 | MARKA2 | MARKA3 | MARKB1 | MARKB2 | MARKB3 | MARKC1 | MARKC2 | MARKC3 | MARKD1 | MARKD2 | MARKD3 | SVALA | SVALB | OPULSA | OPULSB | SYNCA | VIDEOA | VIDEOB | SYNCB | NONE | RTRIGA | RTRIGB | SVALANegated | SVALBNegated | LOW | HIGH | MTRigger | BERRESTOUT | BERDATENOUT | BERCLKOUT | BERDATOUT

`SVALA|SVALB` = Signal Valid A/B, available for `USER4|5|6`
`SVALANegated|SVALBNegated` = Signal Valid A/B (negative), available for `USER4|5|6`
`OPULSA|OPULSB` = Pulse Out A/B, available for `USER4|5|6`

SYNCA | SYNCB = Pulse Sync A/B, available for USER4 | 5 | 6
VIDEOA | VIDEOB = Pulse Video A/B, available for USER4 | 5 | 6
MTRigger = Manual Trigger, available for USER6
RTRIGA | RTRIGB = REG trigger A/B, available for USER4 | 5
BERRESTOUT | BERDATENOUT | BERCLKOUT | BERDATOUT = BERT TestGen Data, Clock, Data Enable and Restart
LOW | HIGH = Always 0/1
NONE = none

*RST: MARKA1

Example: See Example "Configuring global connectors" on page 798.

Options: BERRESTOUT|BERDATENOUT|BERCLKOUT|BERDATOUT require R&S SMM-K80
RTRIGA|RTRIGB require R&S SMM-K78

Manual operation: See "Signal" on page 572

:OUTPut:USER<ch>:TRIGger[:IMMediate]

Generates a short pulse signal and outputs it at the User connector.

This signal can serve as a common external trigger signal for triggering of several R&S SMM100A, see Example "Triggering several R&S SMM100A instruments simultaneously" on page 481.

Suffix:
USER<ch> 1 to 6

Example: See Example "Configuring global connectors" on page 798.

Usage: Event

Manual operation: See "Execute Trigger" on page 573

[:SOURce]:INPut:USER:CLOCk:LEVel <Level>
[:SOURce]:INPut:USER:TRIGger:LEVel <Level>

Sets the threshold for any input signal at the "User 1" to "User 3" connectors.

Parameters:
<Level> float

Range: 0.1 to 2
Increment: 0.1
*RST: 1

Example: See Example "Configuring global connectors" on page 798.

Manual operation: See "Threshold User1-3 Input" on page 574

[:SOURce]:INPut:USER:PULM:LEVel <Level>

Parameters:

<Level> float

Range: 0.1 to 2
Increment: 0.1
*RST: 1
Default unit: V

Example: See Example "Configuring global connectors" on page 798.

Manual operation: See "Threshold User4-6 Input/Threshold Pulse Input" on page 378

[:SOURce]:INPut:USER:CLOCk:IMPedance <Impedance>
[:SOURce]:INPut:USER:TRIGger:IMPedance <Impedance>

Selects the input impedance for the external trigger inputs.

Parameters:

<Impedance> G50 | G1K

G50
50 Ω per ground

G1K
1 kΩ per ground

*RST: G1K

Example: See Example "Configuring global connectors" on page 798.

Manual operation: See "Impedance Clock/Trigger Input" on page 574

[:SOURce]:INPut:USER:CLOCk:SLOPe <Slope>

Sets the polarity of the active slope of an externally applied clock signal.

Parameters:

<Slope> NEGative | POSitive

*RST: POSitive

Example: See Example "Configuring global connectors" on page 798.

Manual operation: See "Clock Input Slope" on page 574

[:SOURce]:INPut:USER:TRIGger:SLOPe <Slope>

Sets the polarity of the active slope of an external trigger signal.

Parameters:

<Slope> NEGative | POSitive

*RST: POSitive

Example: See Example "Configuring global connectors" on page 798.

Manual operation: See "Trigger Input Slope" on page 574

[:SOURce<hw>]:INPut:TM:CLOCk:LEVel <Level>
[:SOURce<hw>]:INPut:TM:TRIGger:LEVel <Level>

Sets the high/low threshold in volts for the trigger and clock signal inputs of the baseband section.

Suffix:
SOURce<hw> 1 | 2
Determines the baseband the connectors belong to, where:
`SOURce1` = Baseband A/C and
`SOURce2` = Baseband B/D

Parameters:
<Level> float

Range: 0.3 to 2
Increment: 0.1
*RST: 1

Manual operation: See "Threshold Clock/Trigger Input" on page 576

[:SOURce<hw>]:INPut:TM:CLOCk:IMPedance <Impedance>
[:SOURce<hw>]:INPut:TM:TRIGger:IMPedance <Impedance>

Selects the input impedance for the external trigger/clock inputs.

Suffix:
SOURce<hw> 1 | 2
Determines the baseband the connectors belong to, where:
`SOURce1` = Baseband A/C and
`SOURce2` = Baseband B/D

Parameters:
<Impedance> G50 | G1K

G50
50 Ω per ground

G1K
1 kΩ per ground

G10K
For backward compatibility with other Rohde & Schwarz signal generators. The R&S SMM100A maps this value to `G1K`.

*RST: G1K

Manual operation: See "Impedance Clock/Trigger Input" on page 576

[:SOURce<hw>]:INPut:TM:CLOCk:SLOPe <Slope>

Sets the polarity of the active slope of an externally applied clock signal.

Suffix:
SOURce<hw> 1 | 2
Determines the baseband the connectors belong to, where:
`SOURce1` = Baseband A/C and
`SOURce2` = Baseband B/D

Parameters:
<Slope> NEGative | POSitive
*RST: POSitive

Manual operation: See "Clock Input Slope" on page 576

[:SOURce<hw>]:INPut:TM:TRIGger:SLOPe <Slope>

Sets the polarity of the active slope of an externally applied trigger signal.

Suffix:
SOURce<hw> 1 | 2
Determines the baseband the connectors belong to, where:
`SOURce1` = Baseband A/C and
`SOURce2` = Baseband B/D

Parameters:
<Slope> NEGative | POSitive
*RST: POSitive

Manual operation: See "Trigger Input Slope" on page 576

13.17.2 SOURce:AWGN subsystem

The `SOURce:AWGN` subsystem contains the commands for setting the noise generator.

Required options

See Section 5.1.1, "Required options", on page 266.

Programming examples

Example: To generate a pure noise signal

The following example generates a pure noise signal with a specified bandwidth and noise level.

```
:SOURce1:AWGN:MODE ONLY
:SOURce1:AWGN:BWIDth 3840000
:SOURce1:AWGN:BWIDth:RATio 2
:SOURce1:AWGN:STATe ON
:SOURce1:AWGN:BWIDth:NOISe?
// Response: 7680000
:SOURce1:AWGN:FREQuency:CENTer:OFFSet 1000000
// Shifts the noise signal by 1 MHz relative to the carrier frequency.
```

```
:SOURce1:AWGN:DISP:MODE RFA
:SOURce1:AWGN:POWer:NOISe -80
:SOURce1:POWer:LEVel:IMMediate:AMPlitude?
// Response: -80
:SOURce1:AWGN:POWer:NOISe:TOTal?
// Response: -80
```

Example: To generate a CW interferer signal

The following example generates a CW interferer signal with a specified target frequency and level.

```
:SOURce1:AWGN:MODE CW
:SOURce1:AWGN:FREQuency:TARGet 20000000
:SOURce1:AWGN:STATe ON
:SOURce1:AWGN:FREQuency:RESult?

:SOURce1:AWGN:POWer:RMODe CARRier
:SOURce1:AWGN:CNRatio 10
:SOURce1:AWGN:POWer:CARRier -80
// The level display indicates the PEP of the carrier.
:SOURce1:POWer:LEVel:IMMediate:AMPlitude?
// Response: -80
// Querry the power of the interfering signal
:SOURce1:AWGN:POWer:NOISe?
// Response: -90
:SOURce1:AWGN:POWer:SUM?
// Response: -79.5860731484178
:SOURce1:AWGN:POWer:SUM:PEP?
// Response: -80
```

Example: To generate an additive noise signal

The following example shows how to adjust the AWGN settings to generate a signal with the following characteristics:

- The carrier signal is an uplink EUTRA/LTE signal with:
  - "Channel Bandwidth" = "1.4 GHz" corresponds to "Occupied Bandwidth" = "1.080 MHz"
  - "RF Frequency" = "1.95 GHz"
  - "RF Level" = "-76 dBm"
- Required is an SNR of 12.7 dB.

```
:SOURce1:FREQuency:CW 1950000000
:SOURce1:POWer:LEVel:IMMediate:AMPlitude -76

:SOURce1:AWGN:MODE ADD
// set the system bandwidht to the occupied bandwidth
:SOURce1:AWGN:BWIDth 1080000
:SOURce1:AWGN:BWIDth:RATio 1.5
```

```
:SOURce1:AWGN:STATe ON
:SOURce1:AWGN:BWIDth:NOISe?
// Response: 1620000

:SOURce1:AWGN:DISP:MODE RFA
:SOURce1:AWGN:POWer:MODE CN
:SOURce1:AWGN:POWer:RMODe CARRier
:SOURce1:AWGN:BRATe?
//  Response: 100000
:SOURce1:AWGN:CNRatio 12.7
:SOURce1:AWGN:ENRatio?
// Response: 23.0342375548695
:SOURce1:AWGN:POWer:CARRier?
// Response: -76
// the Level display indicates the PEP of the carrier

// Querry the resulting noise power, in the system and total bandwidth
:SOURce1:AWGN:POWer:NOISe?
// Response: -88.7
:SOURce1:AWGN:POWer:NOISe:TOTal?
// Response: -88.7
// Querry the carrier+noise power and PEP
:SOURce1:AWGN:POWer:SUM?
// Response: -75.7728170942726
:SOURce1:AWGN:POWer:SUM:PEP?
// Response: -76
```

13.17.2.1 General commands

[:SOURce<hw>]:AWGN:STATe....809
[:SOURce<hw>]:AWGN:MODE....809
[:SOURce<hw>]:AWGN:BWIDth....809
[:SOURce<hw>]:AWGN:BWIDth:RATio....809
[:SOURce<hw>]:AWGN:BWIDth:NOISe?....810
[:SOURce<hw>]:AWGN:DISP:MODE....810
[:SOURce<hw>]:AWGN:POWer:MODE....810
[:SOURce<hw>]:AWGN:POWer:RMODe....811
[:SOURce<hw>]:AWGN:BRATe....811
[:SOURce<hw>]:AWGN:CNRatio....811
[:SOURce<hw>]:AWGN:ENRatio....811
[:SOURce<hw>]:AWGN:POWer:CARRier....812
[:SOURce<hw>]:AWGN:POWer:NOISe....812
[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal?....812
[:SOURce<hw>]:AWGN:POWer:SUM?....813
[:SOURce<hw>]:AWGN:POWer:SUM:PEP?....813
[:SOURce<hw>]:AWGN:FREQuency:CENTer:OFFSet....813
[:SOURce<hw>]:AWGN:FREQuency:TARGet....814
[:SOURce<hw>]:AWGN:FREQuency:RESult?....814

[:SOURce<hw>]:AWGN:STATe <State>

Activates or deactivates the AWGN generator.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "To generate a pure noise signal" on page 806.

Manual operation: See "State" on page 272

[:SOURce<hw>]:AWGN:MODE <Mode>

Determines how the interfering signal is generated.

Parameters:

<Mode> ONLY | ADD | CW

ADD
The AWGN noise signal is added to the baseband signal.

ONLY
The pure AWGN noise signal is modulated to the carrier. The connection to the baseband is interrupted

CW
The sine interfering signal is added to the baseband signal.

*RST: ADD

Example: See Example "To generate an additive noise signal" on page 807

Manual operation: See "Mode" on page 272

[:SOURce<hw>]:AWGN:BWIDth <BWidth>

Sets the system bandwidth.

Parameters:

<BWidth> float

Range: 1000 to 80E6
Increment: 100
*RST: 3.84E6

Example: See Example "To generate an additive noise signal" on page 807.

Manual operation: See "System Bandwidth" on page 272

[:SOURce<hw>]:AWGN:BWIDth:RATio <Ratio>

Sets the ratio of minimum real noise bandwidth to system bandwidth, see also "Signal and noise parameters" on page 267.

Parameters:

<Ratio> float

Range: 1 to Max
Increment: 0.1
*RST: 1

Example: see Example "To generate an additive noise signal" on page 807.

Manual operation: See "Min Noise/System Bandwidth Ratio" on page 272

[:SOURce<hw>]:AWGN:BWIDth:NOISe?

Queries the real noise bandwidth.

Return values:

<Noise> float

Range: 0 to 200E6
Increment: 100
*RST: 0

Example: See Example "To generate an additive noise signal" on page 807.

Usage: Query only

Manual operation: See "Noise Bandwidth" on page 278

[:SOURce<hw>]:AWGN:DISP:MODE <Mode>

Sets the output to that the AWGN settings are related.

Parameters:

<Mode> RFA | IQOUT1

*RST: RF

Example: See Example "To generate an additive noise signal" on page 807.

Manual operation: See "Show Powers For Output" on page 274

[:SOURce<hw>]:AWGN:POWer:MODE <Mode>

Selects the mode for setting the noise level.

Parameters:

<Mode> CN | SN | EN

*RST: SN

Example: see Example "To generate an additive noise signal" on page 807

Manual operation: See "Set Noise Power Via" on page 274

[:SOURce<hw>]:AWGN:POWer:RMODe <RMode>

Determines whether the carrier or the noise level is kept constant when the C/N value or Eb/N0 value is changed.

Parameters:

<RMode> CARRier | NOISe

*RST: CARRier

Example: See Example "To generate an additive noise signal" on page 807

Manual operation: See "Reference Mode" on page 274

[:SOURce<hw>]:AWGN:BRATe <BRate>

Sets the bit rate used for calculation of bit energy to noise power ratio.

Valid units are bps, kbps and mabps as well as b/s, kb/s and mab/s.

Parameters:

<BRate> float

Range: 400 to depends on options
Increment: 0.001
*RST: 100000

Example: see Example "To generate an additive noise signal" on page 807

Manual operation: See "Bit Rate" on page 275

[:SOURce<hw>]:AWGN:CNRatio <CnRatio>

Sets the carrier/interferer ratio.

Parameters:

<CnRatio> float

Range: -50 to depends on options
Increment: 0.01
*RST: 0

Example: See Example "To generate an additive noise signal" on page 807

Manual operation: See "Carrier/Noise Ratio/Signal/Noise Ratio" on page 275

[:SOURce<hw>]:AWGN:ENRatio <EnRatio>

Sets the ratio of bit energy to noise power density.

Parameters:
<EnRatio> float
Range: -50 to depends on options
Increment: 0.01
*RST: 15.84
Default unit: dB

Example: See Example "To generate an additive noise signal" on page 807

Manual operation: See "Eb/N0" on page 275

[:SOURce<hw>]:AWGN:POWer:CARRier <Carrier>

Sets the carrier power.

Parameters:
<Carrier> float
Increment: 0.01
*RST: 0

Example: see Example "To generate an additive noise signal" on page 807

Manual operation: See "Carrier Power/Signal Power" on page 276

[:SOURce<hw>]:AWGN:POWer:NOISe <Noise>

Sets the power of the noise signal in the system respectively total bandwidth.

Parameters:
<Noise> float
Increment: 0.01

Example: see Example "To generate an additive noise signal" on page 807

Manual operation: See "Noise Power (System Bandwidth)/Interferer Power" on page 276

[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal?

Queries the noise level in the total bandwidth.

Return values:
<Total> float
Range: -145 to 20
Increment: 0.01
*RST: -30

Example: see Example "To generate an additive noise signal" on page 807

Usage: Query only

Manual operation: See "Noise Power (Total Bandwidth)" on page 277

[:SOURce<hw>]:AWGN:POWer:SUM?

Queries the overall power of the noise/interferer signal plus useful signal

Return values:

<Sum> float

Range: -145 to 20
Increment: 0.01
*RST: 0

Example: see Example "To generate an additive noise signal" on page 807

Usage: Query only

Manual operation: See "Carrier + Noise Power/Signal + Noise Power (System Bandwidth)/Carrier + Interferer Power/Signal + Interferer Power" on page 277

[:SOURce<hw>]:AWGN:POWer:SUM:PEP?

Queries the peak envelope power of the overall signal comprised of noise signal plus useful signal.

Return values:

<Pep> float

Range: -145 to 20
Increment: 0.01
*RST: 0

Example: see Example "To generate an additive noise signal" on page 807

Usage: Query only

Manual operation: See "Carrier + Noise PEP/Signal + Noise PEP (Total Bandwidth)/Carrier + Interferer PEP/Signal + Interferer PEP" on page 278

[:SOURce<hw>]:AWGN:FREQuency:CENTer:OFFSet <CenterFreqOffs>

Defines the frequency offset of the noise signal relative to the carrier center frequency.

Parameters:

<CenterFreqOffs> float

Range: -40E6 to 40E6
Increment: 0.01
*RST: 0

Example: See Example "To generate a pure noise signal" on page 806.

Manual operation: See "Center Frequency Offset" on page 273

[:SOURce<hw>]:AWGN:FREQuency:TARGet <Target>

Sets the desired frequency of the sine wave.

Parameters:

<Target> float

Range: -40E6 to 40E6
Increment: 0.01
*RST: 0

Example: see Example "To generate a CW interferer signal" on page 807

Manual operation: See "Target CW Frequency Offset" on page 273

[:SOURce<hw>]:AWGN:FREQuency:RESult?

Queries the actual frequency of the sine wave.

Return values:

<Result> float

Range: -40E6 to 40E6
Increment: 0.01
*RST: 0

Example: see Example "To generate a CW interferer signal" on page 807

Usage: Query only

Manual operation: See "Resulting CW Frequency Offset" on page 278

13.17.3 SOURce:BBIN subsystem

The `SOURce:BBIN` subsystem contains the commands for setting the external digital baseband signal.

Required options

Example: Applying an external digital baseband signal (Dig I/Q)

An external digital signal must be applied at the Dig I/Q connectors.

```
// Use the external signal supplied at the CODER 1 interface.
SOURce1:BBIN:DIGital:SOURce CODER1

// SOURce1:BBIN:DIGital:IQSWap:STATe 1

// Set the sample rate source and query the value.
SOURce1:BBIN:SRATe:SOURce DIN
SOURce1:BBIN:SRATe:ACTual? 100000000
SOURce1:BBIN:STATe ON

// enable automatic adjustment of the baseband input signal
SOURce1:BBIN:DIGital:ASETting:STATe ON
```

```
SOURce1:BBIN:MPERiod 10s
SOURce1:BBIN:ALEVel:EXECute
SOURce1:BBIN:CFACtor?
SOURce1:BBIN:POWer:PEAK?
SOURce1:BBIN:POWer:RMS?

// monitor the signal
SOURce1:BBIN:OLOad:STATe?
// 0, i.e. no overflow detected
SOURce1:BBIN:OLOad:HOLD:RESet
SOURce1:BBIN:OLOad:HOLD:STATe?
```

Example: Applying an external digital baseband signal (HS Dig I/Q)

An external digital signal must be applied at the HS Dig I/Q connectors.

```
SOURce1:BBIN:STATe 1

SOURce1:BBIN:DIGital:INTerface HSD
SOURce1:BBIN:SRATe:SOURce? HSD
SOURce1:BBIN:CHANnel0:NAME?
SOURce1:BBIN:CHANnel0:SRATe?
// 100000000
SOURce1:BBIN:CHANnel0:POWer:CFACtor 0.5
SOURce1:BBIN:CHANnel0:POWer:PEAK 3
SOURce1:BBIN:CHANnel0:POWer:RMS?
// 2.5
SOURce1:BBIN:CHANnel0:BB:STATe 1
SOURce1:BBIN:SRATe:SUM?
// 100000000
SOURce1:BBIN:SRATe:MAX?
// 1250000000

// Set the sample rate per channel.
SOURce1:BBIN:SRATe:SOURce USER
SOURce1:BBIN:CHANnel0:SRATe 500000000
SOURce1:BBIN:SRATe:SUM?
// 500000000

SOURce1:BBIN:MPERiod 2
SOURce1:BBIN:ALEVel:EXECute
```

[:SOURce<hw>]:BBIN:STATe 816
[:SOURce<hw>]:BBIN:DIGital:SOURce 816
[:SOURce<hw>]:BBIN:DIGital:INTerface 816
[:SOURce<hw>]:BBIN:CDEVice? 817
[:SOURce<hw>]:BBIN:CHANnel<ch0>:BB:STATe 817
[:SOURce<hw>]:BBIN:CHANnel<ch0>:NAME 817
[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:CFACtor 818
[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:PEAK 818
[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:RMS 818

[:SOURce<hw>]:BBIN:CHANnel<ch0>:SRATe 818
[:SOURce<hw>]:BBIN:MODE 819
[:SOURce<hw>]:BBIN:SRATe:SOURce 819
[:SOURce<hw>]:BBIN:SRATe:SUM? 819
[:SOURce<hw>]:BBIN:SRATe:MAX? 820
[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe 820
[:SOURce<hw>]:BBIN:MPERiod 820
[:SOURce<hw>]:BBIN:ALEVel:EXECute 821
[:SOURce<hw>]:BBIN:POWer:CFACtor 821
[:SOURce<hw>]:BBIN:POWer:PEAK 821
[:SOURce<hw>]:BBIN:POWer:RMS? 821

[:SOURce<hw>]:BBIN:STATe <State>

Enables feeding of an external digital signal into the signal path.

Note: Interdependencies

The following functions cannot be activated simultaneously. **They deactivate each other**.

- The internal baseband generator (`[:SOURce<hw>]:BB:<DigStd>:STATe`) and the external digital baseband input (`[:SOURce<hw>]:BBIN:STATe`)

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814.

Manual operation: See "State" on page 508

[:SOURce<hw>]:BBIN:DIGital:SOURce <DigInpSource>

Defines the connector used as an external signal source.

Parameters:

<DigInpSource> CODER1

*RST: CODER1

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814.

Manual operation: See "Connector" on page 508

[:SOURce<hw>]:BBIN:DIGital:INTerface <BBinDigInterfac>

Selects the input connector at that the signal is fed.

Parameters:

<BBinDigInterfac> DIGital | HSDin | DIGital | HSDin

DIN
Dig I/Q

HSDin
HS Dig I/Q

*RST: HSDin

Example: See Example "Applying an external digital baseband signal (HS Dig I/Q)" on page 815.

Manual operation: See "Interface" on page 508

[:SOURce<hw>]:BBIN:CDEVice?

Indicates the ID of an externally connected Rohde & Schwarz Instrument or Rohde & Schwarz device.

Return values:
<CDevice> string

"None" - no device is connected.

Example: SOURce:BBIN:CDEVice?
Queries the connected device ID.

Usage: Query only

Manual operation: See "Connected Device" on page 509

[:SOURce<hw>]:BBIN:CHANnel<ch0>:BB:STATe <BbinIqHsChanSta>

Activates the channel.

Parameters:
<BbinIqHsChanSta> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Applying an external digital baseband signal (HS Dig I/Q)" on page 815.

Manual operation: See "BB" on page 510

[:SOURce<hw>]:BBIN:CHANnel<ch0>:NAME <BbinIqHsChanNam>

Queries the channel name.

Parameters:
<BbinIqHsChanNam> string

Example: See Example "Applying an external digital baseband signal (HS Dig I/Q)" on page 815.

Manual operation: See "Name" on page 510

[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:CFACtor <BbinIqHsChCrFac>

Sets the crest factor of the individual channels.

Parameters:
<BbinIqHsChCrFac> float
Range: 0 to 30
Increment: 0.01
*RST: 0

Example: See Example "Applying an external digital baseband signal (HS Dig I/Q)" on page 815.

Manual operation: See "Crest Factor" on page 510

[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:PEAK <BbinHsChPoPeak>

Sets the peak level per channel.

Parameters:
<BbinHsChPoPeak> float
Range: -60 to 3.02
Increment: 0.01
*RST: 0

Example: See Example "Applying an external digital baseband signal (HS Dig I/Q)" on page 815.

Manual operation: See "Peak Level" on page 510

[:SOURce<hw>]:BBIN:CHANnel<ch0>:POWer:RMS <BbinIqHsChPoRms>

Queries the estimated RMS level.

Parameters:
<BbinIqHsChPoRms> float
Range: -100 to 10
Increment: 0.01
*RST: 0

Example: See Example "Applying an external digital baseband signal (HS Dig I/Q)" on page 815.

Manual operation: See "Level" on page 510

[:SOURce<hw>]:BBIN:CHANnel<ch0>:SRATe <BbinIqHsChSaRat>

Queries the sample rate per channel.

Parameters:
<BbinIqHsChSaRat> float
Range: 400 to 250E6 ("System Config > Mode = Advanced")/1250E6 ("System Config > Mode = Standard")
Increment: 0.001
*RST: 100E6

Example: See Example "Applying an external digital baseband signal (HS Dig I/Q)" on page 815.

Manual operation: See "Sample Rate" on page 510

[:SOURce<hw>]:BBIN:MODE <Mode>

Defines that a digital external signal is applied.

Parameters:
<Mode> DIGital
*RST: DIGital

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814.

[:SOURce<hw>]:BBIN:SRATe:SOURce <Source>

Sets the digital interface used to estimate the sample rate.

Parameters:
<Source> DIN | HSDin
DIN
Estimates the sample rate based on the digital input signal.
HSDin
Enabled for `[:SOURce<hw>]:BBIN:DIGital:INTerface HSDin`.
*RST: HSDin

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814.

Manual operation: See "Sample Rate Source" on page 508

[:SOURce<hw>]:BBIN:SRATe:SUM?

Queries the sum of the sample rates of all active channels.

Return values:
<DigIqHsOutSRSum> integer
Range: 0 to depends on settings
*RST: 0

Example: See Example "Applying an external digital baseband signal (HS Dig I/Q)" on page 815.

Usage: Query only

Options: R&S SMM-B9

Manual operation: See "Aggregated Link Sample Rate" on page 510

[:SOURce<hw>]:BBIN:SRATe:MAX?

Queries the maximum sample rate.

Return values:
<DigIqHsOutSRMax> integer

Range: 1050E6 to 1250E6
*RST: 1050E6

Example: See Example "Applying an external digital baseband signal (HS Dig I/Q)" on page 815.

Usage: Query only

Manual operation: See "Aggregated Link Sample Rate" on page 510

[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe <State>

Activates automatic adjustment of the baseband input signal.

Parameters:
<State> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814.

Manual operation: See "DIG IQ Auto Setting" on page 511

[:SOURce<hw>]:BBIN:MPERiod <MPeriod>

Sets the recording duration for measuring the baseband input signal by executed `[:SOURce<hw>]:BBIN:ALEVel:EXECute`.

Parameters:
<MPeriod> integer

Range: 1 to 32
*RST: 2
Default unit: s

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814.

Manual operation: See "Measurement Period" on page 511

[:SOURce<hw>]:BBIN:ALEVel:EXECute

Starts measuring the input signal. The measurement estimates the crest factor, peak and RMS level.

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814.

Usage: Event

Manual operation: See "Auto Level Set" on page 511

[:SOURce<hw>]:BBIN:POWer:CFACtor <CFactor>

Sets the crest factor of the external baseband signal.

Parameters:

<CFactor> float

Range: 0 to 30
Increment: 0.01
*RST: 0
Default unit: dB

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814.

[:SOURce<hw>]:BBIN:POWer:PEAK <Peak>

Peak level of the external baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

Parameters:

<Peak> float

Range: -60 to 3.02
Increment: 0.01
*RST: 0
Default unit: dBfs

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814

[:SOURce<hw>]:BBIN:POWer:RMS?

Queries the RMS level of the external digital baseband signal.

Return values:

<Rms> float

Range: -100 to 10
Increment: 0.01
*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig I/Q)" on page 814.

Usage: Query only

13.17.4 Analog modulation subsystems

Option: see Section 7.11, "Analog modulations", on page 370.

The subsystems in this section describe all commands for analog modulation of the RF signal. Divided in separate sections, you can configure amplitude modulation (AM), frequency modulation (FM) , phase modulation (PhiM) and pulse modulation (PULM).

You can perform each of the modulations either with an internally generated modulation signal or with an externally applied signal.

To configure the internal signal, use the commands listed in Section 13.17.12, "SOURce:LFOutput subsystem", on page 991.

For more information:

Section 7.11, "Analog modulations", on page 370

13.17.4.1 SOURce:MODulation subsystem

The command in this subsytem allows you to disable all active modulations at once, and, vice versa, to restore the last active ones.

[:SOURce<hw>]:MODulation[:ALL][:STATe] <State>

Activates all modulations that were active before the last switching off.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example:

```
SOURce1:AM1:DEPTh 30
SOURce1:AM1:SOURce LF1
SOURce1:AM1:STATe 1
SOURce1:FM1:DEViation 1000
SOURce1:FM1:STATe 1
// disable both modulation
SOURce1:MODulation:ALL:STATe 0
SOURce1:AM1:STATe?
// 0
SOURce1:FM1:STATe?
// 0
// enable both modulation
SOURce1:MODulation:ALL:STATe 1
SOURce1:AM1:STATe?
// 1
SOURce1:FM1:STATe?
// 1
```

Manual operation: See "[Mod on/off]" on page 375

13.17.4.2 SOURce:AM subsystem

Option: R&S SMM-K720

The AM subsystem contains the commands for setting the amplitude modulation and also the broadband amplitude modulation.

Enabling amplitude modulation disables ARB, I/Q modulation, digital modulation and all digital standards.

The following examples show some variants for generating AM signals.

The following examples show some variants for generating AM signals.

Example: Creating an amplitude modulated RF signal

Using the internal LF generator, the following command sequence configures an amplitude-modulated signal.

```
// Reset the instrument to start from a defined state.
*RST

// Set RF frequency and amplitude
:SOURce1:FREQuency:CW 6000000000
:SOURce1:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the modulation signal
:SOURce1:LFOutput1:SHAPe SINE
:SOURce1:LFOutput1:FREQuency 20000

// Configure the amplitude modulation settings and switch AM on
:SOURce1:AM1:SOURce LF1
:SOURce1:AM1:DEPTh 30
:SOURce1:AM:RATio 40
:SOURce1:AM1:DEViation:MODe UNC
:SOURce1:AM1:STATe 1
```

Example: Using combined LF signals

Using the internal LF generators of both paths, the following command sequences configure an amplitude-modulated signal with determined deviations depths.

```
// Configure the AM modulation settings with combined LF signal sources
:SOURce1:AM1:SOURce LF1
:SOURce1:AM1:DEPTh 32
// Select the modulation signal source for the second path
:SOURce1:AM2:SOURce LF2
// Combine the signals of both paths with fixed total deviation depth
:SOURce1:AM1:DEViation:MODe TOT
:SOURce1:AM1:DEPTh:SUM 60

// Query the deviation depth of modulation signal in the second path
:SOURce1:AM2:DEPTh?
// Response:  28

// Combine the signals of both paths with fixed ratio
:SOURce1:AM1:DEViation:MODe RAT
:SOURce1:AM1:RATio 100
:SOURce1:AM2:DEPTh 25

// Query the deviation depth of modulation signal in the first path
:SOURce1:AM1:DEPTh?
// Response:  25

:SOURce1:AM1:STATe 1
:SOURce1:AM2:STATe 1
```

Example: Using an external signal source

Using an external signal source, you can also determine whether you want to use only the AC component of the external modulation signal.

```
// Reset the instrument to start from a defined state
*RST

// Set frequency and amplitude
:SOURce1:FREQuency:CW 6000000000
:SOURce1:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the amplitude modulation settings and turn on AM
:SOURce1:AM1:SOURce EXT1
:SOURce1:AM1:DEPTh 40

// Query the input sensitivity at the external modulation input
:SOURce1:AM1:SENSitivity?
// Response:  40
// Since the voltage value for full modulation is 1V,
// the resulting sensitivity is precisely 50%/V.
// This value is assigned to the voltage value for full
// modulation of the input.

// Select the coupling mode AC for external amplitude modulation
:SOURce1:INPut:MODext:COUPling1 AC

// Switch on AM and RF signal output
:SOURce1:AM1:STATe 1
:OUTPut1:STATe 1
```

The following commands are available:

[:SOURce<hw>]:AM<ch>:STATe 825
[:SOURce<hw>]:AM<ch>:SOURce 826
[:SOURce<hw>]:AM<ch>[:DEPTh] 826
[:SOURce<hw>]:AM:DEPTh:SUM 826
[:SOURce<hw>]:AM:DEViation:MODE 827
[:SOURce<hw>]:AM:RATio 827
[:SOURce<hw>]:AM<ch>:SENSitivity 827

[:SOURce<hw>]:AM<ch>:STATe <State>

Activates amplitude modulation.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Creating an amplitude modulated RF signal" on page 823.

Manual operation: See "State" on page 378

[:SOURce<hw>]:AM<ch>:SOURce <Source>

Selects the modulation source for amplitude modulation.

Parameters:

<Source> LF1 | LF2 | NOISe | EXT1 | EXT2 | EXTernal | INTernal

LF1|LF2
Uses an internally generated LF signal.

EXT1|EXT2
Uses an externally supplied LF signal.

NOISe
Uses the internally generated noise signal.

INTernal
Uses the internally generated signal of LF1.

EXTernal
Uses an external LF signal (EXT1).

*RST: LF1 <AM1>; LF2 <AM2>

Example: See Example "Creating an amplitude modulated RF signal" on page 823.

Manual operation: See "Source" on page 379

[:SOURce<hw>]:AM<ch>[:DEPTh] <Depth>

Sets the depth of the amplitude modulation in percent.

Suffix:

<ch> 1..2
Modulation signal channel

Parameters:

<Depth> float

Range: 0 to 100

Example: See Example "Creating an amplitude modulated RF signal" on page 823.

Manual operation: See "Depth" on page 382

[:SOURce<hw>]:AM:DEPTh:SUM <AmDepthSum>

Sets the total depth of the LF signal when using combined signal sources in amplitude modulation.

Parameters:

<AmDepthSum> float

Range: 0 to 100
Increment: 0.1
*RST: 30

Example: See Example "Using combined LF signals" on page 824.

Manual operation: See "Total Depth" on page 382

[:SOURce<hw>]:AM:DEViation:MODE <AmDevMode>

Selects the coupling mode. The coupling mode parameter also determines the mode for fixing the total depth.

Parameters:

<AmDevMode> UNCoupled | TOTal | RATio

UNCoupled
Does not couple the LF signals.
The deviation depth values of both paths are independent.

TOTal
Couples the deviation depth of both paths.

RATio
Couples the deviation depth ratio of both paths

*RST: UNCoupled

Example: See Example "Using combined LF signals" on page 824.

Manual operation: See "Deviation Mode" on page 382

[:SOURce<hw>]:AM:RATio <Ratio>

Sets the deviation ratio (path#2 to path#1) in percent.

Parameters:

<Ratio> float

Range: 0 to 100
Increment: 0.1
*RST: 100

Example: See Example "Creating an amplitude modulated RF signal" on page 823.

Manual operation: See "Ratio Path2/Path1" on page 383

[:SOURce<hw>]:AM<ch>:SENSitivity <Sensitivity>

Sets the sensitivity of the external signal source for amplitude modulation in %/V.

Parameters:

<Sensitivity> float

Range: 0 to 100
Increment: 0.1
*RST: 30

Example: See Example "Creating an amplitude modulated RF signal" on page 823.

Manual operation: See "Sensitivity" on page 382

13.17.4.3 SOURce:FM subsystem

Option: R&S SMM-K720

The FM subsystem contains the commands for setting the frequency modulation.

Example: Creating a frequency modulated RF signal

Using the internal LF generator, the following command sequence configures a frequency-modulated signal.

```
// Reset the instrument to start from a defined state
*RST

// Set RF frequency and amplitude
SOURce1:FREQuency:CW 6000000000
SOURce1:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the modulation signal
SOURce1:LFOutput1:SHAPe SINE
SOURce1:LFOutput1:FREQuency 20000

// Configure the frequency modulation settings and switch FM on
SOURce1:FM1:SOURce LF1
SOURce1:FM1:DEViation 1000
SOURce1:FM:RATio 40
SOURce1:FM:MODe LNOise
SOURce1:FM1:STATe 1

// Switch on LF and RF signal output
SOURce1:LFOutput1:STATe 1
OUTPut1:STATe 1
```

Example: Using combined LF signals

Using the internal LF generators of both paths, the following command sequences configure a frequency-modulated signal with determined deviations.

```
// Configure the FM modulation settings with combined LF signal sources
SOURce1:FM1:SOURce LF1
SOURce1:FM1:DEViation 1000
// Select the modulation signal source for the second path
SOURce1:FM2:SOURce LF2
// Combine the signals of both paths with fixed total deviation depth
SOURce1:FM1:DEViation:MODe TOT
SOURce1:FM1:DEViation:SUM 5000

// Query the deviation depth of modulation signal in the second path
SOURce1:FM2:DEViation?
```

```
// Response:  4000

// Combine the signals of both paths with fixed ratio
SOURce1:FM1:DEViation:MODe RAT
SOURce1:FM1:RATio 100
SOURce1:FM2:DEVIation 10000

// Query the deviation depth of modulation signal in the first path
SOURce1:AM1:DEViation?
// Response:  1000

SOURce1:FM1:STATe 1
SOURce1:FM2:STATe 1
```

Example: Using an external signal source

Alternatively configure the frequency modulation settings with an external modulation signal.

```
// Reset the instrument to start from a defined state
*RST

// Set RF frequency and amplitude
SOURce1:FREQuency:CW 6000000000
SOURce1:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the frequency modulation settings and switch FM on
SOURce1:FM1:SOURce EXT1
SOURce1:FM1:DEViation 5000

// Query the input sensitivity at the external modulation input
:SOURCe1:FM1:SENSitivity?
// Response:  1000
// since the voltage value for full modulation is 1V,
// the resulting sensitivity is precisely 5000 Hz/V.

// Switch on FM and RF signal output
SOURce1:FM1:STATe 1
OUTPut1:STATe 1
```

The following commands are available:

[:SOURce<hw>]:FM<ch>:STATe 830
[:SOURce<hw>]:FM<ch>[:DEViation] 830
[:SOURce<hw>]:FM<ch>:SOURce 830
[:SOURce<hw>]:FM:DEViation:MODE 831
[:SOURce<hw>]:FM:DEViation:SUM 831
[:SOURce<hw>]:FM:RATio 832
[:SOURce<hw>]:FM:MODE 832
[:SOURce<hw>]:FM:SENSitivity? 832

[:SOURce<hw>]:FM<ch>:STATe <State>

Activates frequency modulation.

Suffix:
FM<ch> 1..2
determines the modulation signal channel.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Creating a frequency modulated RF signal" on page 828.

Manual operation: See "State" on page 378

[:SOURce<hw>]:FM<ch>[:DEViation] <Deviation>

Sets the modulation deviation of the frequency modulation in Hz.

Suffix:
FM<ch> 1|2
Modulation signal channel

Parameters:
<Deviation> float
The maximum deviation depends on the RF frequency and the selected modulation mode (see the specifiacton document).
Range: 0 to max
Increment: 0.01
*RST: 1E3

Example: See Example "Creating a frequency modulated RF signal" on page 828.

Manual operation: See "Deviation" on page 379

[:SOURce<hw>]:FM<ch>:SOURce <Source>

Selects the modulation source for frequency modulation.

Suffix:
FM<ch> 1|2
Modulation signal channel.

Parameters:
<Source> INTernal | EXTernal | LF1 | LF2 | NOISe | EXT1 | EXT2
LF1|LF2
Uses an internally generated LF signal.
INTernal = LF1
Works like `LF1`

EXTernal
Works like `EXT1`

EXT1|EXT2
Uses an externally supplied LF signal.

NOISe
Uses the internally generated noise signal.

*RST: LF1 <FM1>; LF2 <FM2>

Example: See Example "Creating a frequency modulated RF signal" on page 828.

Manual operation: See "Source" on page 379

[:SOURce<hw>]:FM:DEViation:MODE <FmDevMode>

Selects the coupling mode. The coupling mode parameter also determines the mode for fixing the total deviation.

Parameters:

<FmDevMode> UNCoupled | TOTal | RATio

UNCoupled
Does not couple the LF signals.
The deviation values of both paths are independent.

TOTal
Couples the deviation of both paths.

RATio
Couples the deviation ratio of both paths

*RST: UNCoupled

Example: See Example "Using combined LF signals" on page 828.

Manual operation: See "Deviation Mode" on page 379

[:SOURce<hw>]:FM:DEViation:SUM <FmDevSum>

Sets the total deviation of the LF signal when using combined signal sources in frequency modulation.

Parameters:

<FmDevSum> float

Range: 0 to 40E6
Increment: 0.01
*RST: 1E3

Example: See Example "Using combined LF signals" on page 828.

Manual operation: See "Total Deviation" on page 380

[:SOURce<hw>]:FM:RATio <Ratio>

Sets the deviation ratio (path2 to path1) in percent.

Parameters:

<Ratio> float

Range: 0 to 100
Increment: 0.1
*RST: 100

Example: See Example "Creating a frequency modulated RF signal" on page 828.

Manual operation: See "Ratio Path2/Path1" on page 380

[:SOURce<hw>]:FM:MODE <Mode>

Selects the mode for the frequency modulation.

Parameters:

<Mode> NORMal | LNOise

NORMal
The maximum range for modulation bandwidth and FM deviation is available.

LNOise
Frequency modulation with phase noise and spurious characteristics close to CW mode. The range for modulation bandwidth and FM deviation is reduced (see the specifications document).

*RST: NORMal

Example: See Example "Creating a frequency modulated RF signal" on page 828.

Manual operation: See "Mode" on page 380

[:SOURce<hw>]:FM:SENSitivity?

Queries the sensitivity of the externally supplied signal for frequency modulation. The sensitivity depends on the set modulation deviation.

Return values:

<Sensitivity> float

Sensitivity in Hz/V.
It is assigned to the voltage value for full modulation of the input.

Range: 0 to max
Increment: 0.01

Example: See Example "Using an external signal source" on page 829.

Usage: Query only

13.17.4.4 SOURce:PM subsystem

Option: R&S SMM-K720

The PM subsystem contains the commands for setting the phase modulation. You can configure the internal modulation source (LF generator) with the commands listed in Section 13.17.12, "SOURce:LFOutput subsystem", on page 991.

Example: Performing phase modulation

The following example shows a command sequence to perform phase modulation.

```
// Reset the instrument to start from an initial state
*RST; *CLS

// Set the RF signal frequency and level
:SOURce:FREQuency:CW 4000000000
:SOURce:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the phase modulation settings
:SOURce1:LFOutput1:SHAPe SINE
:SOURce1:LFOutput1:FREQuency 1000

// Select the LF signal generated by the internal modulation generator
// or the internally generated noise signal
:SOURce1:PM1:DEViation 1
:SOURce1:PM1:SOURce LF1
// :SOURce1:PM1:SOURce INTernal
// :SOURce1:PM1:SOURce NOISe
:SOURce1:PM1:RATio 40
:SOURce1:PM1:MODE HBAN

// Alternatively configure the phase modulation settings for an
// external modulation source and query the input sensitivity.
:SOURce1:PM1:SOURce EXT1
// :SOURce1:PM1:SOURce EXTernal
:SOURce1:PM1:DEViation 1
:SOURce1:PM1:SENSitivity?
// Response: 1
// since the voltage value for full modulation is 1V,
// the resulting sensitivity is precisely 1RAD/V.

// Activate the signal output
:SOURce1:PM1:STATe 1
:OUTPut1:STATe 1
```

Example: Using combined LF signals

Using the internal LF generators of both paths, the following command sequences configure a phase-modulated signal with determined deviations.

```
// Configure the Phase modulation settings with combined LF signal sources
:SOURce1:PM1:SOURce LF1
:SOURce1:PM1:DEViation 1.5
// Select the modulation signal source for the second path
:SOURce1:PM2:SOURce LF2
// Combine the signals of both paths with fixed total deviation depth
:SOURce1:PM1:DEViation:MODe TOT
:SOURce1:PM1:DEViation:SUM 2

// Query the deviation depth of the modulation signal in the second path
:SOURce1:PM2:DEViation?
// Response:  0.5

// Combine the signals of both paths with fixed ratio
:SOURce1:PM1:DEViation:MODe RAT
:SOURce1:PM1:RATio 80
:SOURce1:PM2:DEViation?
// Response:  1.2

// Query the deviation depth of modulation signal in the first path
:SOURce1:PM1:DEViation?
// Response:  1.5

:SOURce1:FM1:STATe 1
:SOURce1:FM2:STATe 1
```

The following commands are available:

[:SOURce<hw>]:PM<ch>:STATe....834
[:SOURce<hw>]:PM<ch>:SOURce....835
[:SOURce<hw>]:PM:MODE....835
[:SOURce<hw>]:PM:DEViation:MODE....836
[:SOURce<hw>]:PM:DEViation:SUM....836
[:SOURce<hw>]:PM:RATio....836
[:SOURce<hw>]:PM:SENSitivity?....836
[:SOURce]:PM<ch>[:DEViation]....837

[:SOURce<hw>]:PM<ch>:STATe <State>

Activates phase modulation.

Activation of phase modulation deactivates frequency modulation.

Suffix:

PM<ch> 1|2
Sets the modulation signal channel.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Performing phase modulation" on page 833.

Manual operation: See "State" on page 378

[:SOURce<hw>]:PM<ch>:SOURce <Source>

Selects the modulation source for phase modulation signal.

Suffix:
PM<ch> 1|2
Sets the modulation signal channel.

Parameters:
<Source> INTernal | EXTernal | LF1 | LF2 | NOISe | EXT1 | EXT2

LF1|LF2
Uses an internally generated LF signal.

EXT1|EXT2
Uses an externally supplied LF signal.

NOISe
Uses the internally generated noise signal.

INTernal
Uses the internally generated signal of LF1.

EXTernal
Uses an external LF signal (EXT1).

*RST: LF1 <PM1>; LF2 <PM2>

Example: See Example "Performing phase modulation" on page 833.

Manual operation: See "Source" on page 379

[:SOURce<hw>]:PM:MODE <Mode>

Selects the mode for the phase modulation.

Parameters:
<Mode> HBANdwidth | HDEViation | LNOise

HBANdwidth
Sets the maximum available bandwidth.

HDEViation
Sets the maximum range for ΦM deviation.

LNOise
Selects a phase modulation mode with phase noise and spurious characteristics close to CW mode.

*RST: HBANdwidth

Example: See Example "Performing phase modulation" on page 833.

Manual operation: See "Mode" on page 381

[:SOURce<hw>]:PM:DEViation:MODE <PmDevMode>

Selects the coupling mode. The coupling mode parameter also determines the mode for fixing the total deviation.

Parameters:

<PmDevMode> UNCoupled | TOTal | RATio

UNCoupled
Does not couple the LF signals.
The deviation values of both paths are independent.

TOTal
Couples the deviation of both paths.

RATio
Couples the deviation ratio of both paths

*RST: UNCoupled

Example: See Example "Using combined LF signals" on page 833

Manual operation: See "Deviation Mode" on page 381

[:SOURce<hw>]:PM:DEViation:SUM <PmDevSum>

Sets the total deviation of the LF signal when using combined signal sources in phase modulation.

Parameters:

<PmDevSum> float

Range: 0 to max
Increment: 1E-6
*RST: 1

Example: See Example "Using combined LF signals" on page 833

Manual operation: See "Total Deviation" on page 381

[:SOURce<hw>]:PM:RATio <Ratio>

Sets the deviation ratio (path2 to path1) in percent.

Parameters:

<Ratio> float

Range: 0 to 100
Increment: 0.01
*RST: 100

Example: See Example "Performing phase modulation" on page 833.

Manual operation: See "Ratio Path2/Path1" on page 381

[:SOURce<hw>]:PM:SENSitivity?

Queries the sensitivity of the externally applied signal for phase modulation.

The returned value reports the sensitivity in RAD/V. It is assigned to the voltage value for full modulation of the input.

Return values:
<Sensitivity> float

Example: See Example "Performing phase modulation" on page 833.

Usage: Query only

[:SOURce]:PM<ch>[:DEViation] <Deviation>

Sets the modulation deviation of the phase modulation in RAD.

Parameters:
<Deviation> float

The maximal deviation depends on the RF frequency and the selected modulation mode (see the specifications document).

Range: 0 to max
Increment: 1
*RST: 1
Default unit: RAD

Example: See Example "Performing phase modulation" on page 833.

Manual operation: See "Deviation" on page 380

13.17.4.5 SOURce:PULM subsystem

Option: see Section 7.11.1, "Required options", on page 371.

The `PULM` subsystem contains the commands for setting the pulse modulation.

- Pulse modulation settings 837

Pulse modulation settings

With the commands described in this section, you can configure the settings for pulse modulation, select the trigger mode and determine delay times for the pulse modulation signal.

Example: Perform pulse modulation

The example shows a command sequence to perform pulse modulation.

```
// Reset the instrument to start from an initial state
*RST; *CLS

// Set the RF signal frequency and level
:SOURce:FREQuency:CW 4000000000
:SOURce:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the pulse modulation settings
```

```
// Select the internal modulation generator,
// set trigger mode, select pulse mode, transition type

// and select the polarity of the internally generated pulse video output

:SOURce:PULM:SOURce INT
:SOURce:PULM:TRIGger:MODE SING
:SOURce:PULM:MODE DOUB
:SOURce:PULM:TTYPe SMO

:SOURce:PULM:OUTPut:VIDeo:POLarity INVerted

// Alternatively configure the pulse modulation settings for
// external modulation source
// Select the source, set the polarity of the external signal,
// select the impedance for the external pulse modulation input/
// for the external pulse modulation trigger input
:SOURce:PULM:SOURce EXT
:SOURce:PULM:POLarity NORMal
:SOURce:PULM:IMPedance G1K

:SOURce:PULM:TRIGger:EXTernal:IMPedance G10K

// Configure the pulse generator settings
// Set pulse period, width, and delay
:SOURce:PULM:PERiod 10 us
:SOURce:PULM:WIDth 8 us
:SOURce:PULM:DOUBle:WIDTh 0.0000012
:SOURce:PULM:DOUBle:DELay 0.0000045

// Activate the signal output
:SOURce:PGENerator:OUTPut:STATe 1
:SOURce:PULM:STATe 1
:OUTPut1:STATe 1
```

The following commands are available:

[:SOURce<hw>]:PULM:MODE 839
[:SOURce<hw>]:PULM:TRIGger:MODE 839
[:SOURce<hw>]:PULM:PERiod 839
[:SOURce<hw>]:PULM:WIDTh 839
[:SOURce<hw>]:PULM:DELay 840
[:SOURce<hw>]:PULM:DOUBle:DELay 840
[:SOURce<hw>]:PULM:DOUBle:WIDTh 840
[:SOURce<hw>]:PULM:DOUBle:STATe 840
[:SOURce<hw>]:PULM:STATe 841
[:SOURce<hw>]:PULM:SOURce 841
[:SOURce<hw>]:PULM:TTYPe 841
[:SOURce<hw>]:PULM:OUTPut:VIDeo:POLarity 842
[:SOURce<hw>]:PULM:POLarity 842
[:SOURce<hw>]:PULM:IMPedance 842
[:SOURce<hw>]:PULM:TRIGger:EXTernal:IMPedance 842

[:SOURce<hw>]:PULM:MODE <Mode>

Selects the mode for the pulse modulation.

Parameters:

<Mode> SINGle | DOUBle

SINGle
Generates a single pulse.

DOUBle
Generates two pulses within one pulse period.

*RST: SINGle

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Pulse Mode" on page 384

[:SOURce<hw>]:PULM:TRIGger:MODE <Mode>

Selects a trigger mode - auto, external, external single or external gated - for generating the modulation signal.

Parameters:

<Mode> AUTO | EXTernal | EGATe | ESINgle

*RST: AUTO

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Trigger Mode" on page 384

[:SOURce<hw>]:PULM:PERiod <Period>

Sets the period of the generated pulse, that means the repetition frequency of the internally generated modulation signal.

Parameters:

<Period> float

The minimum value depends on the installed options R&S SMM-K22 or R&S SMM-K23

Range: 20E-9 to 100
Increment: 5E-9
*RST: 10E-6

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Pulse Period" on page 386

[:SOURce<hw>]:PULM:WIDTh <Width>

Sets the width of the generated pulse, that means the pulse length. It must be at least 20ns less than the set pulse period.

Parameters:

<Width> float

Range: 20E-9 to 100
Increment: 10E-9
*RST: 2E-6

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Pulse Width" on page 386

[:SOURce<hw>]:PULM:DELay <Delay>

Sets the pulse delay.

Parameters:

<Delay> float

*RST: 1ms

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Pulse Delay" on page 387

[:SOURce<hw>]:PULM:DOUBle:DELay <Delay>

Sets the delay from the start of the first pulse to the start of the second pulse.

Parameters:

<Delay> float

*RST: 1E-6

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Double Pulse Delay" on page 387

[:SOURce<hw>]:PULM:DOUBle:WIDTh <Width>

Sets the width of the second pulse.

Parameters:

<Width> float

Increment: 5E-9

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Double Pulse Width" on page 386

[:SOURce<hw>]:PULM:DOUBle:STATe <State>

Provided for backward compatibility with former Rohde & Schwarz signal generators.

Works like the command `[:SOURce<hw>]:PULM:MODE DOUBle`.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

[:SOURce<hw>]:PULM:STATe <State>

Activates pulse modulation.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "State" on page 377

[:SOURce<hw>]:PULM:SOURce <Source>

Selects between the internal (pulse generator) or an external pulse signal for the modulation.

Parameters:
<Source> INTernal | EXTernal
*RST: INTernal

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Source" on page 377

[:SOURce<hw>]:PULM:TTYPe <Source>

Sets the transition mode for the pulse signal.

Parameters:
<Source> SMOothed | FAST

SMOothed
flattens the slew rate, resulting in longer rise/fall times.

FAST
enables fast transitions with shortest rise and fall times.

*RST: FAST

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Transition Type" on page 377

[:SOURce<hw>]:PULM:OUTPut:VIDeo:POLarity <Polarity>

Sets the polarity of the pulse video (modulating) signal, related to the RF (modulated) signal.

Parameters:

<Polarity> NORMal | INVerted

NORMal
the video signal follows the RF signal, that means it is high wihen RF signal is high and vice versa.

INVerted
the video signal follows in inverted mode.

*RST: NORMal

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Video Polarity" on page 377

[:SOURce<hw>]:PULM:POLarity <Polarity>

Sets the polarity of the externally applied modulation signal.

Parameters:

<Polarity> NORMal | INVerted

NORMal
Suppresses the RF signal during the pulse pause.

INVerted
Suppresses the RF signal during the pulse.

*RST: NORMal

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Polarity Pulse Input" on page 378

[:SOURce<hw>]:PULM:IMPedance <Impedance>

Sets the impedance for the external pulse modulation input.

Parameters:

<Impedance> G50 | G1K

*RST: G1K

Example: See Example "Perform pulse modulation" on page 837.

Manual operation: See "Impedance Pulse Input" on page 378

[:SOURce<hw>]:PULM:TRIGger:EXTernal:IMPedance <Impedance>

Sets the impedance for the external pulse trigger.

Parameters:
<Impedance> G50 | G10K
*RST: G50

Example: See Example "Perform pulse modulation" on page 837.

13.17.5 SOURce:BB subsystem

This subsystem contains all commands for digital signal generation. It is divided into several subsystems which are described separately.

- SOURce:BB subsystem general commands 843
- SOURce:BB:DM subsystem 845
- SOURce:BB:ARBitrary subsystem 873
- SOURce:BB:MCCW subsystem 926
- SOURce:BB:IMPairment subsystem 945
- SOURce:BB:GRAPhics subsystem 950
- SOURce:BB:PROGress subsystem 953

13.17.5.1 SOURce:BB subsystem general commands

The following section describes the commands for setting the frequency shift and the phase offset for the signal at the output of the "Baseband" and "BB Input" blocks.

Commands:

[:SOURce<hw>]:BBIN:FOFFset 843
[:SOURce<hw>]:BB:FOFFset 843
[:SOURce<hw>]:BBIN:POFFset 844
[:SOURce<hw>]:BB:POFFset 844
[:SOURce<hw>]:BB:ROUTe 844
[:SOURce<hw>]:BBIN:ROUTe 844
[:SOURce<hw>]:BB:POWer:PEAK? 844
[:SOURce<hw>]:BB:CFACtor? 845
[:SOURce<hw>]:BB:POWer:RMS? 845

[:SOURce<hw>]:BBIN:FOFFset <FOffset>
[:SOURce<hw>]:BB:FOFFset <FOffset>

Sets a frequency offset for the internal or external baseband signal. The offset affects the generated baseband signal.

Parameters:
<FOffset> float
Range: depends on options
Increment: 0.01
*RST: 0
Default unit: Hz

Example:
```
SOURce1:BB:FOFFset 2MHZ
```

Manual operation: See "Frequency Offset" on page 264

[:SOURce<hw>]:BBIN:POFFset <POffset>

Sets the relative phase offset for the external baseband signal.

Parameters:

<POffset> float

Range: -999.99 to 999.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `SOURce1:BBIN:POFFset 0.5`

Manual operation: See "Phase Offset" on page 264

[:SOURce<hw>]:BB:POFFset <POffset>

Sets the relative phase offset for the selected baseband signal.

Parameters:

<POffset> float

Range: 0 to 359.9
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `SOURce1:BB:POFFset 0.5DEG`

Manual operation: See "Phase Offset" on page 264

[:SOURce<hw>]:BB:ROUTe <Route>
[:SOURce<hw>]:BBIN:ROUTe <Route>

Selects the signal route for the internal/external baseband signal.

Parameters:

<Route> A

Example: `SOURce1:BBIN:ROUTe A`

[:SOURce<hw>]:BB:POWer:PEAK?

Queries the peak level of the baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

Return values:

<Peak> float

Range: -145 to 30
Increment: 0.01
*RST: 0
Default unit: dBfs

Example: `BB:POW:PEAK`
Queries the peak level of the baseband signal.

Usage: Query only

[:SOURce<hw>]:BB:CFACtor?

Queries the crest factor of the baseband signal.

Return values:

<CFactor> float

Range: 0 to 100
Increment: 0.01
*RST: 0
Default unit: dB

Example: `SOURce1:BB:CFACtor?`
Queries the crest factor of the baseband signal.

Usage: Query only

[:SOURce<hw>]:BB:POWer:RMS?

Queries the RMS level of the baseband signal relative to full scale of 0.5V (in terms of dB full scale).

Return values:

<Rms> float

Range: -145 to 30
Increment: 0.01
*RST: 0
Default unit: dBfs

Example: `BB:POW:RMS?`
Queries the rms level of the baseband signal.

Usage: Query only

13.17.5.2 SOURce:BB:DM subsystem

This section list the commands of the `SOURce:BB:DM` subsystem. The commands are divided into sections, where the last one describes how to use lists for digital modulation in remote control, and all other sections describe the configuration of the digital modulation.

Required options

See Section 4.5.1, "Required options", on page 117.

The commands are grouped in the following sections:

- General commands....846
- Save/recall commands....850
- Filter commands....851
- Modulation and coding commands....853
- Power ramping....856
- Trigger commands....859
- Marker commands....865
- Clock commands....867
- Handling list files....867

General commands

Example: To configure general CDM settings

This example shows how to enable custom digital modulation (CDM) with predefined settings as basis for further customization (e.g. adjusting the data source); intermediate results and configuration are stored with the save/recall function.

```
// Reset the instrument.
*RST; *CLS

:SOURce1:BB:DM:PRESet
:SOURce1:BB:DM:STANDard W3GPp
// Query the symbol rate.
:SOURce1:BB:DM:SRATe?
// Response in symbols: "3840000"
:SOURce1:BB:DM:CODing?
// Response: "WCDMA"
:SOURce1:BB:DM:FORMat?
// Response: "QPSK45"
:SOURce1:BB:DM:STATe ON
:SOURce1:BB:DM:SETTing:STORe "/var/user/ digMod/CustDM3GPP"

// Create a waveform file. Set a sequence length of 10000 symbols.
:SOURce1:BB:DM:SLENgth 10000
// Create the waveform file "test_CDM.wv".
:SOURce1:BB:DM:WAVeform:CREate "test_CDM.wv"

// Recall settings
:MMEM:CDIR "/var/user/digMod"
:SOURce1:BB:DM:SETTing:CATalog?
// CustDigMod,cdm3gpp, CustDM3GPP
:SOURce1:BB:DM:SETTing:DELete "cdm3gpp"
:SOURce1:BB:DM:SETTing:LOAD "CustDigMod"

// Change the data source.
:SOURce1:BB:DM:SOURce?
// PRBS
```

```
:SOURce1:BB:DM:PRBS:LENGth?
// 9
:SOURce1:BB:DM:SOURce DLISt
// Set the default directory and query the existing data lists
:MMEM:CDIR "/var/user/DLists"
:SOURce1:BB:DM:DLISt:CATalog?
// Response: "DList1","DList2"
// Delete a list and create a new data list
:SOURce1:BB:DM:DLISt:DELete "DList1"
:SOURce1:BB:DM:DLISt:SELect "DList2"
// Copy the content of an existing data list to the new data list.
:SOURce1:BB:DM:DLISt:COPY "DList3"
// Query the content of the new data list and modify the data.
FORM ASCI
:SOURce1:BB:DM:DLISt:DATA? 2048,1024
// 1,1,0,0,0, ...
:SOURce1:BB:DM:DLISt:DATA:APPend 1,1,1,0,0,0,1,1,0,1...
:SOURce1:BB:DM:DLISt:SELect "DList3"
// Query the free memory and the used number of bits.
:SOURce1:BB:DM:DLISt:FREE?
:SOURce1:BB:DM:DLISt:POINts?
```

Commands:

[:SOURce<hw>]:BB:DM:STATe....847
[:SOURce<hw>]:BB:DM:PRESet....848
[:SOURce<hw>]:BB:DM:SRATe....848
[:SOURce<hw>]:BB:DM:SLENgth....848
[:SOURce<hw>]:BB:DM:WAVeform:CREate....848
[:SOURce<hw>]:BB:DM:STANdard....849
[:SOURce<hw>]:BB:DM:SOURce....849
[:SOURce<hw>]:BB:DM:PATTern....849
[:SOURce<hw>]:BB:DM:PRBS[:LENGth]....850

[:SOURce<hw>]:BB:DM:STATe <State>

Enables digital modulation.

Switching on digital modulation turns off all the other digital standards in the same signal path.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "To configure general CDM settings" on page 846.

Manual operation: See "State" on page 119

[:SOURce<hw>]:BB:DM:PRESet

Sets the default settings for digital modulation (`*RST` values specified for the commands).

Not affected is the state set with the following command:

`:SOURce<hw>:BB:DM:STATe`

Example: See Example "To configure general CDM settings" on page 846.

Usage: Event

Manual operation: See "Set To Default" on page 119

[:SOURce<hw>]:BB:DM:SRATe <SRate>

Sets the symbol rate in Hz/kHz/MHz or sym/s, ksym/s and Msym/s.

Parameters:

<SRate> float

Range: 50 to depends on options
Increment: 1E-3
*RST: 270833.333
Default unit: Hz or dym/s

Example: See Example "To configure general CDM settings" on page 846.

Manual operation: See "Symbol Rate" on page 121

[:SOURce<hw>]:BB:DM:SLENgth <Slength>

Sets the sequence length of the waveform signal in symbols. The maximum number of symbols depends on the ARB memory and its installed option.

The R&S SMM100A creates an ARB file with this length. The length equals the input sequence in symbols. It is not the length of the I/Q sequence after an upsampling. The product of the "Sequence Length" * "Oversampling" is limited by the maximum number of samples of the selected ARB.

Parameters:

<Slength> integer

Range: 1 to depends on options
*RST: 10000

Example: See Example "To configure general CDM settings" on page 846.

Manual operation: See "Generate Waveform Sequence Length" on page 120

[:SOURce<hw>]:BB:DM:WAVeform:CREate <Filename>

Saves the current settings as an ARB signal in a waveform file with the file extension `*.wv` and a defined sequence length.

Setting parameters:
<Filename> string

Example: See Example "To configure general CDM settings" on page 846.

Usage: Setting only

Manual operation: See "Generate Waveform" on page 120

[:SOURce<hw>]:BB:DM:STANdard <Standard>

Selects predefined set of settings according to the selected standard, see Table 4-6.

Parameters:
<Standard> USER | BLUetooth | DECT | ETC | GSM | GSMEdge | NADC | PDC | PHS | TETRa | W3GPp | TDSCdma | CFORward | CREVerse | WORLdspace | TFTS | APCOPH1C4fm | APCOPH1CQpsk | APCOPH2HCpm | APCOPH2HDQpsk | APCOPH2HD8PSKW | APCOPH2HD8PSKN | APCOPH1Lsm | APCOPH1Wcqpsk | CWBPsk | SOQPSKTG

A query returns the value `USER` if settings deviate from standard-compliant settings.

*RST: GSM

Example: See Example "To configure general CDM settings" on page 846.

Manual operation: See "Set according to Standard" on page 120

[:SOURce<hw>]:BB:DM:SOURce <Source>

Selects the data source.

Parameters:
<Source> ZERO | ONE | PRBS | PATTern | DLISt

*RST: PRBS

Example: See Example "To configure general CDM settings" on page 846.

Manual operation: See "Data Source" on page 122

[:SOURce<hw>]:BB:DM:PATTern <Pattern>, <BitCount>

Selects the data pattern for the internal data source.

Parameters:
<Pattern> numeric

*RST: #H0

<BitCount> integer

Range: 1 to 64
*RST: 1

Example: SOURce:BB:DM:SOURce PATT
SOURce:BB:DM:PATTern #B01110111010101010,17
Generates the user-defined sequence of 0/1 data.

Manual operation: See "Data Source" on page 122

[:SOURce<hw>]:BB:DM:PRBS[:LENGth] <Length>

Defines the length of the pseudo-random sequence in accordance with the following equation:

Length = (2^Length) - 1

Parameters:

<Length> 9 | 11 | 15 | 16 | 20 | 21 | 23 | PN9 | PN11 | PN15 | PN16 | PN20 | PN21 | PN23

*RST: 9

Example: See Example "To configure general CDM settings" on page 846.

Manual operation: See "Data Source" on page 122

Save/recall commands

[:SOURce<hw>]:BB:DM:STANdard:ULISt:CATalog? 850
[:SOURce<hw>]:BB:DM:SETTing:CATalog? 850
[:SOURce<hw>]:BB:DM:STANdard:ULISt:STORe 851
[:SOURce<hw>]:BB:DM:SETTing:STORe 851
[:SOURce<hw>]:BB:DM:STANdard:ULISt:LOAD 851
[:SOURce<hw>]:BB:DM:SETTing:LOAD 851
[:SOURce<hw>]:BB:DM:STANdard:ULISt:DELete 851
[:SOURce<hw>]:BB:DM:SETTing:DELete 851

[:SOURce<hw>]:BB:DM:STANdard:ULISt:CATalog?
[:SOURce<hw>]:BB:DM:SETTing:CATalog?

Queries the files with digital modulation respectively user standard settings in the default directory. Listed are files with the file extension *.dm and *.dm_stu.

Return values:

<Catalog> "<filename1>,<filename2>,..."

Returns a string of filenames separated by commas.

Example: See Example "To configure general CDM settings" on page 846.

Usage: Query only

Manual operation: See "Save/Recall" on page 120

[:SOURce<hw>]:BB:DM:STANdard:ULISt:STORe <Filename>
[:SOURce<hw>]:BB:DM:SETTing:STORe <Filename>

Saves the current settings into the selected file; the file extension (`*.dm` respectively `*.dm_stu`) is assigned automatically.

See also Section 13.6.2, "Handling files in the default or in a specified directory", on page 721.

Setting parameters:
<Filename> string

Example: See Example "To configure general CDM settings" on page 846.

Usage: Setting only

Manual operation: See "Save/Recall" on page 120

[:SOURce<hw>]:BB:DM:STANdard:ULISt:LOAD <Filename>
[:SOURce<hw>]:BB:DM:SETTing:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.dm` respectively `*.dm_stu`.

See also Section 13.6.2, "Handling files in the default or in a specified directory", on page 721.

Setting parameters:
<Filename> string

Example: See Example "To configure general CDM settings" on page 846.

Usage: Setting only

Manual operation: See "Save/Recall" on page 120

[:SOURce<hw>]:BB:DM:STANdard:ULISt:DELete <Filename>
[:SOURce<hw>]:BB:DM:SETTing:DELete <Filename>

Deletes the selected file from the default or specified directory. Deleted are files with the file extension `*.dm` respectively `*.dm_stu`.

Setting parameters:
<Filename> string

Example: See Example "To configure general CDM settings" on page 846.

Usage: Setting only

Manual operation: See "Save/Recall" on page 120

Filter commands

[:SOURce<hw>]:BB:DM:FILTer:TYPE <Type>

Selects the filter type.

If you select a standard (`:BB:DM:STAN`), the firmware automatically sets the standard-compliant filter type and filter parameter.

Parameters:

<Type> RCOSine | COSine | GAUSs | LGAuss | CONE | COF705 | COEQualizer | COFequalizer | C2K3x | APCO25 | SPHase | RECTangle | USER | PGAuss | LPASs | DIRac | ENPShape | EWPShape | LTEFilter | LPASSEVM | APCO25Hcpm | APCO25Lsm | HRP | SOQPSK | OQPSK

*RST: GAUSs

Example: See `[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase` on page 852.

Manual operation: See "Filter" on page 127

[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25 <Apco25>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:GAUSs <Gauss>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:LOWPass <FiltParm>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine:BANDwidth <Bandwidth>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine[:ROLLoff] <Cosine>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:GAUSs <Gauss>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASs <LPass>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASSEVM <LPassEvm>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:PGAuss <PGauss>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:RCOSine <RCosine>
[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase <SPhase>

Sets the filter parameter.

Filter Type	Parameter	Parameter Name	Min	Max	Increment	Default
APCO25	Rolloff factor	<Apco25>	0.05	0.99	0.01	0.2
APCO25Lsm	Cutoff frequency lowpass filter (:LOWPass)	<Cosine>	50 Hz	depends on options	1E-3 Hz	270833.333 Hz
APCO25Lsm	Cutoff frequency Gaussian filter (:GAUSs)	<FiltParm>	50 Hz	depends on options	1E-3 Hz	270833.333 Hz
COSine	Bandwidth	<Bandwidth>	50 Hz	depends on options	1E-3 Hz	270833.333 Hz
COSine	Rolloff factor	<Cosine>	0.05	1	0.01	0.35
GAUSs	Rolloff factor	<Gauss>	0.15	100000	0.01	0.3
LPASs	Cutoff frequency factor	<LPass>	0.05	2	0.01	0.5
LPASSEVM	Cutoff frequency factor	<LPassEvm>	0.05	2	0.01	0.5
PGAuss	B*T	<PGauss>	0.15	2.5	0.01	0.3
RCOSine	Rolloff factor	<RCosine>	0.05	1	0.001	0.35
SPHase	B*T	<SPhase>	0.15	2.5	0.01	2

The maximum values of the cutoff frequency of a filter and the filter bandwidth depends on the installed options.

For more information, refer to the specifications document.

Parameters:

<SPhase> float

Range: 0.15 to 2.5
Increment: 0.01
*RST: 2

Example:
```
:SOURce:BB:DM:FILTer:TYPE SPHase
:SOURce:BB:DM:FILTer:PARameter:SPHase 0.5
```

Options: 200 MHz maximum frequencies require R&S SMM-K523.

Manual operation: See "Roll Off Factor/B*T" on page 127

[:SOURce<hw>]:DM:FILTer:PARameter <Parameter>

Sets the filter parameter of the currently selected filter type.

To set the filter type, use command `[:SOURce<hw>]:BB:DM:FILTer:TYPE` on page 851.

Parameters:

<Parameter> float

Range: 0.05 to 2.5
Increment: 0.01
*RST: 0.35

Example: See `[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase` on page 852

Modulation and coding commands

[:SOURce<hw>]:BB:DM:CODing <Coding>

Selects the modulation coding.

Parameters:

<Coding> OFF | DIFF | DPHS | DGRay | GRAY | GSM | NADC | PDC | PHS | TETRa | APCO25 | PWT | TFTS | INMarsat | VDL | EDGE | APCO25FSK | ICO | CDMA2000 | WCDMA | APCO258PSK

OFF
The coding is automatically disabled if the selected modulation type is not possible with the coding that has been set.

DPHS
Phase Difference

DGRay
Difference + Gray

*RST: GSM

Example: See Example "To configure general CDM settings" on page 846.

Manual operation: See "Coding" on page 121

[:SOURce<hw>]:BB:DM:FORMat <Format>

Sets the modulation type.

When a standard is selected ([:SOURce<hw>]:BB:DM:STANdard), the modulation type is set to the default value.

Parameters:

<Format> ASK | BPSK | P2DBpsk | QPSK | QPSK45 | OQPSk | P4QPsk | P4DQpsk | PSK8 | P8D8psk | P8EDge | QAM16 | QAM32 | QAM64 | QAM256 | QAM1024 | MSK | FSK2 | FSK4 | USER | FSKVar | QAM128 | QEDGe | QAM16EDge | QAM32EDge | AQPSk | QAM4096 | APSK16 | APSK32 | FSK32 | FSK64 | FSK8 | FSK16 | QAM512 | QAM2048

*RST: MSK

Example: See Example "To configure general CDM settings" on page 846.

Manual operation: See "Modulation Type" on page 124

[:SOURce<hw>]:BB:DM:AQPSk:ANGLe <Angle>

For AQPSK modulation, sets the angle alpha between the point (0,0) and the I axis.

Parameters:

<Angle> float

Range: 0 to 180
Increment: 0.01
*RST: 0
Default unit: Deg

Example:

```
BB:DM:FORM AQPS
BB:DM:AQPS:ANGL 45
```

Manual operation: See "Angle Alpha" on page 125

[:SOURce<hw>]:BB:DM:ASK:DEPTh <Depth>

Sets the ASK modulation depth for modulation type ASK.

Parameters:

<Depth> float

Range: 0 to 100
Increment: 0.1
*RST: 100
Default unit: PCT

Example:
```
BB:DM:FORM ASK
BB:DM:ASK:DEPT 50 PCT
```

Manual operation: See "ASK Depth" on page 125

[:SOURce<hw>]:BB:DM:FSK:DEViation <Deviation>

Sets the frequency deviation when FSK modulation is selected.

Parameters:

<Deviation> float

The value range depends on the symbol rate.

Range: 1 to 40E6
Increment: 0.5
*RST: 135416.5

Example:
```
SOURce:BB:DM:FORMat FSK4
SOURce:BB:DM:FSK:DEViation 1MHZ
```

Manual operation: See "FSK Deviation" on page 125

[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation <Deviation>

Sets the deviation of the selected symbol for variable FSK modulation mode.

The value range depends on the configured symbol rate.

For more information, refer to the specifications document.

Parameters:

<Deviation> float

Range: depends on settings
Increment: 0.5
Default unit: Hz

Example:
```
SOURce:BB:DM:FORMat FSKVar
SOURce:BB:DM:FSK:VARiable:TYPE FSK4
SOURce:BB:DM:FSK:VARiable:SYMBol0:DEViation 135000
```

Manual operation: See "Deviation xxxx" on page 125

[:SOURce<hw>]:BB:DM:FSK:VARiable:TYPE <Type>

The command selects the modulation type for Variable FSK.

Parameters:

<Type> FSK4 | FSK8 | FSK16

*RST: FSK4

Example: See `[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation` on page 855

Manual operation: See "FSK Type" on page 125

[:SOURce<hw>]:BB:DM:APSK16:GAMMa <Gamma>

Sets the gamma function γ for the 16APSK modulation.

Parameters:

<Gamma> G2D3 | G3D4 | G4D5 | G5D6 | G8D9 | G9D10
`GxDy`: G = Gamma function, `xy` = code rate
*RST: G2D3

Example:
```
SOURce1:BB:DM:FORMat APSK16
SOURce1:BB:DM:APSK16:GAMMa G9D10
```

Manual operation: See "Gamma/Gamma 1" on page 126

[:SOURce<hw>]:BB:DM:APSK32:GAMMa <Gamma>

Sets the gamma function γ for the 32APSK modulation.

Parameters:

<Gamma> G3D4 | G4D5 | G5D6 | G8D9 | G9D10
`GxDy`: G = Gamma function, `xy` = code rate
*RST: G3D4

Example:
```
SOURce1:BB:DM:FORMat APSK32
SOURce1:BB:DM:APSK32:GAMMa G9D10
```

Manual operation: See "Gamma/Gamma 1" on page 126

[:SOURce<hw>]:BB:DM:SWITching:STATe <State>

Enables switching between a modulated and an unmodulated signal.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Manual operation: See "State Modulation CW Switching" on page 126

Power ramping

Example: Enable power ramping

The following example lists the provided commands

```
SOURce1:BB:DM:PRAMp:SOURce INTernal
SOURce1:BB:DM:PRAM:SHAP COS
SOURce1:BB:DM:PRAMp:TIME 5
SOURce1:BB:DM:PRAMp:RDELay 0
SOURce1:BB:DM:PRAMp:FDELay -1
SOURce1:BB:DM:PRAMp:ATTenuation 10
```

```
SOURce1:BB:DM:PRAMp:BBONly:STATe ON
SOURce1:BB:DM:PRAMp:STATe ON
```

Commands:

[:SOURce<hw>]:BB:DM:PRAMp:SOURce....857
[:SOURce<hw>]:BB:DM:PRAMp:SHAPe....857
[:SOURce<hw>]:BB:DM:PRAMp:TIME....857
[:SOURce<hw>]:BB:DM:PRAMp:FDELay....858
[:SOURce<hw>]:BB:DM:PRAMp:RDELay....858
[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation....858
[:SOURce<hw>]:BB:DM:PRAMp:BBONly[:STATe]....858
[:SOURce<hw>]:BB:DM:PRAMp[:STATe]....858

[:SOURce<hw>]:BB:DM:PRAMp:SOURce <Source>

Sets the source for the power ramp control signals.

Parameters:

<Source> INTernal

*RST: INTernal

Example: See Example "Enable power ramping" on page 856.

Manual operation: See "Source" on page 129

[:SOURce<hw>]:BB:DM:PRAMp:SHAPe <Shape>

Sets the edge shape of the ramp envelope.

Parameters:

<Shape> LINear | COSine

*RST: COSine

Example: See Example "Enable power ramping" on page 856.

Manual operation: See "Ramp Function" on page 129

[:SOURce<hw>]:BB:DM:PRAMp:TIME <Time>

Sets the power ramping rise time and fall time for a burst.

Parameters:

<Time> float

Range: 0.25 to 16
Increment: 0.01
*RST: 1
Default unit: symbol

Example: See Example "Enable power ramping" on page 856.

Manual operation: See "Ramp Time" on page 129

[:SOURce<hw>]:BB:DM:PRAMp:FDELay <FDelay>
[:SOURce<hw>]:BB:DM:PRAMp:RDELay <RDelay>

Sets the delay in the rising edge.

Parameters:

<RDelay> float

Range: 0 to 4
Increment: 0.01
*RST: 0
Default unit: symbol

Example: See Example "Enable power ramping" on page 856.

Manual operation: See "Rise Delay" on page 129

[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation <Attenuation>

Sets the level attenuation for signal ranges that are flagged with the level attribute attenuated by the control signal.

Parameters:

<Attenuation> float

Range: 0 to 50
Increment: 0.1
*RST: 15
Default unit: dB

Example: See Example "Enable power ramping" on page 856.

Manual operation: See "Attenuation" on page 129

[:SOURce<hw>]:BB:DM:PRAMp:BBONly[:STATe] <State>

Enables power ramping in the baseband only or mixed power ramping in the baseband and the RF section.

The ON setting is mandatory if, with power ramping active, only the baseband signal is output (I/Q outputs).

Only then can a signal with a defined, predictable level be output.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Enable power ramping" on page 856.

Manual operation: See "In Baseband Only" on page 130

[:SOURce<hw>]:BB:DM:PRAMp[:STATe] <State>

Enables power ramping.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Enable power ramping" on page 856.

Manual operation: See "State" on page 128

Trigger commands

Example: To configure trigger, marker and clock settings

The following example provides command sequences to configure trigger, marker and clock settings.

```
// Configure trigger settings to define the signal generation start.
:SOURce1:BB:DM:TRIGger:SEQuence SINGle
:SOURce1:BB:DM:TRIGger:SLENgth 200
// the first 200 samples will be output after the next trigger event
:SOURce1:BB:DM:TRIGger:SEQuence ARETrigger
// Provide the external trigger signal at the connector, for example
// for an external global trigger signal.
:SOURce1:BB:DM:TRIGger:SOURce EGT1
:SOURce1:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut ON
:SOURce1:BB:DM:TRIGger:EXTernal:DELay 200
:SOURce1:BB:DM:TRIGger:EXTernal:INHibit 100

// with internal trigger source
:SOURce1:BB:DM:TRIGger:SEQuence AAUTo
:SOURce1:BB:DM:TRIGger:SOURce INTernal
:SOURce1:BB:DM:STAT ON
:SOURce1:BB:DM:TRIGger:EXEC

// Configure and enable standard marker signals.
:SOURce1:BB:DM:TRIGger:OUTPut2:MODE PULSe
:SOURce1:BB:DM:TRIGger:OUTPut2:PULSe:DIVider 5
:SOURce1:BB:DM:TRIGger:OUTPut2:PULSe:FREQuency?
:SOURce1:BB:DM:TRIGger:OUTPut3:MODE PATTern
:SOURce1:BB:DM:TRIGger:OUTPut3:PATTern #HE0F52,20
:SOURce1:BB:DM:TRIGger:OUTPut1:MODE RATio
:SOURce1:BB:DM:TRIGger:OUTPut1:ONTime 40
:SOURce1:BB:DM:TRIGger:OUTPut1:OFFTime 20
:SOURce1:BB:DM:TRIGger:OUTPut2:DELay 16

// Configure clock settings.
:SOURce1:BB:DM:CLOCk:SOURce INTernal
```

Commands:

[:SOURce<hw>]:BB:DM[:TRIGger]:SEQuence....860
[:SOURce<hw>]:BB:DM:TRIGger:SOURce....860
[:SOURce<hw>]:BB:DM:TRIGger:SLENgth....861

[:SOURce<hw>]:BB:DM:TRIGger:RMODe?....861
[:SOURce<hw>]:BB:DM:TRIGger:TIME:DATE....861
[:SOURce<hw>]:BB:DM:TRIGger:TIME:TIME....862
[:SOURce<hw>]:BB:DM:TRIGger:TIME[:STATe]....862
[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut....863
[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute....863
[:SOURce<hw>]:BB:DM:TRIGger:EXECute....863
[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT....863
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay....863
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:TDELay....864
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:RDELay?....864
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit....865

[:SOURce<hw>]:BB:DM[:TRIGger]:SEQuence <Sequence>

Selects the trigger mode.

See also "About trigger modes" on page 93.

Parameters:

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGle

*RST: AUTO

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "Mode" on page 107

[:SOURce<hw>]:BB:DM:TRIGger:SOURce <Source>

Selects the trigger signal source and determines the way the triggering is executed. Provided are the following trigger sources:

- `INTernal`: Internal manual triggering of the instrument
- External trigger signal via one of the local or global connectors:
  - `EGT1|EGT2`: External global trigger
  - `EGC1|EGC2`: External global clock
- For secondary instruments (`SCONfiguration:MULTiinstrument:MODE SEC`), triggering via the external baseband synchronization signal of the primary instrument:
  `SOURce1:BB:ARB:TRIGger:SOURce BBSY`
- `OBASeband|BEXTernal|EXTernal`: Setting only
  Provided only for backward compatibility with other Rohde & Schwarz signal generators. The R&S SMM100A accepts these values and maps them automatically as follows:
  `OBASeband = INTA`, `BEXTernal = EGT2`, `EXTernal = EGT1`

Parameters:

<Source> INTernal|EGT1|EGT2|EGC1|EGC2|EXTernal|BBSY

*RST: INTernal

Example: See Example "To configure trigger, marker and clock settings" on page 859

Manual operation: See "Source" on page 109

[:SOURce<hw>]:BB:DM:TRIGger:SLENgth <SLength>

Defines the length of the signal sequence to be output in the `SINGle` trigger mode.

Parameters:

<SLength> integer

Range: 1 to 4294967295
*RST: 1000
Default unit: symbol

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "Signal Duration" on page 111

[:SOURce<hw>]:BB:DM:TRIGger:RMODe?

Queries the status of signal generation.

Return values:

<RMode> STOP | RUN

Example:

```
SOURce1:BB:DM:TRIGger:SOURce ELTRigger
SOURce1:BB:DM:TRIGger:SEQuence ARETrigger
SOURce1:BB:DM:TRIGger:RMODe?
Response: RUN
```

Usage: Query only

Manual operation: See "Running/Stopped" on page 107

[:SOURce<hw>]:BB:DM:TRIGger:TIME:DATE <Year>, <Month>, <Day>

Sets the date for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this date via the following command:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Year> integer

Range: 1980 to 9999

<Month> integer

Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: See Example "Configure a time-based trigger signal" on page 916.

Manual operation: See "Trigger Time" on page 108

[:SOURce<hw>]:BB:DM:TRIGger:TIME:TIME <Hour>, <Minute>, <Second>

Sets the time for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this time via the following command:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Hour> integer
Range: 0 to 23

<Minute> integer
Range: 0 to 59

<Second> integer
Range: 0 to 59

Example: See Example "Configure a time-based trigger signal" on page 916.

Manual operation: See "Trigger Time" on page 108

[:SOURce<hw>]:BB:DM:TRIGger:TIME[:STATe] <TimeTrigState>

Activates time-based triggering with a fixed time reference. If activated, the R&S SMM100A triggers signal generation when its operating system time matches a specified time.

Specify the trigger date and trigger time with the following commands:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:DATE`

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:TIME`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<TimeTrigState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configure a time-based trigger signal" on page 916.

Manual operation: See "Time Based Trigger" on page 108

[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut <Output>

Enables signal output synchronous to the trigger event.

Parameters:
<Output> 1 | ON | 0 | OFF
*RST: 1

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "Sync. Output to Ext. Trigger/Sync. Output to Trigger" on page 109

[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute

Stops the signal generation; a subsequent internal or external trigger event restarts the signal generation.

Example: See also Example "To configure trigger, marker and clock settings" on page 859.

Usage: Event

Manual operation: See "Arm" on page 108

[:SOURce<hw>]:BB:DM:TRIGger:EXECute

Executes a trigger.

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Usage: Event

Manual operation: See "Execute Trigger" on page 109

[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT <TrigDelUnit>

Sets the unit of the trigger delay.

Parameters:
<TrigDelUnit> SAMPle | TIME
*RST: SAMPle

Example: See Example "To specify delay and inhibit values in time units" on page 916.

Manual operation: See "External Delay Unit/Delay Unit" on page 110

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay <Delay>

Sets the trigger delay in symbols.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 98.

Parameters:

<Delay> float

Range: 0 to depends on the symbol rate
Increment: 0.01
*RST: 0
Default unit: symbol

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 110

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:TDELay <ExtTimeDelay>

Sets the trigger delay for external triggering. The value affects all external trigger signals.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 98.

Parameters:

<ExtTimeDelay> float

Range: 0 to 7929.170398682
Increment: 0.25E-9
*RST: 0
Default unit: s

Example: See Example "To specify delay and inhibit values in time units" on page 916.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 110

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:RDELay?

Queries the time (in seconds) an external trigger event is delayed for.

Return values:

<ResTimeDelaySec> float

Range: 0 to 688
Increment: 0.25E-9
*RST: 0

Example: See Example "To specify delay and inhibit values in time units" on page 916.

Usage: Query only

Manual operation: See "Actual Trigger Delay/Actual External Delay" on page 110

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit <Inhibit>

Sets the number of symbols that inhibit a restart of the signal generation.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 98.

Parameters:

<Inhibit> integer

Range: 0 to 21.47 * (symbol rate)
*RST: 0
Default unit: symbol

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "External Inhibit/Trigger Inhibit" on page 109

Marker commands

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE 865
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime 865
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime 865
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern 866
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider 866
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency? 866
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay 867

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE <Mode>

Defines the signal for the selected marker output.

For detailed description of the regular marker modes, refer to "Marker modes" on page 90.

Parameters:

<Mode> CLISt | PULSe | PATTern | RATio

CLISt
A marker signal that is defined in the selected control list is generated.

*RST: RATio

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime <OnTime>
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the number of symbols in a period (on-time + off-time) for marker `RATio`.

Parameters:

<OffTime> integer

Range: 1 to 16777215
*RST: 1
Default unit: symbol

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern <Pattern>, <BitCount>

Defines the bit pattern used to generate the marker signal.

Parameters:

<Pattern> numeric

*RST: #H2

<BitCount> integer

0 = marker off, 1 = marker on

Range: 1 to 64
*RST: 2

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for pulse marker mode (`PULSe`).

Parameters:

<Divider> integer

Range: 2 to 1024
*RST: 2

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal `PULSe`.

Return values:

<Frequency> float

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Usage: Query only

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay <Delay>

Defines the delay between the signal on the marker outputs and the start of the signal, expressed in terms of symbols.

Parameters:

<Delay> float

Range: 0 to 16777215
Increment: 1
*RST: 0

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "Delay" on page 112

Clock commands

[:SOURce<hw>]:BB:DM:CLOCk:SOURce 867

[:SOURce<hw>]:BB:DM:CLOCk:SOURce <Source>

Selects the clock source:

- `INTernal`: Internal clock reference
- `ELCLock`: External local clock
- `EXTernal = ELCLock`: Setting only
  Provided for backward compatibility with other Rohde & Schwarz signal generators

Parameters:

<Source> INTernal

*RST: INTernal

Example: See Example "To configure trigger, marker and clock settings" on page 859.

Manual operation: See "Clock Source" on page 113

Handling list files

[:SOURce<hw>]:BB:DM:CLISt:CATalog?
[:SOURce<hw>]:BB:DM:FLISt:CATalog?
[:SOURce<hw>]:BB:DM:MLISt:CATalog?
[:SOURce<hw>]:BB:DM:DLISt:CATalog?

Reads out the list of files present in the default directory.

List type	Command	File extension
Data list	...:DLISt...	*.dm_iqd
Control list	...:CLISt...	*.dm_iqc
User filter files	...:FLISt...	*.vaf
User mapping lists	...:MLISt...	*.vam

See also Section 13.6.2, "Handling files in the default or in a specified directory", on page 721.

Return values:
<Catalog> "<filename1>,<filename2>,..."
Returns a string of filenames separated by commas.

Example: See Example "To configure general CDM settings" on page 846.

Usage: Query only

Manual operation: See "Data Source" on page 122
See "Select Data List" on page 123
See "Directory, File List and Filename" on page 531

[:SOURce<hw>]:BB:DM:CLISt:SELect <Filename>
[:SOURce<hw>]:BB:DM:FLISt:SELect <Filename>
[:SOURce<hw>]:BB:DM:MLISt:SELect <Filename>
[:SOURce<hw>]:BB:DM:DLISt:SELect <Select>

Selects the specified list file from the default directory or in the directory specified with the complete file path.

See also `:MMEMory:CDIRectory`.

If a list with the specified name does not yet exist, it is created. The file extension can be omitted.

See also Section 13.6.2, "Handling files in the default or in a specified directory", on page 721.

List type	Command	File extension
Data list	...:DLISt...	*.dm_iqd
Control list	...:CLISt...	*.dm_iqc
User standard	...:ULISt...	*.dm_stu
User filter files	...:FLISt...	*.vaf
User mapping lists	...:MLISt...	*.vam

Parameters:
<Select> <list name>

Example: See Example "To configure general CDM settings" on page 846.

Manual operation: See "Data Source" on page 122
See "Select Data List" on page 123
See "Functions for handling of data lists" on page 538

[:SOURce<hw>]:BB:DM:CLISt:DELete <Filename>
[:SOURce<hw>]:BB:DM:FLISt:DELete <Filename>
[:SOURce<hw>]:BB:DM:MLISt:DELete <Filename>
[:SOURce<hw>]:BB:DM:DLISt:DELete <Filename>

Deletes the specified list from the default directory or from the directory specified with the complete file path.

See also Section 13.6.2, "Handling files in the default or in a specified directory", on page 721.

List type	Command	File extension
Data list	`...:DLISt...`	`*.dm_iqd`
Control list	`...:CLISt...`	`*.dm_iqc`
User standard	`...:ULISt...`	`*.dm_stu`
User filter files	`...:FLISt...`	`*.vaf`
User mapping lists	`...:MLISt...`	`*.vam`

Setting parameters:
<Filename> string

Example: See Example "To configure general CDM settings" on page 846.

Usage: Setting only

Manual operation: See "Select Data List" on page 123

[:SOURce<hw>]:BB:DM:CLISt:FREE?
[:SOURce<hw>]:BB:DM:FLISt:FREE?
[:SOURce<hw>]:BB:DM:MLISt:FREE?
[:SOURce<hw>]:BB:DM:DLISt:FREE?

Queries the list free memory.

List type	Command	File extension
Data list	`...:DLISt...`	`*.dm_iqd`
Control list	`...:CLISt...`	`*.dm_iqc`
User filter files	`...:FLISt...`	`*.vaf`
User mapping lists	`...:MLISt...`	`*.vam`

Return values:
<Free> integer
Range: 0 to INT_MAX
*RST: 0

Example: See Example "To configure general CDM settings" on page 846.

Usage: Query only

[:SOURce<hw>]:BB:DM:CLISt:POINts?

Queries the number of lines (2 bytes) in the currently selected list.

Return values:
<Points> integer
Range: 0 to INT_MAX
*RST: 0

Example:
```
SOURce:BB:DM:CLISt:SELect "c_list"
SOURce:BB:DM:CLISt:POINts?
// 20
// the control list consists of 20 lines
```

Usage: Query only

[:SOURce<hw>]:BB:DM:DLISt:POINts <Points>

Defines the number of bits in the selected data list to be utilized. When a list is being filled with block data, this data is only ever sent in multiples of 8 bits. However the exact number of bits to be exploited can be set to a different figure. The superfluous bits in the list are then ignored.

Parameters:
<Points> integer
Range: 0 to INT_MAX
*RST: 0

Example:
```
SOURce:BB:DM:DLISt:POINts 234
```
Defines the number of bits in the data list to be utilized as 234 bits. If the list was filled with block data, at least the last 6 bits are ignored.

[:SOURce<hw>]:BB:DM:FLISt:POINts?
[:SOURce<hw>]:BB:DM:MLISt:POINts?

Queries the user modulation mapping/user filter list length.

Return values:
<Points> integer
Range: max
*RST: 0

Example:
```
BB:DM:FORM USER
BB:DM:MLIS:POIN?
```

Usage: Query only

[:SOURce<hw>]:BB:DM:CLISt:COPY <Filename>
[:SOURce<hw>]:BB:DM:DLISt:COPY <Filename>

Copies the selected data list (`*.dm_iqd`)/ control list (`*.dm_iqc`) as a new list with name specified by `<Filename>`. If a list with the specified name exists, it is overwritten. If it does not yet exist, it is created.

The source file has to be available in the default directory.

See also Section 13.6.2, "Handling files in the default or in a specified directory", on page 721.

Setting parameters:
<Filename> string

Example: See Example "To configure general CDM settings" on page 846.

Usage: Setting only

Manual operation: See "Select Data List" on page 123

[:SOURce<hw>]:BB:DM:CLISt:DATA <Data>

Sends the data to the currently selected control list. If the list already contains data, it is *overwritten*. This command only writes data into the data section of the file.

The values for the control signals are sent, arranged in an 8-bit value as defined in Table 13-1.

Table 13-1: Contents of a control lists

Signal	Order	Decimal value of bits
Marker 1 Marker 2 Marker 3	LSB	1 2 4
Burst	LSB	16
LevAtt1	LSB	32
CWMod	LSB	64
Hop	MSB	128

The data can also be sent as a binary block. Each binary block is a 2-byte value, in which the 16 bits represent the binary values (16-bit unsigned integer, 2 bytes, LSB first).

When binary data transmission is in use, use the command `:SYSTem:COMMunicate:GPIB:LTERminator EOI` to set the termination character mode to 'EOI control data message only' so that a random `LF` in the data sequence is not interpreted as `End`, thereby prematurely terminating the data transmission. The command `...LTER STAN` resets the mode.

According to the specifications, the byte sequence is defined as 'most significant byte first'.

Tip: Control lists are created in binary format. Use an ASCII format to create a waveform file with R&S WinIQSIM2.

See also Section 4.6.4.8, "Creating control lists with tag file format", on page 177.

The command `*RST` has no effect on data lists.

Setting parameters:

<Data> string

Example:

```
:MMEMory:CDIrectory "/var/user/clists"
:SOURce1:BB:DM:CLISt:SELect "clist_marker3"
:SOURce1:BB:DM:CLISt:DATA 0,0,0,0,4,4,4,0,0,0,0...
// Enters the control values in the selected list.
// In the example, only ramps for Marker 3 are set.
```

Usage: Setting only

Manual operation: See "Select Ramp to Edit" on page 134

[:SOURce<hw>]:BB:DM:DLISt:DATA <Data>
[:SOURce<hw>]:BB:DM:DLISt:DATA? [<Start>[, <Count>]]

The setting command sends the bit data to the selected data list. Any existing content in the list is overwritten. This command only writes data into the data section of the file.

Data can be sent as block data in binary or packet format (`:FORMat ASCii | PACKed`), each byte being interpreted as 8 data bits.

When binary data transmission is in use, use the command `:SYSTem:COMMunicate:GPIB:LTERminator EOI` to set the termination character mode to 'EOI control data message only' so that a random `LF` in the data sequence is not interpreted as `End`, thereby prematurely terminating the data transmission. The command `...LTER STAN` resets the mode.

According to the specifications, the byte sequence is defined as 'most significant byte first'.

The query command reads out the data part of the list file. If the query is expanded by using the two parameters `<Start>` and `<Count>`, the list is read out in smaller sections. Without the parameters, the total length is always read out starting from address 1.

The command `*RST` has no effect on data lists.

Parameters:

<Data> integer
bit data

Query parameters:

<Start> integer
Range: 1 to 2147483647

<Count> integer
Range: 1 to 2147483647

Example: See Example "To configure general CDM settings" on page 846.

[:SOURce<hw>]:BB:DM:DLISt:DATA:APPend <Bits>

Appends the bit data onto the end of the existing data in the selected data list. Existing content in the data list is not overwritten. Hence, you can create long data lists piecemeal.

The command cannot be used with an empty data list, for example, a data list that has been created. Use the command `[:SOURce<hw>]:BB:DM:DLISt:DATA` first and enter modulation data in the list.

The command `*RST` has no effect on data lists.

Setting parameters:

<Bits> 0 | 1 {,0 | 1 } | block data

Example: See Example "To configure general CDM settings" on page 846.

Usage: Setting only

[:SOURce<hw>]:BB:DM:CLISt:TAG?
[:SOURce<hw>]:BB:DM:DLISt:TAG?

Queries the content of the specified tag in the selected file.

Return values:

<Tag> <control list>,<tag name>
For a description of the available tag formats, see Section 4.6.5, "Tags for waveforms, data and control lists", on page 180.

Example: `:SOURce1:BB:DM:DLISt:TAG? "D_list","date"`
Queries the `Date` tag in list `D_list`.

Usage: Query only

13.17.5.3 SOURce:BB:ARBitrary subsystem

This section list the commands of the `SOURce:BB:ARBitrary` subsystem.

Required options

See Section 4.6.1, "Required options", on page 150.

The commands are grouped in the following sections:

- Programming examples....874
- General commands....882
- Test signal commands....883
- Waveform commands....887
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- Multi-segment sequencing commands....896
- Multicarrier commands....900
- Notch filter commands....912
- Trigger commands....915
- Marker commands....923
- Clock commands....925

Programming examples

Example: To create test signals

This example provides the commands to configure the different test signals.

```
// ****************************************************************************
// Reset the instrument first.
// ****************************************************************************
*RST; *CLS
:SOURce1:BB:ARBitrary:PRESet

// ****************************************************************************
// Create test signals.
// ****************************************************************************
:SOURce1:BB:ARBitrary:SIGNal:TYPE CIQ
:SOURce1:BB:ARBitrary:TSIGnal:CIQ:I -0.5
:SOURce1:BB:ARBitrary:TSIGnal:CIQ:Q -0.33
:SOURce1:BB:ARBitrary:TSIGnal:CIQ:CREate

:SOURce1:BB:ARBitrary:TSIGnal:SINE:FREQuency 1MHz
:SOURce1:BB:ARBitrary:TSIGnal:SINE:SAMPles 100
:SOURce1:BB:ARBitrary:TSIGnal:SINE:PHASe -90
:SOURce1:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed "/var/user/sine_test"

:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:FREQuency 100kHz
:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:SAMPles 1000
:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude 0.5
:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:OFFSet -0.3
:SOURce1:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed "/var/user/rect_test"

:SOURce1:BB:ARBitrary:STATe ON
```

Example: To manage waveform files

The following example lists the commands provided for handling of waveform files.

```
// ***************************************************************************
// Reset instrument first
// ***************************************************************************
*RST; *CLS
:SOURce1:BB:ARBitrary:PRESet

// ***************************************************************************
// Set the default directory and list the available waveform files
// ***************************************************************************
MMEM:CDIR "/var/user/ARBtestSigs"
:SOURce1:BB:ARBitrary:WAVeform:CATalog?
// sineTest,rectTest,ciqTestSignal,waveformTest,test2
:SOURce1:BB:ARBitrary:WAVeform:CATalog:LENGth?
// Response is the number of files: "5"
// Optionally query free disk space.
:SOURce1:BB:ARBitrary:WAVeform:FREE?

// ***************************************************************************
// Select a waveform and querry information
// ***************************************************************************
:SOURce1:BB:ARBitrary:WAVeform:DELete "/var/user/ARBtestSigs/test2"
:SOURce1:BB:ARBitrary:WAVeform:SELect "/var/user/ARBtestSigs/wvTest"
:SOURce1:BB:ARBitrary:WAVeform:POINts?
// 100
:SOURce1:BB:ARBitrary:WAVeform:TAG? "TYPE"
// "SMU-WV"
:SOURce1:BB:ARBitrary:WAVeform:TAG? "COMMENT"
// "Waveform for test purposes"
// alternatively: query the comment tag of the current waveform file
:SOURce1:BB:ARBitrary:WAVeform:DATA?
// Response is the comment: "Waveform for test purposes"
// Query the date tag of a specific waveform file.
:SOURce1:BB:ARBitrary:WAVeform:DATA? "/var/user/ARBtestSigs/waveformTest","date"
// Response: #2192014-04-15;16:19:30
```

Example: To configure marker signals

This example provides the commands to configure the marker signals.

```
// ****************************************************************************
// Configure and enable standard marker signals
// ****************************************************************************
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE RESTart
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE RATio
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:ONTime 40
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:OFFTime 20
// ****************************************************************************
// Configure a pulsed marker signal.
// ****************************************************************************
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE PULSe
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:PULSe:DIVider 5
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:PULSe:FREQuency?
// Response in Hz: "20000000"
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:DELay 16
// ****************************************************************************
// Configure a pattern marker signal.
// ****************************************************************************
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE PATTern
SOURce1:BB:ARBitrary:TRIGger:OUTPut1:PATTern #HE0F52,20
```

Example: To configure clock settings

This example provides the commands to configure the clock settings.

```
// ****************************************************************************
// Clock settings
// ****************************************************************************
SOURce1:BB:ARBitrary:CLOCk:SOURce INTernal
SOURce1:BB:ARBitrary:CLOCk?
// Response in Hz: "1000000"
// The clock frequency is 1 MHz.
// Or alternativelly use the following tag:
SOURce1:BB:ARBitrary:WAVeform:TAG? "CLOCK"
```

Example: To enable HDD waveform streaming

The following example provides commands to enable and query waveform streaming from an HDD connected to the R&S SMM100A.

```
SOURce1:BB:ARBitrary:WAVeform:HDDStreaming:STATe ON
SOURce1:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel?
// Response in percent: "94"
```

Example: Creating a multi-segment waveform

The following example lists the commands to create a multi-segment waveform.

```
// ***************************************************************************
// Reset instrument first
// ***************************************************************************
*RST; *CLS
// :SOURce1:BB:ARBitrary:PRESet

// ***************************************************************************
// Set the default directory and list the available waveform files
// ***************************************************************************
:MMEM:CDIR "/var/user/ARB/multi_segment"
:SOURce1:BB:ARBitrary:WAVeform:CATalog:LENGth?
// 4
:SOURce1:BB:ARBitrary:WAVeform:CATalog?
// Seg_0, Seg_1, Seg_2, Seg_3
// ***************************************************************************
// List the available configuration files and select/create file
// ***************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// multi_segment,ms_waveform
// the directory contains the configuration files multi_segment.inf_mswv
and ms_waveform.inf_mswv
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:DELete "ms_waveform.inf_mswv"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect
"/var/user/ARB/multi_segment/config.inf_mswv"
// Creates an empty configuration file "config.inf_mswv".

// ***************************************************************************
// Append waveforms to the multi segment sequence
// ***************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_0"
// Waveform Seg_0.wv will be the first segment of a
// multi segment waveform created with configuration file config.inf_mswv
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_1"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_2"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_3"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend 1000,100000000
// adds a blank segment with 1000 samples and 100 MHz clock rate
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex0:DOWN
// Changes the segment order by shifting the first segment behind the second.
// segment. You can also move later segments up or delete segements.
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex1:UP
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex2:DELete
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:LEVel:MODE ERMS
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE HIGHest
// :SOURce1:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE USER
// :SOURce1:BB:ARBitrary:WSEGment:CONFigure:CLOCk 30000000
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE TAKE
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect
```

```
"/var/user/ARB/multi_segment/config.inf_mswv"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:COMMent "Multi Segment File"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:OFILe "ms_0to3"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?
// /var/user/ARB/multi_segment/Seg_0.wv,/var/user/ARB/multi_segment/Seg_1.wv,
// /var/user/ARB/multi_segment/Seg_2.wv,/var/user/ARB/multi_segment/Seg_3.wv

// ********************************************************************************
// Create and load the multi segment waveforms
// ********************************************************************************
// The first segment is output deppending on the trigger settings.
:SOURce1:BB:ARBitrary:WSEGment:CREate "/var/user/ARB/multi_segment/config.inf_mswv"
:SOURce1:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"
:SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUTo
:SOURce1:BB:ARBitrary:TRIGger:SOURce INTernal
:SOURce1:BB:ARBitrary:STAT ON
:SOURce1:BB:ARBitrary:TRIGger:EXEC
```

Example: To configure the output order of the segments

The following example lists the commands necessary to trigger the output of the segments in the desired playback order. The example lists only the relevant commands.

We assume that the multi-segment sequence `ms_0to3` composed of four segments, Seg_0, Seg_1, Seg_2 and Seg_3 is created and loaded in the ARB (see Example "Creating a multi-segment waveform" on page 877). The required output order of the segments is Seg_0, Seg_3 [2], Seg_2.

```
// ********************************************************************************
// Select a multi segment waveform
// ********************************************************************************
:MMEM:CDIR "/var/user/ARB/multi_segment"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// config
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect "config"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3"
:SOURce1:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"

// ********************************************************************************
// Adjust trigger settings and enable the ARB
// ********************************************************************************
:SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUTo
:SOURce1:BB:ARBitrary:TRIGger:SOURce INTernal
:SOURce1:BB:ARBitrary:STATe ON

// ********************************************************************************
// Select the next segment trigger mode and source
// ********************************************************************************
:SOURce1:BB:ARBitrary:TRIGger:SMODe NEXT
// :SOURce1:BB:ARBitrary:TRIGger:SMODe NSEam
:SOURce1:BB:ARBitrary:WSEGment:NEXT:SOURce INTernal
:SOURce1:BB:ARBitrary:WSEGment?
```

```
// 0
:SOURce1:BB:ARBitrary:WSEGment:NAME?
// "/var/user/ARB/multi_segment/Seg_0.wv"
// Seg_0 is output continuously

// ***************************************************************************
// Trigger a switch over to the next segment
// ***************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:NEXT 3
// stops Seg_0 and starts immediatly Seg_3; Seg_3 is output continuously
:SOURce1:BB:ARBitrary:TRIGger:EXECute
//restarts Seg_3
:SOURce1:BB:ARBitrary:WSEGment:NEXT 2
:SOURce1:BB:ARBitrary:WSEGment:NEXT 0

// ***************************************************************************
// Scrolling trough the segments, i.e. shwitch over in incremental order
// ***************************************************************************
:SOURce1:BB:ARBitrary:WSEGment:NEXT:EXECute
:SOURce1:BB:ARBitrary:WSEGment?
// 1
:SOURce1:BB:ARBitrary:WSEGment:NEXT:EXECute
:SOURce1:BB:ARBitrary:WSEGment?
// 2
```

Example: To use the ARB sequencer mode

The following example lists the commands necessary to configure a play list. The example lists only the relevant commands.

We assume that the multi-segment sequence `ms_0to3` composed of four segments, Seg_0, Seg_1, Seg_2 and Seg_3 is created and loaded in the ARB (see Example "Creating a multi-segment waveform" on page 877). The required output order of the segments is Seg_0, Seg_3 [2], Seg_2.

The ARB sequencer mode requires waveform files with equal clock rate.

```
// ***************************************************************************
// Select a multi-segment waveform with equal segment clock rates.
// ***************************************************************************
:MMEM:CDIR "/var/user/ARB/multi_segment"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// config
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect "config"
:SOURce1:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// Response: "/var/user/ARB/multi_segment/ms_0to3.wv"

// ***************************************************************************
// Select a sequencing list (*.wvs).
// ***************************************************************************
```

```
:SOURce1:BB:ARBitrary:WSEGment:SEQuence:SELect "play_list"
:SOURce1:BB:ARBitrary:WSEGment:SEQuence:APPend ON,0,1,NEXT
// Adds the segment number 0 as a new (first) segment in the sequencing list.
// This segment is activ and will be repeated once followed by the next segment.
:SOURce1:BB:ARBitrary:WSEGment:SEQuence:APPend ON,3,2,NEXT
:SOURce1:BB:ARBitrary:WSEGment:SEQuence:APPend ON,2,1,SEG0

:SOURce1:BB:ARBitrary:TRIGger:SMODe SEQuencer
:SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUTo
:SOURce1:BB:ARBitrary:TRIGger:SOURce INTernal
:SOURce1:BB:ARBitrary:STAT ON
:SOURce1:BB:ARBitrary:TRIGger:EXEC
```

Example: Adding extra marker signals

The following example lists the commands to add two marker signals, a sequence restart marker and a segment restart marker, to the multi-segment sequence. The example lists only the relevant commands.

```
// Select the multi segment file and the corresponding configuration list.
:MMEM:CDIR "/var/lists/ARB/multi_segment"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// Response: "config"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:SELect "config"
:SOURce1:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3.wv"

// Enable restart markers on marker trace 1 and 2.
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE IGNore
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment MRK1
:SOURce1:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment MRK2

:SOURce1:BB:ARBitrary:TRIGger:OUTPut1:MODE UNCHanged
:SOURce1:BB:ARBitrary:TRIGger:OUTPut2:MODE UNCHanged
```

Example: To generate a multicarrier signal

The following example lists the commands to configure and generate an ARB multicarrier signal.

```
// ***************************************************************************
// Generating a single-carrier or standard waveform signal.
// ***************************************************************************
// Load a standardized 3GPP downlink test model, e.g. "Test Model 1 16 Channels"
:SOURce1:BB:W3GPp:SETTing:TMODel:BSTation "Test_Model_1_16channels"'
// Confirm that the standardized 3GPP downlink test model is currently selected
:SOURce1:BB:W3GPp:SETTing:TMODel:BSTation?
// "Test_Model_1_16channels"
// Enable the generation of 3GPP FDD signal
:SOURce1:BB:W3GPp:STATe ON
// Generate a 3GPP FDD ARB waveform file with name "3gpp_arb".
```

```
// Save the waveform in the default directory "/var/user".
:SOURce1:BB:W3GPp:WAVeform:CREate "3gpp_arb"

// ******************************************************************************
// Enable a multicarrier scenario with 4 carriers and carrier spacing of 5 MHz.
// ******************************************************************************
:SOURce1:BB:ARBitrary:MCARrier:CARRier:COUNt 4
:SOURce1:BB:ARBitrary:MCARrier:CARRier:SPACing 5 MHz
:SOURce1:BB:ARBitrary:MCARrier:CARRier1:STATe ON
:SOURce1:BB:ARBitrary:MCARrier:CARRier2:STATe ON
:SOURce1:BB:ARBitrary:MCARrier:CARRier3:STATe ON
:SOURce1:BB:ARBitrary:MCARrier:CARRier4:STATe ON

// ******************************************************************************
// Select and load the waveform file "3gpp_arb" to all 4 carriers
// ******************************************************************************
// The file "3gpp_arb" is in default directory "/var/user".
:SOURce1:BB:ARBitrary:MCARrier:CARRier1:FILE "3gpp_arb"
:SOURce1:BB:ARBitrary:MCARrier:CARRier2:FILE "3gpp_arb"
:SOURce1:BB:ARBitrary:MCARrier:CARRier3:FILE "3gpp_arb"
:SOURce1:BB:ARBitrary:MCARrier:CARRier4:FILE "3gpp_arb"

// ******************************************************************************
// Trigger the signal caulation and load the waveform in the ARB generator
// ******************************************************************************
// Define the file name of the multi carrier output file, e.g. "3gpp_mc"
:SOURce1:BB:ARBitrary:MCARrier:OFILe "3gpp_mc"
// Create and load the multicarrier waveform file in the ARB.
:SOURce1:BB:ARBitrary:MCARrier:CLOad
// Alternatively, load the multicarrier subsequently in the ARB.
// :SOURce1:BB:ARBitrary:MCARrier:CREate
// :SOURce1:BB:ARBitrary:WAVeform:SELect"3gpp_mc"

// Activate the ARB.
:SOURce1:BB:ARBitrary:STATe ON

// ******************************************************************************
// Use the save and recall function.
// ******************************************************************************
// Query available settings files in a specified directory.
MMEM:CDIR "/var/user/waveform"
:SOURce1:BB:ARBitrary:MCARrier:SETTing:CATalog?
// mcar1, mcar2
// The directory contains the files mcar1.arb_multcarr and mcar2.arb_multcarr.
:SOURce1:BB:ARBitrary:MCARrier:SETTing:STORe "3gpp_mc"
```

Example: Generating AWGN test signal

```
SOURce1:BB:ARBitrary:SIGNal:TYPE AWGN
SOURce1:BB:ARBitrary:TSIGnal:AWGN:SAMPles 10000000
SOURce1:BB:ARBitrary:TSIGnal:AWGN:CREate

SOURce1:BB:ARBitrary:STATe 1
```

Example: To create notch filters

```
:SOURce1:BB:ARBitrary:CLOCK 1000000
:SOURce1:BB:ARBitrary:NOTCh:CLOCk?
// Response in Hz: 1000000
:SOURce1:BB:ARBitrary:NOTCh:COUNt 3

:SOURce1:BB:ARBitrary:NOTCh1:STATe 1
:SOURce1:BB:ARBitrary:NOTCh1:FREQuency:OFFSet 0
:SOURce1:BB:ARBitrary:NOTCh1:BWIDth:RELative 3
:SOURce1:BB:ARBitrary:NOTCh1:BWIDth:ABSolute?
// Response in Hz: 30000

:SOURce1:BB:ARBitrary:NOTCh2:FREQuency:OFFSet -25000000
:SOURce1:BB:ARBitrary:NOTCh2:BWIDth:ABSolute 20000
:SOURce1:BB:ARBitrary:NOTCh2:BWIDth:RELative?
//  2
:SOURce1:BB:ARBitrary:NOTCh3:FREQuency:OFFSet 25000000
:SOURce1:BB:ARBitrary:NOTCh3:BWIDth:ABSolute 5000
:SOURce1:BB:ARBitrary:NOTCh3:BWIDth:RELative 0.5

:SOURce1:BB:ARBitrary:NOTCh1:APPLy
:SOURce1:BB:ARBitrary:NOTCh 1
:SOURce1:BB:ARBitrary:STATe 1
```

General commands

[:SOURce<hw>]:BB:ARBitrary:PRESet

Sets all ARB generator parameters to their default values.

Example: See Example "To create test signals" on page 874.

Usage: Event

Manual operation: See "Set To Default" on page 157

[:SOURce<hw>]:BB:ARBitrary:STATe <State>

Enables the ARB generator.

A waveform must be selected before the ARB generator is activated.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "To create test signals" on page 874.

Manual operation: See "State" on page 157

[:SOURce<hw>]:BB:ARBitrary:PRAMp[:STATe] <ArbPramState>

If activated, the burst gate marker signal included in the ARB waveform file is used as marker signal for the pulse modulator.

Parameters:

<ArbPramState> 1 | ON | 0 | OFF

*RST: 0

Example:

```
SOURce1:BB:ARBitrary:WAVeform:SELect "/var/user/Pulse_PMod_Burst"
SOURce1:BB:ARBitrary:PRAMp:STATe 1
SOURce1:BB:ARBitrary:STATe 1
```

Options: R&S SMM-K22

Manual operation: See "RF Power Ramping with Burst Marker" on page 159

Test signal commands

[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE 883
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I 884
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q 884
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude 884
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency 884
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet 884
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:SAMPles 885
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency 885
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:PHASe 885
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles 886
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed 886
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed 886
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed 886
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate 886
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate 886
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate 886
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:AWGN:SAMPles 886
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:AWGN:CREate 887

[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE <ArbSignalType>

Selects the type of test signal.

Parameters:

<ArbSignalType> SINE | RECT | CIQ

*RST: SINE

Example: See Example "To create test signals" on page 874.

Manual operation: See "Test Signal Form" on page 159

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I <I>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q <TSig>

Sets the value for the I and Q component of the test signal

Parameters:

<TSig> float

Range: -1 to 1
Increment: 0.001
*RST: 0
Default unit: FS

Example: See Example "To create test signals" on page 874.

Manual operation: See "I ValueIQ Value" on page 163

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude <Amplitude>

Sets the digital amplitude of the rectangular wave.

Parameters:

<Amplitude> float

Range: 0 to 1
Increment: 0.001
*RST: 0.800
Default unit: FS

Example: See Example "To create test signals" on page 874.

Manual operation: See "Amplitude" on page 162

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency <Frequency>

Sets the frequency of the test signal.

Parameters:

<Frequency> float

Range: 100 to depends on options
Increment: 0.01
*RST: 1000
Default unit: Hz

Example: See Example "To create test signals" on page 874.

Manual operation: See "Frequency" on page 162

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet <Offset>

Sets the DC component.

Parameters:

<Offset> float

Range: -1 to 1
Increment: 0.001
*RST: 0
Default unit: FS

Example: See Example "To create test signals" on page 874.

Manual operation: See "Offset DC" on page 162

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:SAMPles <Samples>

Sets the number of sample values required for the rectangular signal per period.

Parameters:

<Samples> integer

Range: 4 to 1000
*RST: 100

Example: See Example "To create test signals" on page 874.

Manual operation: See "Samples per Period" on page 162

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency <Frequency>

Sets the frequency of the simple sinusoidal test signal.

Parameters:

<Frequency> float

Range: 100 to depends on options
Increment: 0.01
*RST: 1000
Default unit: Hz

Example: See Example "To create test signals" on page 874.

Manual operation: See "Frequency" on page 160

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:PHASe <Phase>

Sets the phase offset of the sine wave on the Q channel relative to the sine wave on the I channel.

Parameters:

<Phase> float

Range: -180 to 180
Increment: 0.01
*RST: 90
Default unit: DEG

Example: See Example "To create test signals" on page 874.

Manual operation: See "Phase Offset Q" on page 160

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles <Samples>

Sets the sample rate for the sine signal in samples per period.

Make sure that the resulting clock rate does not exceed the maximum ARB clock rate. The maximum value is automatically restricted by reference to the set frequency and has to fulfill the rule *Frequency * Samples <= ARB clock rate*.

For more information, refer to the specifications document.

Parameters:

<Samples> integer

Range: 4 to 1000
*RST: 100

Example: See Example "To create test signals" on page 874.

Manual operation: See "Samples per Period" on page 160

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed <Filename>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed <Filename>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed <Filename>

Generates a signal and saves it to a waveform file.

Setting parameters:

<Filename> string

Example: See Example "To create test signals" on page 874.

Usage: Setting only

Manual operation: See "Generate Signal File" on page 161

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate

Generates a signal and uses it as output straight away.

Example: See Example "To create test signals" on page 874.

Usage: Event

Manual operation: See "Generate Signal RAM" on page 161
See "Generate Signal RAM" on page 162

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:AWGN:SAMPles <ParAwgnSamp>

Sets the number of samples generated for the AWGN waveform.

Parameters:

<ParAwgnSamp> integer

Range: 1E6 to 1E9
*RST: 1E8

Example: See Example "Generating AWGN test signal" on page 881.

Options: R&S SMM-K811

Manual operation: See "Samples" on page 203

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:AWGN:CREate

Generates a signal and uses it as output straight away.

Example: See Example "Generating AWGN test signal" on page 881.

Usage: Event

Options: R&S SMM-K811

Manual operation: See "Generate Signal RAM" on page 203

Waveform commands

The following rule applies for all commands described in this section.

By default, the waveform files are saved in the default directory of the instrument that is the `/var/user/` directory or the directory specified with the command `:MMEMory:CDIRectory`. To access the waveform files in this default directory, only the filename is required, without the path and the file extension (`*.wv`).

However, to access waveform files located in a directory different to the default one, the complete file path and filename are required.

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog? 887
[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog:LENGth? 888
[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect 888
[:SOURce<hw>]:BB:ARBitrary:WAVeform:DELete 888
[:SOURce<hw>]:BB:ARBitrary:WAVeform:FREE? 889
[:SOURce<hw>]:BB:ARBitrary:WAVeform:POINts? 889
[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA 889
[:SOURce<hw>]:BB:ARBitrary:WAVeform:TAG? 890
[:SOURce<hw>]:BB:ARBitrary:CLOCk 890
[:SOURce<hw>]:BB:ARBitrary:WAVeform:CLOCk 891

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog?

Reads out the files extension `*.wv` in the default directory.

Return values:
<Catalog> string
Returns a list of the file names separated by commas

Example: See Example "To manage waveform files" on page 875.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog:LENGth?

Reads out the files with extension `*.wv` in the default directory and returns the number of waveform files in this directory. The default directory is set using command `MMEM:CDIRectory`.

Return values:
<Length> integer
Number of waveform files in default directory
Range: 0 to INT_MAX
*RST: 0

Example: See Example "To manage waveform files" on page 875.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect <Filename>

Selects a waveform file in the default directory.

You can omit the file extension. For supported file formats, see Section 4.6.2.1, "About ARB file formats", on page 151.

Parameters:
<Filename> string

Example: See Example "To manage waveform files" on page 875.

Manual operation: See "Load Waveform" on page 158

[:SOURce<hw>]:BB:ARBitrary:WAVeform:DELete <Filename>

Deletes the specified waveform file. If the file is not on the default path, the path must be specified at the same time. The file extension may be omitted. Only files with the file extension `*.wv` are deleted.

Setting parameters:
<Filename> string

Example: See Example "To manage waveform files" on page 875.

Usage: Setting only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:FREE?

Queries the free disk space on the default path of the instrument's hard disk.

Return values:

<Free> integer

Range: 0 to INT_MAX
*RST: 1

Example: See Example "To manage waveform files" on page 875.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:POINts?

Queries the number of samples (the number of I/Q values pairs) in the selected waveform file.

Return values:

<Points> <waveform filename>

Range: 0 to 1000
*RST: 1

Example: See Example "To manage waveform files" on page 875.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA <Filename>, <Data>
[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA? <Tag>

The **setting** command writes the binary block data `<data>` to the file identified by `<filename>`. The *complete content* of the waveform file (i.e. including all tags) must be specified; the complete content is transmitted as binary data block.

Tip: To ensure trouble-free data transmission, set the GPIB delimiter to EOI.

The **query** command retrieves the content of the specified tag of the currently selected waveform file or the waveform file specified with the `<filename>`.

See also Section 4.6.5, "Tags for waveforms, data and control lists", on page 180.

Parameters:

<Filename> string

Specifies the name of the waveform file in that the binary data is copied

Setting parameters:

<Data> block data

Binary block data with the following syntax:
`#<Digits><Length><Binary data>`

#
Indicates the start of the binary block

<Digits>
Decimal value
Gives the number of decimal digits used for the `<Length>` value

<Length>
Decimal value
Number of bytes the follow in the `<Binary data>` part

<Binary data>
Binary data in ASCII format

Query parameters:

<Tag> 'comment' | 'copyright' | 'date' | 'lacpfilter' | 'marker name' | 'poweroffset'

Example: **Query**
See Example "To manage waveform files" on page 875.

Example: **Setting**

```
SOURce:BB:ARB:WAVeform:DATA "/var/user/test1.wv",#220<binary data>
// Writes the binary block data <binary data> to file test1.wv
// <binary data> contains 20 bytes
// <binary data> is a placeholder;
// the actual ASCII values are not printable
```

[:SOURce<hw>]:BB:ARBitrary:WAVeform:TAG?

Queries the content of the specified tag of the selected waveform file (see also Section 4.6.5, "Tags for waveforms, data and control lists", on page 180).

Return values:

<Tag> 'comment' | 'copyright' | 'date' | 'lacpfilter' | 'marker name' | 'poweroffset' | 'samples'

Example: See Example "To manage waveform files" on page 875.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:CLOCk <Clock>

Sets the clock frequency.

If you load a waveform, the clock rate is determined as defined with the waveform tag `{CLOCK: frequency}`. This command subsequently changes the clock rate; see specifications document for value range.

For more information, refer to the specifications document.

Parameters:

<Clock> float

Range: depends on options
Increment: 0.001
*RST: 1E6
Default unit: Hz

Example: See Example "To manage waveform files" on page 875.

Manual operation: See "Clock Frequency" on page 158

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CLOCk <Filename>, <Clock>

Appends information on the ARB clock rate to the specified waveform file. This file must contain I/Q or marker data.

Use the following command to create the data:

`:MMEMory:DATA:UNPRotected` on page 728

Parameters:

<Filename> string

Complete file path and filename with file extension (`*.wv`).
If the file is in the default directory, the file path can be omitted.

Setting parameters:

<Clock> float

Range: 400 to 100E6
Increment: 1E-3
*RST: 1E6

Example: See `:MMEMory:DATA:UNPRotected` on page 728.

Multi-segment commands

Required options

See Section 4.9.1, "Required options", on page 204.

[:SOURce<hw>]:BB:ARBitrary:WSEGment? ... 891
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME? ... 892
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT ... 892
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute ... 892
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce ... 893
[:SOURce<hw>]:BB:ARBitrary:WSEGment:LMODe ... 893
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog? ... 893
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect ... 893
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend ... 894
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate ... 894
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad ... 894
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE ... 895
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment ... 895
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment ... 895
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe ... 895

[:SOURce<hw>]:BB:ARBitrary:WSEGment?

Queries the index of the currently processed segment.

Return values:
<WSegment> integer
Range: 0 to 1023
*RST: 0

Example: see Example "To configure the output order of the segments" on page 878

Usage: Query only

Manual operation: See "Current Segment/Current Segment Index" on page 223

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME?

Queries the name of the waveform of the currently output segment of the multi-segment waveform.

Return values:
<Name> string

Example: See Example "To configure the output order of the segments" on page 878

Usage: Query only

Manual operation: See "Current Segment/Current Segment Index" on page 223

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT <Next>

Selects the segment to be output.

Parameters:
<Next> integer
Range: 0 to 1023
*RST: 0

Example: see Example "To configure the output order of the segments" on page 878

Manual operation: See "Segment" on page 223

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute

Triggers manually switchover to the subsequent segment in the multi-segment file.

This command is disabled, if a sequencing play list is enabled.

Example: See Example "To configure the output order of the segments" on page 878

Usage: Event

Manual operation: See "Execute Next Segment" on page 225

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce <Source>

Selects the next segment source.

Parameters:
<Source> INTernal | NSEGM1 | INTernal | NSEGM1
*RST: INTernal

Example: See Example "To configure the output order of the segments" on page 878.

Manual operation: See "Next Segment Source" on page 225

[:SOURce<hw>]:BB:ARBitrary:WSEGment:LMODe <LevelMode>

Sets how the segments are leveled.

Parameters:
<LevelMode> HIGHest | UNCHanged
*RST: HIGHest

Example:
```
:SOURce1:BB:ARBitrary:WSEGment:LMODe HIGHest
```

Manual operation: See "Level Mode" on page 225

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?

Queries the segments of the currently selected configuration file.

Return values:
<Catalog> string

Example: See Example "Creating a multi-segment waveform" on page 877.

Usage: Query only

Manual operation: See "Segment Table" on page 214

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect <Filename>

Selects the sequencing list (files with extension `*.wvs`)

Parameters:
<Filename> string

Example: see Example "To use the ARB sequencer mode" on page 879

Manual operation: See "New Sequencing List/Load Sequencing List" on page 220
See "Append" on page 222
See "Sequencing List" on page 225

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend <State>, , <Count>, <Next>

Appends a new segment to the selected sequencing play list.

Setting parameters:

<State> ON | OFF
Activates/deactivates the appended segment
*RST: ON

 integer
Indicates the number of the segment as in the multi-segment waveform file
Range: 0 to SegmentCount - 1

<Count> integer
Defines how many times this segment is repeated
Range: 1 to 1048575

<Next> NEXT | BLANk | ENDLess | SEG0 | SEG1 | ... | SEG31 | 0...maxSegment
Determines the action after completing the current segment, like for instance which segment is processed after the processing of the current one is finished.

Example: See Example "To use the ARB sequencer mode" on page 879

Usage: Setting only

Manual operation: See "Append" on page 222

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate <FilenameInput>

Creates a multi-segment waveform (`*.wv`) using the current settings of the specified *configuration file* (`*.inf_mswv`).

Setting parameters:

<FilenameInput> Complete file path, file name of the configuration file and file extension (*.inf_mswv)

Example: See Example "Creating a multi-segment waveform" on page 877

Usage: Setting only

Manual operation: See "Create Output File/Create and Load Output File" on page 212

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad <FilenameInput>

Creates a multi-segment waveform using the current entries of the specified *configuration file* (`*.inf_mswv`).

The ARB generator is activated, the new multi-segment waveform (`*.wv`) is loaded and the first segment is output in accordance to the trigger settings.

Setting parameters:

<FilenameInput> string

Complete file path, file name of the configuration file and file extension (`*.inf_mswv`)

Example: See Example "Creating a multi-segment waveform" on page 877

Usage: Setting only

Manual operation: See "Create Output File/Create and Load Output File" on page 212

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE <Mode>

Defines the way the marker information within the separate segments is processed.

Parameters:

<Mode> IGNore | TAKE

*RST: TAKE

Example: see Example "Adding extra marker signals" on page 880

Manual operation: See "Segment Marker" on page 217

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment <Mode>
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment <Mode>

Enables/disables the generation of an additional marker restart signal at the beginning of the first segment (`FSEGment`) or at the beginning of each segment (`ESEGment`).

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered.

Parameters:

<Mode> OFF | MRK1 | MRK2 | MRK3 | MRK4

*RST: OFF

Example: see Example "Adding extra marker signals" on page 880

Manual operation: See "Sequence Restart" on page 217

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe <SMode>

Selects the extended trigger mode for multi segment waveforms.

Parameters:

<SMode> SAME | NEXT | SEQuencer | NSEam

NSEam = Next Segment Seamless

*RST: NEXT

Example: See Example "To configure the output order of the segments" on page 878.

Manual operation: See "Next Segment Mode" on page 224

Multi-segment sequencing commands

Required options

See Section 4.9.1, "Required options", on page 204.

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend....896
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?....897
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk....897
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE....897
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE]....897
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent....898
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete....898
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe....898
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend....898
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DELete....899
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DOWN....899
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:UP....899
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect....900

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend
<SampCount>, <Frequency>

Adds a blank segment to the multi-segment file.

Setting parameters:

<SampCount> float

Specifies the number of samples.

Range: 512 to 1E7
Increment: 1
*RST: 1000

<Frequency> float

Determines the clock rate.

Range: 400 Hz to depends on options
Increment: 0.001
*RST: 1E8

Example: See Example "Creating a multi-segment waveform" on page 877

Usage: Setting only

Manual operation: See "Clock Rate" on page 215
See "Samples" on page 215
See "Period" on page 215
See "Append Blank" on page 216

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?

Queries the available configuration files in the default directory. See also Section 4.9.2.3, "File concept", on page 205.

Return values:
<Catalog> string

Example: see Example "Creating a multi-segment waveform" on page 877

Usage: Query only

Manual operation: See "Load List" on page 211

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk <Clock>

Defines the clock rate used for multi-segment waveform output, if the clock mode is `USER`.

Parameters:
<Clock> float
Increment: 1E-3
*RST: maximum sample rate

Example: See Example "Creating a multi-segment waveform" on page 877

Manual operation: See "User Clock Rate" on page 217

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE <Mode>

Selects the clock rate mode for the multi segment waveform. Use the command `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk` to define the clock in clock mode user.

Parameters:
<Mode> UNCHanged | HIGHest | USER
*RST: UNCHanged

Example: See Example "Creating a multi-segment waveform" on page 877.

Manual operation: See "Clock" on page 217

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE] <Mode>

Selects the level mode, unchanged or equal RMS, for the multi-segment waveform.

Parameters:
<Mode> UNCHanged | ERMS
*RST: UNCHanged

Example: See Example "Creating a multi-segment waveform" on page 877.

Manual operation: See "Level" on page 216

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent <Comment>

Enters a comment for the selected configuration file.

Parameters:
<Comment> string

Example: See Example "Creating a multi-segment waveform" on page 877

Manual operation: See "Comment" on page 212

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete <Filename>

Deletes the selected configuration file.

Setting parameters:
<Filename> string

Example: See Example "Creating a multi-segment waveform" on page 877.

Usage: Setting only

Manual operation: See "Load List" on page 211

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe <OFile>

Defines the file name of the output multi-segment waveform.

Parameters:
<OFile> string

Example: See Example "Creating a multi-segment waveform" on page 877

Manual operation: See "Output File" on page 212
See "Create Output File/Create and Load Output File" on page 212

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend <Waveform>

Appends the specified waveform to the configuration file.

Setting parameters:
<Waveform> string

Example: see Example "Creating a multi-segment waveform" on page 877

Usage: Setting only

Manual operation: See "Append" on page 214

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DELete

Deletes the selected waveform segment in the segment table.

Suffix:
INDex<ch0> 0 to depends on settings
Waveform segment number

Example: See Example "Creating a multi-segment waveform" on page 877.

Usage: Event

Manual operation: See "Delete" on page 215

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:DOWN

Shifts the selected waveform segment down by one segment in the segment table.

Suffix:
INDex<ch0> 0 to depends on settings
Waveform segment number

Example: See Example "Creating a multi-segment waveform" on page 877.

Usage: Event

Manual operation: See "Shift Segment Down" on page 215

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:INDex<ch0>:UP

Shifts the selected waveform segment up by one segment in the segment table.

Suffix:
INDex<ch0> 0 to depends on settings
Waveform segment number

Example: See Example "Creating a multi-segment waveform" on page 877.

Usage: Event

Manual operation: See "Shift Segment Up" on page 215

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect <Filename>

Selects a configuration file from the default directory. If a configuration file with the specified name does not yet exist, it is created. The file extension `*.inf_mswv` may be omitted.

Parameters:
<Filename> string

Example: see Example "Creating a multi-segment waveform" on page 877

Manual operation: See "New List" on page 211
See "Load List" on page 211

Multicarrier commands

Required options

See Section 4.10.1, "Required options", on page 235.

Common suffixes

Suffix	Value range
CARRier<ch>	1 to 512

[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet ... 901
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog? ... 901
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD ... 901
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe ... 902
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt ... 902
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE ... 902
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing ... 902
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles? ... 903
[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME ... 903
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CFACtor:MODE ... 903
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor ... 904
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff ... 904
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] ... 904
[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME:MODE ... 905
[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence ... 905
[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe ... 905
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad ... 905
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk? ... 906
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate ... 906
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe ... 906
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency ... 907
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe ... 907
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer ... 907
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay ... 908
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE ... 908

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict? 908
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe 908
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt 909
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP 909
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP 909
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer[:STARt] 909
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP 910
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe[:STARt] 910
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP 910
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay[:STARt] 911
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE 911
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute 911

[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet

Sets all the multicarrier parameters to their default values.

Example: See Example "To generate a multicarrier signal" on page 880.

Usage: Event

Manual operation: See "Set to Default" on page 239

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog?

Queries the files with settings in the default directory. Listed are files with the file extension `*.arb_multcarr`.

Return values:
<Catalog> string

Example: See Example "To generate a multicarrier signal" on page 880.

Usage: Query only

Manual operation: See "Save/Recall" on page 239

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.arb_multcarr`.

Setting parameters:
<Filename> "<filename>"
Filename or complete file path; file extension can be omitted.

Example: See Example "To generate a multicarrier signal" on page 880.

Usage: Setting only

Manual operation: See "Save/Recall" on page 239

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe <Filename>

Saves the current settings into the selected file; the file extension (`*.arb_multcarr`) is assigned automatically.

Setting parameters:

<Filename> string

Filename or complete file path

Example: See Example "To generate a multicarrier signal" on page 880.

Usage: Setting only

Manual operation: See "Save/Recall" on page 239

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt <Count>

Sets the number of carriers in the ARB multicarrier waveform.

Parameters:

<Count> integer

Range: 1 to 512
*RST: 1

Example: See Example "To generate a multicarrier signal" on page 880.

Manual operation: See "Number of Carriers" on page 239
See "Number of Carriers" on page 245

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE <Mode>

Sets the carrier frequency mode for the single carriers.

Parameters:

<Mode> EQUidistant | ARBitrary

*RST: EQUidistant

Example: `BB:ARB:MCAR:CARR:MODE EQU`
Sets an equidistant carrier spacing. The carrier frequency cannot be set.

Manual operation: See "Mode" on page 239

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing <Spacing>

Sets the frequency spacing between adjacent carriers of the multicarrier waveform.

See also Section 4.10.2.1, "Defining the carrier frequency", on page 236.

Parameters:

<Spacing> float

Range: 0.0 to depends on options, for example 120E6
Increment: 0.01
*RST: 0
Default unit: Hz

Example: See Example "To generate a multicarrier signal" on page 880.

Manual operation: See "Carrier Spacing" on page 240

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?

Queries the resulting file size.

Return values:

<Samples> integer

Range: 0 to INT_MAX
*RST: 0
Default unit: samples

Example: `SOURce1:BB:ARBitrary:MCARrier:SAMPles?`
Queries the file size of the currently calculated multi-carrier waveform.

Usage: Query only

Manual operation: See "File Size" on page 244

[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME <Time>

Sets the user-defined signal period.

Parameters:

<Time> float

Range: 0 to 1E9
Increment: 1E-9
*RST: 0
Default unit: s

Example: `SOURce1:BB:ARBitrary:MCARrier:MODE USER`
Selects signal period mode user.
`SOURce1:BB:ARBitrary:MCARrier:TIME 10`
Sets a signal period of 10 seconds

Manual operation: See "Signal Period Mode" on page 241

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CFACtor:MODE <Mode>

Sets the mode for optimizing the crest factor by calculating the carrier phases.

Parameters:

<Mode> OFF | MIN | MAX

*RST: OFF

Example: `SOURce1:BB:ARBitrary:MCARrier:CFACtor:MODE OFF`
Switches off automatic crest factor optimization.

Manual operation: See "Crest Factor Mode" on page 240

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor <CFactor>

Sets the value of the desired crest factor, if baseband clipping is enabled.

A target crest factor above the crest factor of the unclipped multicarrier signal has no effect.

Parameters:

<CFactor> float

Range: -50 to 50
Increment: 0.01
*RST: 50
Default unit: dB

Example: See `[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe]` on page 904.

Manual operation: See "Target Crest Factor" on page 240

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff <Cutoff>

Sets the cutoff frequency of the final low pass filter, if baseband clipping is enabled.

Parameters:

<Cutoff> float

Range: 0 to 50E6
Increment: 0.01
*RST: 50E6

Example: See `[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe]` on page 904.

Manual operation: See "Filter Cut Off Frequency" on page 240

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] <State>

Switches baseband clipping on and off.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example:
```
SOURce1:BB:ARBitrary:MCARrier:CLIPping:STATe ON
SOURce1:BB:ARBitrary:MCARrier:CLIPping:CFACtor 37
SOURce1:BB:ARBitrary:MCARrier:CLIPping:CUToff 50
```

Manual operation: See "Clipping" on page 240

[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME:MODE <Mode>

Selects the mode for calculating the resulting signal period of the multi-carrier waveform. The resulting period is always calculated for all carriers in the carrier table irrespective of their state (ON/OFF).

Parameters:

<Mode> USER | LONG | SHORt | LCM

*RST: LONG

Example:
```
BB:ARB:MCAR:TIME:MODE LONG
```
The resulting signal period is defined by the longest I/Q file in the carrier table. Shorter I/Q files are periodically repeated.

Manual operation: See "Signal Period Mode" on page 241

[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence <Reference>

Defines the way the individual carriers in a composed multi carrier signal are leveled.

Parameters:

<Reference> RMS | PEAK

*RST: RMS

Manual operation: See "Power Reference" on page 241

[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe <OFile>

Sets the output filename for the multicarrier waveform (file extension `*.wv`).

This filename is required to calculate the waveform with the commands `[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad` or `[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate`.

Parameters:

<OFile> string

Example: See Example "To generate a multicarrier signal" on page 880.

Manual operation: See "Output File" on page 243

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad

Creates a multicarrier waveform using the current entries of the carrier table and enables the ARB.

Use the command [:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe to define the multicarrier waveform filename. The file extension is *.wv.

Example: See Example "To generate a multicarrier signal" on page 880.

Usage: Event

Manual operation: See "Create/Create and Load" on page 243

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk?

Queries the resulting sample rate at which the multi-carrier waveform is output by the arbitrary waveform generator. The output clock rate depends on the number of carriers, carrier spacing, and input sample rate of the leftmost or rightmost carriers.

Return values:

<Clock> float

Range: 400 to Max
Increment: 1E-3

Example: BB:ARB:MCAR:CLOC?
Queries the ARB multi-carrier output clock rate.

Usage: Query only

Manual operation: See "Clock Rate" on page 244

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate

Creates a multicarrier waveform using the current settings of the carrier table.

Use the command [:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe to define the multicarrier waveform filename. The file extension is *.wv.

Example: See Example "To generate a multicarrier signal" on page 880.

Usage: Event

Manual operation: See "Create/Create and Load" on page 243

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe <State>

Enables the selected single carrier of the multicarrier signal.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "To generate a multicarrier signal" on page 880.

Manual operation: See "State" on page 245

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency <Frequency>

Sets or indicates the carrier frequency, depending on the selected carrier frequency mode.

Parameters:

<Frequency> integer

Range: depends on options
*RST: 0

Example: `SOURce1:BB:ARBitrary:MCARrier:CARRier:MODE ARB`
`SOURce1:BB:ARBitrary:MCARrier:CARRier1:FREQuency 5.0`
Sets 5.0 MHz carrier frequency.

Manual operation: See "Carrier Freq. Offs. (MHz)" on page 245

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe <Phase>

Sets the start phase of the selected carrier.

Parameters:

<Phase> float

Range: 0 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `SOURce1:BB:ARBitrary:MCARrier:CARRier19:PHASe 90`
Sets a start phase.

Manual operation: See "Phase (deg)" on page 245

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer <Power>

Sets the gain of the selected carrier.

Parameters:

<Power> float

Range: -80 to 0
Increment: 0.01
*RST: 0
Default unit: dB

Example: `SOURce1:BB:ARBitrary:MCARrier:CARRier15:POWer -50`
Sets the power of carrier 15 to -50 dB.

Manual operation: See "Gain (dB)" on page 245

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay <Delay>

Sets the start delay of the selected carrier.

Parameters:

<Delay> float

Range: 0 to 1
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:CARR15:DEL 5us`
sets a start delay of 50 us for carrier 15.

Manual operation: See "Delay (ns)" on page 245

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE <File>

Selects the I/Q data file that contains the I/Q samples for modulation onto the selected single carrier.

Parameters:

<File> <file name>

Example: See Example "To generate a multicarrier signal" on page 880.

Manual operation: See "File" on page 246

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?

Queries carrier conflicts. A conflict arises when the carriers overlap.

Return values:

<Conflict> 1 | ON | 0 | OFF

0
No conflict

*RST: 0

Example: `BB:ARB:MCAR:CARR:CONF?`

Usage: Query only

Manual operation: See "!!!" on page 246

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe <State>

Switches all the carriers in the selected carrier range on or off.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Example: `BB:ARB:MCAR:EDIT:CARR:STAT ON`
Sets all the carriers in the carrier range to ON.

Manual operation: See "Carrier State" on page 247

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt <Start>
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP <Stop>

Selects the last carrier in the carrier range to which the settings shall apply.

Parameters:

<Stop> integer

Range: 0 to 511
*RST: 0

Example: `BB:ARB:MCAR:EDIT:CARR:STOP 4`
The carrier range stops at carrier 4.

Manual operation: See "Carrier Start" on page 247
See "Carrier Stop" on page 247

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP <Step>

Sets the step width by which the starting power of the carriers in the defined carrier range is incremented.

Parameters:

<Step> float

Range: -80 to 80
Increment: 0.01
*RST: 0
Default unit: dB

Example: `BB:ARB:MCAR:EDIT:CARR:POW -80dB`
Sets a power of -80 dB for the carriers in the carrier range.
`BB:ARB:MCAR:EDIT:CARR:POW:STEP 1 dB`
The power is incremented by 1dB for each carrier.
That is, the first carrier has -80 dB, the second -79 dB, and so on.

Manual operation: See "Gain Step" on page 247

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer[:STARt] <Start>

Sets the power for the individual carriers in the defined carrier range.

Parameters:

<Start> float

Range: -80 to 0
Increment: 0.01
*RST: 0
Default unit: dB

Example: `BB:ARB:MCAR:EDIT:CARR:POW -50 dB`
sets the power of the carriers in the carrier range to -50 dB.

Manual operation: See "Gain Start" on page 247

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP <Step>

Sets the step width by which the start phases of the carriers in the defined carrier range is incremented.

Parameters:

<Step> float

Range: -359.99 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `BB:ARB:MCAR:EDIT:CARR:PHAS 90 DEG`
Sets a start phase of 90° for the carriers in the carrier range.
`BB:ARB:MCAR:EDIT:CARR:PHAS:STEP 1 DEG`
The start phase is incremented by 1° for each carrier. That is, the first carrier has a start phase of 90°, the second a start phase of 91°, and so on.

Manual operation: See "Phase Step" on page 248

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe[:STARt] <Start>

Sets the start phase for the individual carriers in the defined carrier range.

Parameters:

<Start> float

Range: 0 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `BB:ARB:MCAR:EDIT:CARR:PHAS 90 DEG`
sets a start phase of 90° for the carriers in the carrier range.

Manual operation: See "Phase Start" on page 248

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP <Step>

Sets the step width by which the start delays of the carriers in the defined carrier range is incremented.

Parameters:

<Step> float

Range: -1 to 1
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:EDIT:CARR:DEL 5 us`
Sets a start delay of 5 us for the carriers in the carrier range.
`BB:ARB:MCAR:EDIT:CARR:DEL:STEP 1 us`
The start delay is incremented by 1us for each carrier. That is, the first carrier has a start delay of 5 us, the second a start delay of 6 us, and so on.

Manual operation: See "Delay Step" on page 248

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay[:STARt] <Start>

Sets the start delay for the individual carriers in the defined carrier range.

Parameters:
<Start> float

Range: 0 to 1
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:EDIT:CARR:DEL 5us`
Sets a start delay of 5 us for the carriers in the carrier range.

Manual operation: See "Delay Start" on page 248

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE <File>

Selects the input file. The data of the file are modulated onto the carriers in the defined carrier range.

Parameters:
<File> string

Example: `BB:ARB:MCAR:EDIT:CARR:FILE "/var/user/temp/IQ_wcdma"`
selects input file `IQ_wcdma`.

Manual operation: See "Input Waveform File" on page 248

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute

Adopts the settings for the selected carrier range.

Example:
```
BB:ARB:MCAR:EDIT:CARR:STAR 4
BB:ARB:MCAR:EDIT:CARR:STOP 20
BB:ARB:MCAR:EDIT:CARR:STAT ON
BB:ARB:MCAR:EDIT:CARR:EXEC
```

Usage: Event

Manual operation: See "Apply Assistant Settings" on page 248

Notch filter commands

Option: R&S SMM-K811.

See also Section 4.7.1, "Required options", on page 198.

[:SOURce<hw>]:BB:EUTRa:NOTCh 912
[:SOURce<hw>]:BB:OFDM:NOTCh 912
[:SOURce<hw>]:BB:ARBitrary:NOTCh 912
[:SOURce<hw>]:BB:EUTRa:NOTCh:CLOCk? 912
[:SOURce<hw>]:BB:OFDM:NOTCh:CLOCk? 912
[:SOURce<hw>]:BB:ARBitrary:NOTCh:CLOCk? 912
[:SOURce<hw>]:BB:EUTRa:NOTCh:COUNt 913
[:SOURce<hw>]:BB:OFDM:NOTCh:COUNt 913
[:SOURce<hw>]:BB:ARBitrary:NOTCh:COUNt 913
[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:STATe 913
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:STATe 913
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:STATe 913
[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:FREQuency:OFFSet 913
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:FREQuency:OFFSet 913
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:FREQuency:OFFSet 913
[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:BWIDth[:ABSolute] 914
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:BWIDth[:ABSolute] 914
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:BWIDth[:ABSolute] 914
[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:BWIDth:RELative 914
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:BWIDth:RELative 914
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:BWIDth:RELative 914
[:SOURce<hw>]:BB:EUTRa:NOTCh:APPLy 914
[:SOURce<hw>]:BB:OFDM:NOTCh:APPLy 914
[:SOURce<hw>]:BB:ARBitrary:NOTCh:APPLy 914

[:SOURce<hw>]:BB:EUTRa:NOTCh <NotchState>
[:SOURce<hw>]:BB:OFDM:NOTCh <NotchState>
[:SOURce<hw>]:BB:ARBitrary:NOTCh <NotchState>

Enables or disables the notch filter.

Parameters:

<NotchState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "To create notch filters" on page 882.

Manual operation: See "State" on page 200

[:SOURce<hw>]:BB:EUTRa:NOTCh:CLOCk?
[:SOURce<hw>]:BB:OFDM:NOTCh:CLOCk?
[:SOURce<hw>]:BB:ARBitrary:NOTCh:CLOCk?

Queries the current clock frequency of the waveform signal.

Works like the command `[:SOURce<hw>]:BB:ARBitrary:CLOCk`.

Return values:
<ChBw> integer
Range: 400 to 2000E6
*RST: 1E6

Example: See Example "To create notch filters" on page 882.

Usage: Query only

Manual operation: See "Clock Frequency" on page 200

[:SOURce<hw>]:BB:EUTRa:NOTCh:COUNt <NumOfNotch>
[:SOURce<hw>]:BB:OFDM:NOTCh:COUNt <NumOfNotch>
[:SOURce<hw>]:BB:ARBitrary:NOTCh:COUNt <IdPDbNotchedNum>

Sets the number of notches.

Parameters:
<IdPDbNotchedNum> integer
Range: 1 to 25
*RST: 1

Example: See Example "To create notch filters" on page 882.

Manual operation: See "Number of Notches" on page 200

[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:STATe <NotchState>
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:STATe <NotchValEnable>
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:STATe <ValEnable>

Enables the particular notch.

Parameters:
<ValEnable> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "To create notch filters" on page 882.

Manual operation: See "State" on page 200

[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:FREQuency:OFFSet <FreqOffs>
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:FREQuency:OFFSet <FreqOffs>
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:FREQuency:OFFSet <ChBw>

Specifies the center frequency of the notch

Parameters:
<ChBw> integer
Range: -2000E6 to 2000E6
Increment: dynamic
*RST: 0

Example: See Example "To create notch filters" on page 882.

Manual operation: See "Frequency Offset (kHz)/Frequency Offset (MHz)" on page 201

[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:BWIDth[:ABSolute] <BwHz>
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:BWIDth[:ABSolute] <BwHz>
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:BWIDth[:ABSolute] <NoBw>

Sets the absolute notch bandwidth.

You can set this bandwidth also relative to the clock frequency via the following command:

`[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:BWIDth:RELative`

Parameters:

<NoBw> float

Range: 0 to dynamic
Increment: dynamic
*RST: dynamic

Example: See Example "To create notch filters" on page 882.

Manual operation: See "Notch Bandwidth (kHz)/Notch Bandwidth (MHz)" on page 201

[:SOURce<hw>]:BB:EUTRa:NOTCh<ch>:BWIDth:RELative <BwPct>
[:SOURce<hw>]:BB:OFDM:NOTCh<ch>:BWIDth:RELative <BwPct>
[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:BWIDth:RELative <NoBwRel>

Sets the notch bandwidth relative to the clock frequency.

Query the clock frequency via the following command:

`[:SOURce<hw>]:BB:ARBitrary:NOTCh:CLOCk?`

You can also set the absolute noise bandwidth via the following command:

`[:SOURce<hw>]:BB:ARBitrary:NOTCh<ch>:BWIDth[:ABSolute]`

Parameters:

<NoBwRel> float

Range: 0 to 10
Increment: 0.01
*RST: 5

Example: See Example "To create notch filters" on page 882.

Manual operation: See "Notch Bandwidth (%)" on page 201

[:SOURce<hw>]:BB:EUTRa:NOTCh:APPLy
[:SOURce<hw>]:BB:OFDM:NOTCh:APPLy
[:SOURce<hw>]:BB:ARBitrary:NOTCh:APPLy

Adopt the configured settings.

Example: See Example "To create notch filters" on page 882.

Usage: Event

Manual operation: See "Apply" on page 201

Trigger commands

This section provides trigger commands for the `SOURce:BB:ARBitrary` subsystem.

Example: To configure trigger settings

This example provides the commands to configure the trigger settings.

```
// ****************************************************************************
// Configure for a single trigger event.
// ****************************************************************************
SOURce1:BB:ARBitrary:TRIGger:SEQuence SINGle
SOURce1:BB:ARBitrary:TRIGger:SLUNit SAMPles
SOURce1:BB:ARBitrary:TRIGger:SLENgth 200
// Outputs the first 200 samples of the waveform after the next trigger event.
SOURce1:BB:ARBitrary:TRIGger:SOURce?
// Response: "INTernal"
SOURce1:BB:ARBitrary:STATe ON

// ****************************************************************************
// Configure for an external trigger event.
// ****************************************************************************
SOURce1:BB:ARBitrary:TRIGger:SEQuence ARETrigger
// Sets the armed retrigger mode.
SOURce1:BB:ARBitrary:TRIGger:SOURce EGT1
// Expects an external trigger signal at a USER connector.
SOURce1:BB:ARBitrary:TRIGger:EXTernal:SYNChronize:OUTPut ON
// Synchronizes the baseband signal output to the external trigger event.
// Query the processing time between the input of the external trigger event
// and the output of the baseband signal.
SOURce1:BB:ARBitrary:TRIGger:PTIMe?
// Response: "0.00021"
// The processing time is 210 mircoseconds.
// Optionally, add a trigger delay.
SOURce1:BB:ARBitrary:TRIGger:EXTernal:DELay 200
SOURce1:BB:ARBitrary:TRIGger:EXTernal:INHibit 100
SOURce1:BB:ARBitrary:STATe ON

// ****************************************************************************
// Execute an internal trigger manually.
// ****************************************************************************
SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUTo
SOURce1:BB:ARBitrary:TRIGger:SOURce INTernal
SOURce1:BB:ARBitrary:STATe ON
SOURce1:BB:ARBitrary:TRIGger:EXEC
SOURce1:BB:ARBitrary:TRIGger:RMODe?
// Response: "RUN"
```

Example: To specify delay and inhibit values in time units

The following example lists the commands to configure trigger delays and trigger inhibit values. See also "To set delay and inhibit values" on page 98.

```
SOURce1:BB:ARBitrary:TRIGger:SEQuence AAUT
SOURce1:BB:ARBitrary:TRIGger:SOURce EGT1
SOURce1:BB:ARBitrary:TRIGger:DELay:UNIT SAMP
SOURce1:BB:ARBitrary:TRIGger:EXTernal:DELay 100
SOURce1:BB:ARBitrary:TRIGger:EXTernal:RDELay?
// Response in samples: 100
SOURce1:BB:ARBitrary:TRIGger:DELay:UNIT TIME
SOURce1:BB:ARBitrary:TRIGger:EXTernal:TDELay 0.00001
SOURce1:BB:ARBitrary:TRIGger:EXTernal:RDELay?
// Response in seconds: 0.00001
// The actual external delay is 10 microseconds.
SOURce1:BB:ARBitrary:TRIGger:DELay:UNIT SAMP
SOURce1:BB:ARBitrary:TRIGger:EXTernal:DELay 10
```

Example: Configure a time-based trigger signal

Configuring a time-based trigger is analogous for all digital standards that support this feature. This example illustrates time-based triggering for the arbitrary waveform generator.

You can use the configuration for other digital standards by replacing the `ARBitrary` mnemonic, for example, replace it with `NR5G` for 5G NR digital standard.

```
// ***************************************************************************
Configure an internal time-based trigger signal.
// ***************************************************************************
SOURce1:BB:ARBitrary:TRIGger:SEQuence SINGle
SOURce1:BB:ARBitrary:TRIGger:MODE INTernal
// Configure time-based trigger settings.
SOURce1:BB:ARBitrary:TRIGger:TIME:DATE 2023,10,1
// Time-based trigger signal date is 2023-10-01 in format YYYY-MM-DD.
SOURce1:BB:ARBitrary:TRIGger:TIME:TIME 11,0,0
// Time-based trigger signal time is 11 a.m. in format hh:mm:ss.
SOURce1:BB:ARBitrary:TRIGger:TIME:STATe 1
// Activates time-based triggering. That means, trigger signal generation, if
// the operating system time matches date and time of the time-based trigger.
SOURce1:BB:ARBitrary:STATe 1

// Query the operating system date and time of your R&S SMM100A.
SYSTem:DATE?
// Response: "2023,10,1"
// The date matches the date of the time-based trigger.
SYSTem:TIME?
// Response 10,59,50.
// The system time is 10 seconds before the time of the time-based trigger.
// Query if the trigger is active.
SOURce1:BB:ARBitrary:TRIGger:RMODe?
// Response: "STOP"
```

```
// Query system time again.
SYSTem:TIME?
// Response 11,0,50.
// The system time equals the time of the time-based trigger.
// Query if the trigger is active.
SOURce1:BB:ARBitrary:TRIGger:RMODe?
// Response: "RUN"
```

Commands:

[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence 917
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce 918
[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe? 918
[:SOURce<hw>]:BB:ARBitrary:TRIGger:TIME:DATE 918
[:SOURce<hw>]:BB:ARBitrary:TRIGger:TIME:TIME 919
[:SOURce<hw>]:BB:ARBitrary:TRIGger:TIME[:STATe] 919
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth 920
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit 920
[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute 920
[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute 921
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut 921
[:SOURce<hw>]:BB:ARBitrary:TRIGger:PTIMe? 921
[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT 921
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:DELay 922
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:TDELay 922
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:RDELay? 922
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:INHibit 923

[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence <Sequence>

Selects the trigger mode:

- `AUTO` = auto
- `RETRigger` = retrigger
- `AAUTo` = armed auto
- `ARETrigger` = armed retrigger
- `SINGle` = single

See also "About trigger modes" on page 93.

Parameters:

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGle
*RST: AUTO

Example: See Example "To configure trigger settings" on page 915.

Manual operation: See "Mode" on page 107

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce <Source>

Selects the trigger signal source and determines the way the triggering is executed. Provided are the following trigger sources:

- `INTernal`: Internal manual triggering of the instrument
- External trigger signal via one of the local or global connectors:
  - `EGT1|EGT2`: External global trigger
  - `EGC1|EGC2`: External global clock
- For secondary instruments (`SCONfiguration:MULTiinstrument:MODE SEC`), triggering via the external baseband synchronization signal of the primary instrument:
  `SOURce1:BB:ARB:TRIGger:SOURce BBSY`
- `OBASeband|BEXTernal|EXTernal`: Setting only
  Provided only for backward compatibility with other Rohde & Schwarz signal generators. The R&S SMM100A accepts these values and maps them automatically as follows:
  `OBASeband = INTA, BEXTernal = EGT2, EXTernal = EGT1`

Parameters:

<Source> INTernal|EGT1|EGT2|EGC1|EGC2|EXTernal|BBSY

*RST: INTernal

Example: See Example "To configure trigger settings" on page 915.

Manual operation: See "Source" on page 109

[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe?

Queries the status of waveform output.

Return values:

<RMode> STOP | RUN

RUN
Outputs the waveform. A trigger event occurred in the triggered mode.

STOP
No waveform output. A trigger event did not occur in the triggered modes, or waveform output was stopped/armed.

Example: See Example "To configure trigger settings" on page 915.

Usage: Query only

Manual operation: See "Running/Stopped" on page 107

[:SOURce<hw>]:BB:ARBitrary:TRIGger:TIME:DATE <Year>, <Month>, <Day>

Sets the date for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this date via the following command:

SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe

<DigStd> is the mnemonic for the digital standard, for example, ARB. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Year> integer
Range: 1980 to 9999

<Month> integer
Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: See Example "Configure a time-based trigger signal" on page 916.

Manual operation: See "Trigger Time" on page 108

[:SOURce<hw>]:BB:ARBitrary:TRIGger:TIME:TIME <Hour>, <Minute>, <Second>

Sets the time for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this time via the following command:

SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe

<DigStd> is the mnemonic for the digital standard, for example, ARB. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Hour> integer
Range: 0 to 23

<Minute> integer
Range: 0 to 59

<Second> integer
Range: 0 to 59

Example: See Example "Configure a time-based trigger signal" on page 916.

Manual operation: See "Trigger Time" on page 108

[:SOURce<hw>]:BB:ARBitrary:TRIGger:TIME[:STATe] <State>

Activates time-based triggering with a fixed time reference. If activated, the R&S SMM100A triggers signal generation when its operating system time matches a specified time.

Specify the trigger date and trigger time with the following commands:

SOURce<hw>:BB:<DigStd>:TRIGger:TIME:DATE

SOURce<hw>:BB:<DigStd>:TRIGger:TIME:TIME

<DigStd> is the mnemonic for the digital standard, for example, ARB. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Configure a time-based trigger signal" on page 916.

Manual operation: See "Time Based Trigger" on page 108

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth <SLength>

Sets the length of the signal sequence that is output in the SINGle trigger mode.

Parameters:

<SLength> integer

The maximum value depends on the selected units [:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit as follows:
SAMPle: Max = 2^{32}-1
SEQuence: Max = 1000

Range: 1 to dynamic
*RST: 1

Example: See Example "To configure trigger settings" on page 915.

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit <SLUnit>

Sets the unit for the entry of the length of the signal sequence to be output in the Single trigger mode.

Parameters:

<SLUnit> SEQuence | SAMPle

*RST: SEQuence

Example: See Example "To configure trigger settings" on page 915.

Manual operation: See "Signal Duration" on page 111

[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute

Stops the waveform output to arm the trigger.

Example: See Example "To manage waveform files" on page 875.

Usage: Event

Manual operation: See "Arm" on page 108

[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute

Triggers signals generation manually for an internal trigger event.

Example: See Example "To configure trigger settings" on page 915.

Usage: Event

Manual operation: See "Execute Trigger" on page 109

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut <Output>

Enables signal output synchronous to the trigger event.

Parameters:

<Output> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "To configure trigger settings" on page 915.

Manual operation: See "Sync. Output to Ext. Trigger/Sync. Output to Trigger" on page 109

[:SOURce<hw>]:BB:ARBitrary:TRIGger:PTIMe?

Queries the internal processing time.

The processing time is the elapsed time between the input of the external trigger event and the output of the baseband signal.

Return values:

<ArbTrigProcTime> string

Example: See Example "To configure trigger settings" on page 915.

Usage: Query only

Manual operation: See "Processing Time" on page 164

[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT <TrigDelUnit>

Sets the unit of the trigger delay.

Parameters:

<TrigDelUnit> SAMPle | TIME

*RST: SAMPle

Example: See Example "To specify delay and inhibit values in time units" on page 916.

Manual operation: See "External Delay Unit/Delay Unit" on page 110

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:DELay <Delay>

Specifies the trigger delay in samples.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 98.

Parameters:

<Delay> float

Range: 0 to depends on the sample rate
Increment: 0.01
*RST: 0
Default unit: sample

Example: See Example "To specify delay and inhibit values in time units" on page 916.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 110

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:TDELay <ExtTimeDelay>

Specifies the trigger delay for external triggering. The value affects all external trigger signals.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 98.

Parameters:

<ExtTimeDelay> float

Range: 0 to 2147483647 / (clock frequency)
Increment: 1E-9
*RST: 0
Default unit: s

Example: See Example "To specify delay and inhibit values in time units" on page 916.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 110

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:RDELay?

Queries the time (in seconds) an external trigger event is delayed for.

Return values:

<ResTimeDelaySec> float

Range: 0 to 688
Increment: 0.25E-9
*RST: 0

Example: See Example "To specify delay and inhibit values in time units" on page 916.

Usage: Query only

Manual operation: See "Actual Trigger Delay/Actual External Delay" on page 110

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:INHibit <Inhibit>

Sets the number of samples that inhibit a restart of the signal generation.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 98.

Parameters:

<Inhibit> integer

Range: 0 to 21.47 * (clock frequency)
*RST: 0
Default unit: samples

Example: See Example "To specify delay and inhibit values in time units" on page 916.

Manual operation: See "External Inhibit/Trigger Inhibit" on page 109

Marker commands

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE 923
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime 924
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime 924
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern 924
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider 924
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency? 924
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay 925
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DINSec? 925

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE <Mode>

Sets the marker mode that is the marker signal for the selected marker output.

See also "Marker modes" on page 90.

Parameters:

<Mode> UNCHanged | RESTart | PULSe | PATTern | RATio

UNCHanged
A marker signal as defined in the waveform file (tag `'marker mode x'`) is generated.

*RST: UNCHanged

Example: See Example "To configure marker signals" on page 876.

Manual operation: See "Mode" on page 164

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime <OnTime>
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the number of samples or duration of the marker-on and marker-off periods.

Parameters:

<OffTime> integer

Range: 1 to 14913079
*RST: 1

Example: See Example "To configure marker signals" on page 876.

Manual operation: See "Mode" on page 164

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern <Pattern>, <BitCount>

Sets the bit pattern to generate the marker signal.

Parameters:

<Pattern> numeric

*RST: #H2

<BitCount> integer

0 = marker off, 1 = marker on

Range: 1 to 64
*RST: 2

Example: See Example "To configure marker signals" on page 876.

Manual operation: See "Mode" on page 164

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for the pulsed marker signal.

Parameters:

<Divider> integer

Range: 2 to 1024
*RST: 2

Example: See Example "To configure marker signals" on page 876.

Manual operation: See "Mode" on page 164

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal. The pulse frequency is the symbol rate divided by the divider.

Return values:

<Frequency> float

Increment: 0.001

Example: See Example "To configure marker signals" on page 876.

Usage: Query only

Manual operation: See "Mode" on page 164

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay <Delay>

Sets the delay between the signal on the marker outputs and the start of the signal.

Parameters:

<Delay> integer

Range: 0 to depends on other values
Increment: 1
*RST: 0
Default unit: Symbol

Example: See Example "To configure marker signals" on page 876.

Manual operation: See "Delay" on page 112

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DINSec?

Queries the marker delay in microseconds.

You can define a marker delay in samples via the following command:

`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay` on page 925

Return values:

<DelayInS> float

Range: 0 to 16777215
Increment: 1E-3
*RST: 0

Example: See Example "To configure marker signals" on page 876.

Usage: Query only

Manual operation: See "Delay (Time)" on page 164

Clock commands

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce <Source>

Selects the clock source:

- `INTernal`: Internal clock reference
- `ELCLock`: External local clock
- `EXTernal = ELCLock`: Setting only
  Provided for backward compatibility with other Rohde & Schwarz signal generators

Parameters:

<Source> INTernal

*RST: INTernal

Example: See Example "To configure clock settings" on page 876.

Manual operation: See "Clock Source" on page 113

13.17.5.4 SOURce:BB:MCCW subsystem

This subsystem contains the commands for setting the Multi-Carrier CW signals.

The generation of multi-carrier CW signals requires an instrument equipped with the software options R&S SMM-K61.

Common Suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
SOURce<ch>	1	Available baseband signals
OUTPut<ch>	1 to 3	Available markers

Required options

See Section 4.11.1, "Required options", on page 252

Programming examples

The following examples illustrate how to generate multi-carrier signals for dedicated applications.

Example: Testing the frequency response of a DUT

```
// ***************************************************************************
// Reset the instrument first
// ***************************************************************************
*RST; *CLS

// ***************************************************************************
// Configuring and enabling the multi-carrier signal
// ***************************************************************************
SOURce1:BB:MCCW:CARRier:COUNt 81
SOURce1:BB:MCCW:CARRier:SPACing 1E6
// Set the number of carriers and their distance
// Further settings stay in default state, for example, trigger settings.
SOURce1:BB:MCCW:STATe ON
// Enable signal generation
OUTPut ON
// Enable the signal output
```

```
// ********************************************************************************
// Saving the current settings
// ********************************************************************************
MMEMory:MDIR '/var/user/savrcl'
// Create a new directory "savrcl"
*SAV 4
MMEMory:STORe:STATe 4,"/var/user/savrcl/mccw_SSB.savrcltxt"
// Save the current settings in an intermediate memory with number 4.
// Save the settings file in the specified directory, also specify the complete
// path and filename.
```

To visualize the configured signal as in Example "Testing the frequency response of a DUT" on page 926, proceed as follows:

1. Switch to local mode with the following command:
   `&NREN`
2. To monitor the single carriers, select "Multi-carrier Continuous Wave" > "Carrier Graph".

Example: Testing the image rejection of an SSB filter

This example generates a multi-carrier single sideband signal as shown in Figure 13-1.

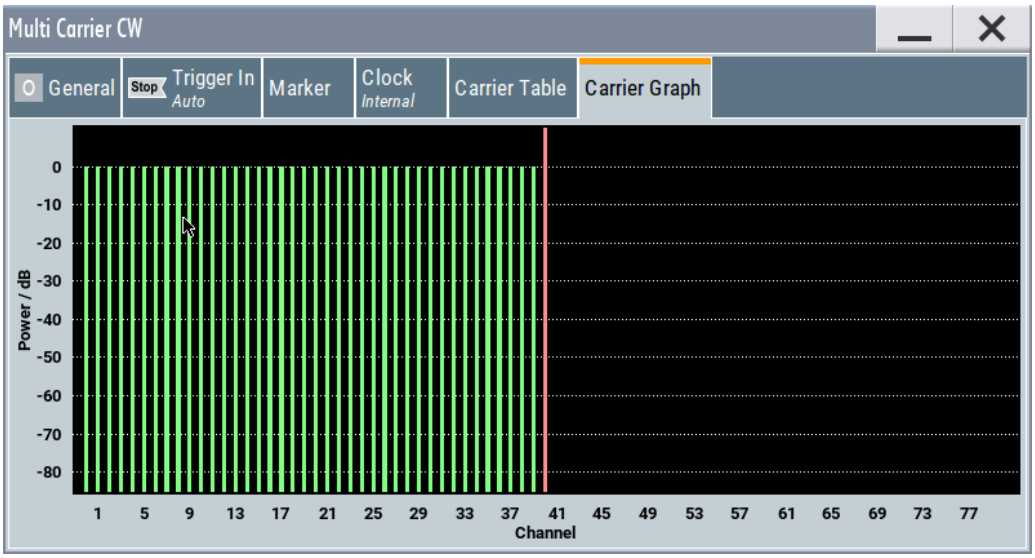

Figure 13-1: Multi-carrier signal to test the image rejection of an SSB filter

```
// ********************************************************************************
// Reset the instrument first
// ********************************************************************************
*RST; *CLS

// ********************************************************************************
// Configuring and enabling the multi-carrier signal
// ********************************************************************************
SOURce1:BB:MCCW:CARRier:COUNt 81
```

```
SOURce1:BB:MCCW:CARRier:SPACing 1E6
// Set the number of carriers and their distance
// Further settings stay in default state, for example, trigger settings.
SOURce1:BB:MCCW:EDIT:CARRier:STARt 40
SOURce1:BB:MCCW:EDIT:CARRier:STOP 80
SOURce1:BB:MCCW:EDIT:CARRier:STATe OFF
SOURce1:BB:MCCW:EDIT:CARRier:EXECute
// Configure the carrier table for the single sideband signal:
// Set the carriers no. 40 to 80 to "OFF"
SOURce1:BB:MCCW:STATe ON
// Enable signal generation
OUTPut ON
// Enable signal output.
```

Example: Generating a composed multi-carrier signal

This example generates a multi-carrier signal as shown in Figure 13-2.

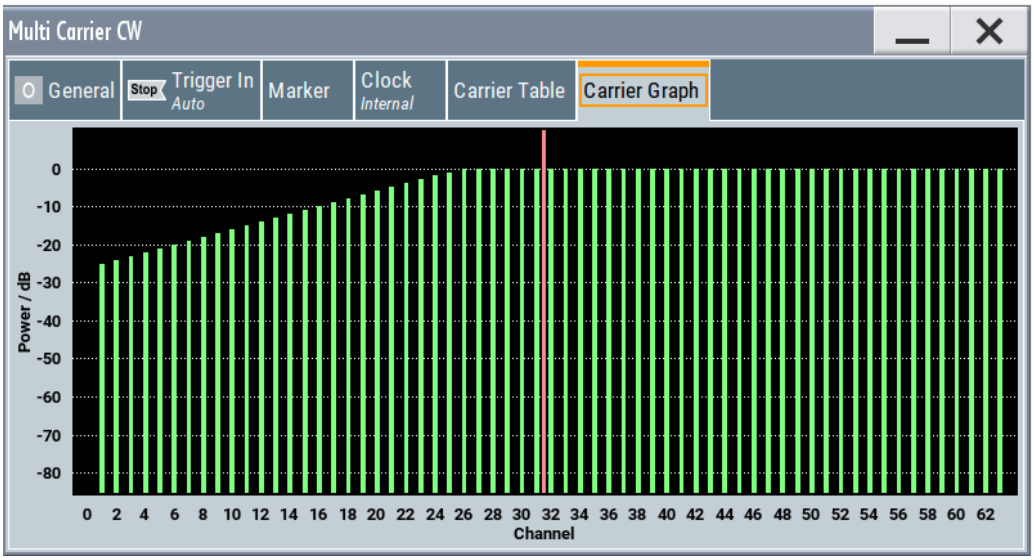

Figure 13-2: Composed multi-carrier signal

```
// ****************************************************************
// Reset the instrument first
// ****************************************************************
*RST; *CLS

// ****************************************************************
// Configure the multi-carrier signal
// ****************************************************************
SOURce1:BB:MCCW:CARRier:COUNt 100
SOURce1:BB:MCCW:CARRier:SPACing 500000
// Setup 100 carriers with a spacing of 500kHz
SOURce1:BB:MCCW:CLOCk?
// Return value 128000000
SOURce1:BB:MCCW:CFACtor:MODE SLOW
```

```
SOURce1:BB:MCCW:CFACtor 3
SOURce1:BB:MCCW:CFACtor:ACTual?
// Response: "3"

// ****************************************************************
// Adjust the settings of a group of carriers
// ****************************************************************
SOURce1:BB:MCCW:CARRier:LIST:POWer -6,-12,-18,-12,-6,0
// Set the power levels for carriers no. 0 to 5 to -10dB,-15dB,-20dB,-15dB,-10dB,0dB
SOURce1:BB:MCCW:CARRier:LIST:STATe ON,ON,ON,ON,ON,ON,OFF,ON
// Set the state of the carriers no. 0 to 7
SOURce1:BB:MCCW:EDIT:CARRier:STARt 15
SOURce1:BB:MCCW:EDIT:CARRier:STOP 35
SOURce1:BB:MCCW:EDIT:CARRier:STATe ON
SOURce1:BB:MCCW:EDIT:CARRier:POWer:STAR -10
SOURce1:BB:MCCW:EDIT:CARRier:POWer:STEP 0.5
SOURce1:BB:MCCW:EDIT:CARRier:EXECute
// Activates the carriers no. 15 to 35
// Increase the power in 0.5dB steps starting with a power level of -10dB
// Apply the settings
SOURce1:BB:MCCW:CARRier:POWer 38,0
SOURce1:BB:MCCW:CARRier:STATe 38,1
// Set a power level of 0dB for carrier no. 38 and activates it
SOURce1:BB:MCCW:EDIT:CARRier:STARt 41
SOURce1:BB:MCCW:EDIT:CARRier:STOP 61
SOURce1:BB:MCCW:EDIT:CARRier:STATe ON
SOURce1:BB:MCCW:EDIT:CARRier:POWer:STARt 0
SOURce1:BB:MCCW:EDIT:CARRier:POWer:STEP -0.5
SOURce1:BB:MCCW:EDIT:CARRier:EXECute
// Activates the carriers no. 41 to 61
// Decrease the power in 0.5dB steps starting with a power level of 0dB
// Apply the settings.
SOURce1:BB:MCCW:EDIT:CARRier:STARt 70
SOURce1:BB:MCCW:EDIT:CARRier:STOP 85
SOURce1:BB:MCCW:EDIT:CARRier:STATe ON
SOURce1:BB:MCCW:EDIT:CARRier:EXECute
// Activates the carriers no. 70 to 85.
// Apply the settings.

// ****************************************************************
// Configuring the clock settings
// ****************************************************************
SOURce1:BB:MCCW:CLOCk:SOURce INTernal

// ****************************************************************************
// Configuring and enabling marker signals
// ****************************************************************************
SOURce1:BB:MCCW:TRIGger:OUTPut1:MODE RESTart
SOURce1:BB:MCCW:TRIGger:OUTPut2:MODE PULSe
SOURce1:BB:MCCW:TRIGger:OUTPut2:PULSe:DIVider 5
SOURce1:BB:MCCW:TRIGger:OUTPut2:PULSe:FREQuency?
```

```
SOURce1:BB:MCCW:TRIGger:OUTPut3:MODE PATTern
SOURce1:BB:MCCW:TRIGger:OUTPut3:PATTern #HE0F52,20
// SOURce1:BB:MCCW:TRIGger:OUTPut1:MODE RATio
// SOURce1:BB:MCCW:TRIGger:OUTPut1:ONTime 40
// SOURce1:BB:MCCW:TRIGger:OUTPut1:OFFTime 20
SOURce1:BB:MCCW:TRIGger:OUTPut2:DELay 16

// ***************************************************************************
// Configuring and enabling signal triggering
// ***************************************************************************
SOURce1:BB:MCCW:TRIGger:SEQuence SINGle
SOURce1:BB:MCCW:TRIGger:SLENgth 200
// The first 200 samples of the current waveform will be output after the next
// trigger event.
SOURce1:BB:MCCW:TRIGger:SEQuence ARETrigger
SOURce1:BB:MCCW:TRIGger:SOURce INTernal
// SOURce1:BB:MCCW:TRIGger:SOURce EGT1
// Provide an external global trigger signal at the connector that expects
// an external global trigger signal.
// SOURce1:BB:MCCW:TRIGger:EXTernal:SYNChronize:OUTPut ON
// SOURce1:BB:MCCW:TRIGger:EXTernal:DELay 200
// SOURce1:BB:MCCW:TRIGger:EXTernal:INHibit 100

// ***************************************************************************
// Applying the settings and enabling signal generation
// ***************************************************************************
*TRG
SOURce1:BB:MCCW:STATe ON
// Stop the internal trigger manually.
SOURce1:BB:MCCW:TRIGger:ARM:EXECute
// Execute manual internal trigger, i.e. restarting signal generation
SOURce1:BB:MCCW:TRIGger:EXECute
SOURce1:BB:MCCW:TRIGger:RMODe?
// Response: "RUN"
```

General commands

[:SOURce<hw>]:BB:MCCW:PRESet 931
[:SOURce<hw>]:BB:MCCW:STATe 931
[:SOURce<hw>]:BB:MCCW:SETTing:LOAD 931
[:SOURce<hw>]:BB:MCCW:SETTing:CATalog? 931
[:SOURce<hw>]:BB:MCCW:SETTing:DELete 932
[:SOURce<hw>]:BB:MCCW:SETTing:STORe 932
[:SOURce<hw>]:BB:MCCW:WAVeform:CREate 932
[:SOURce<hw>]:BB:MCCW:CARRier:COUNt 932
[:SOURce<hw>]:BB:MCCW:CARRier:SPACing 933
[:SOURce<hw>]:BB:MCCW:CLOCk? 933
[:SOURce<hw>]:BB:MCCW:CFACtor:MODE 933
[:SOURce<hw>]:BB:MCCW:CFACtor 933
[:SOURce<hw>]:BB:MCCW:CFACtor:ACTual? 934
[:SOURce<hw>]:BB:MCCW:CARRier:STATe 934

[:SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe 934
[:SOURce<hw>]:BB:MCCW:CARRier:PHASe 935
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe 935
[:SOURce<hw>]:BB:MCCW:CARRier:POWer 936
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer 936
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe[:STARt] 937
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer[:STARt] 937
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe:STEP 937
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer:STEP 937
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STARt 938
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STOP 938
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STATe 938
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:EXECute 938

[:SOURce<hw>]:BB:MCCW:PRESet

Sets all multi carrier signal parameters to their default values.

Example: See "Programming examples" on page 926

Usage: Event

Manual operation: See "Set To Default" on page 254

[:SOURce<hw>]:BB:MCCW:STATe <State>

Enables/disables the multi carrier CW signal.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See "Programming examples" on page 926

Manual operation: See "State" on page 253

[:SOURce<hw>]:BB:MCCW:SETTing:LOAD <Filename>

Recalls the dialog related settings from a selected file with the extension `*.mccw_set`.

Setting parameters:
<Filename> string

Usage: Setting only

Manual operation: See "Save/Recall" on page 254

[:SOURce<hw>]:BB:MCCW:SETTing:CATalog?

Queries all available files with file extension `*.mccw_set`, which contain dialog related settings.

Usage: Query only

Manual operation: See "Save/Recall" on page 254

[:SOURce<hw>]:BB:MCCW:SETTing:DELete <Filename>

Deletes a stored file with file extension `*.mccw_set`, which contains dialog related settings, from the instrument.

Setting parameters:
<Filename> string

Example: `SOURce1:BB:MCCW:SETTing:DELete "test"`

Usage: Setting only

Manual operation: See "Save/Recall" on page 254

[:SOURce<hw>]:BB:MCCW:SETTing:STORe <Filename>

Saves the dialog related settings in a file with the predefined extension `*.mccw_set`.

Setting parameters:
<Filename> string

Usage: Setting only

Manual operation: See "Save/Recall" on page 254

[:SOURce<hw>]:BB:MCCW:WAVeform:CREate <filename>

With enabled signal generation, triggers the instrument to save the current settings of an MCCW waveform signal in a waveform file with the extension `*.wv`. You can define the filename and the directory, in that you want to save the file.

Setting parameters:
<filename> string

Usage: Setting only

Manual operation: See "Generate Waveform" on page 254

[:SOURce<hw>]:BB:MCCW:CARRier:COUNt <Count>

Sets the number of carriers in the multi carrier CW signal.

Parameters:
<Count> integer

Range: 1 to 160001
*RST: 64

Example: see "Programming examples" on page 926

Manual operation: See "Number of Carriers" on page 254

[:SOURce<hw>]:BB:MCCW:CARRier:SPACing <Spacing>

Sets the carrier spacing.

Parameters:

<Spacing> float

Value range depends on the available bandwidth and the number of carriers, see "Cross-reference between total bandwidth, carrier spacing, and number of carriers" on page 254.

Range: 0 to depends on options, for example 120E6
Increment: 0.01
*RST: 10E3

Example: See "Programming examples" on page 926

Manual operation: See "Carrier Spacing" on page 254

[:SOURce<hw>]:BB:MCCW:CLOCk?

Queries the output clock rate. The output clock rate depends on the number of carriers and on the selected carrier spacing.

Return values:

<Clock> float

Range: 0 to Max
Increment: 1E-3
*RST: 0

Example: See "Programming examples" on page 926

Usage: Query only

Manual operation: See "Clock Frequency" on page 255

[:SOURce<hw>]:BB:MCCW:CFACtor:MODE <Mode>

Sets the mode by which automatic settings minimize the crest factor or hold it at a chosen value.

Parameters:

<Mode> OFF | CHIRp | SLOW

SLOW
corresponds to the manual control "Target Crest"

*RST: CHIRp

Example: See "Programming examples" on page 926

Manual operation: See "Optimize Crest Factor Mode" on page 255

[:SOURce<hw>]:BB:MCCW:CFACtor <CFactor>

Sets the desired crest factor, if the optimization mode target crest factor is used.

Parameters:

<CFactor> float

Range: 0 to 30
Increment: 0.01
*RST: 3

Example: See "Programming examples" on page 926

Manual operation: See "Desired Crest Factor" on page 255

[:SOURce<hw>]:BB:MCCW:CFACtor:ACTual?

Queries the actual Crest Factor for optimization mode target crest.

Return values:

<Actual> float

Range: 0 to 100
Increment: 0.01
*RST: 3

Example: See "Programming examples" on page 926

Usage: Query only

[:SOURce<hw>]:BB:MCCW:CARRier:STATe <CarrierIndex>, <State>

Switches the selected carrier on or off.

Parameters:

<CarrierIndex> integer

Range: 0 to lastCarrier

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See "Programming examples" on page 926

Manual operation: See "Carrier Table" on page 257

[:SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe <Stat0[,Stat1..]>]
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe? <Start>, <Count>

Switches the carrier on or off with the aid of a value list.

The first value in the list is assigned to the carrier with index 0, the second value to the carrier with index 1, etc. The maximum length corresponds to the maximum number of multi carriers. There is no need to enter all the values every time. Values not set by the value list are set with the default values provided they have already been explicitly set by a previous command. If this is the case, the values continue to apply until overwritten.

Setting parameters:

<Stat0[,Stat1..]> ON | OFF

Query parameters:

<Start> integer
start carrier index
Range: 0 to lastCarrier

<Count> integer
number of carriers in the carrier range, starting from the <Start> carrier
Range: 1 to lastCarrier

Return values:

<State[,State..]> select

Example: See "Programming examples" on page 926

Manual operation: See "Carrier Table" on page 257

[:SOURce<hw>]:BB:MCCW:CARRier:PHASe <CarrierIndex>, <Phase>

For disabled optimization of the crest factor, sets the start phase of the selected carrier.

Parameters:

<CarrierIndex> integer
Range: 0 to lastCarrier

<Phase> float
Range: 0 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: see "Programming examples" on page 926

Manual operation: See "Carrier Table" on page 257

[:SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe <Phas0[,Phas1..]>
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe? [<Start>[, <Count>]]

Sets the start phase of the carrier with the aid of a value list.

Setting parameters:

<Phas0[,Phas1..]> float
Range: 0 to 360
Increment: 0.01
*RST: 0
Default unit: DEG

Query parameters:

<Start> integer
start carrier index
Range: 0 to lastCarrier

<Count> integer
number of carriers in the carrier range, starting from the <Start> carrier
Range: 1 to max

Return values:
<Phas[,Phas..]> float

Example: see "Programming examples" on page 926

Manual operation: See "Carrier Table" on page 257

[:SOURce<hw>]:BB:MCCW:CARRier:POWer <CarrierIndex>, <Power>

Sets the power of the selected carrier.

Parameters:
<CarrierIndex> integer
Range: 0 to lastCarrier

<Power> float
Range: -80 to 0
Increment: 0.01
*RST: 0

Example: see "Programming examples" on page 926

Manual operation: See "Carrier Table" on page 257

[:SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer <Pow0[,Pow1..]>
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer? <Start>, <Count>

Sets the power of the carrier with the aid of a value list.

Setting parameters:
<Pow0[,Pow1..]> float
Increment: 0.01
*RST: 0 dB

Query parameters:
<Start> integer
start carrier index
Range: 0 to lastCarrier

<Count> integer
number of carriers in the carrier range, starting from the <Start> carrier
Range: 1 to lastCarrier

Return values:
<Pow[,Pow..]> float

Example: see "Programming examples" on page 926

Manual operation: See "Carrier Table" on page 257

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe[:STARt] <Start>
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer[:STARt] <Start>

Sets the power/pahse for the starting carrier. The power of the remaining carriers is stepped up or down by the power specified with the `[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer:STEP` command.

Parameters:

<Start> float

Range: -80 to 0
Increment: 0.01
*RST: 0

Example: see "Programming examples" on page 926

Manual operation: See "Power Start" on page 257

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe:STEP <Step>

For disabled optimization of the crest factor, sets the step width by which the start phase of the carriers in the defined carrier range is incremented.

Parameters:

<Step> float

Range: -359.99 to 359.99
Increment: 0.01
*RST: 0

Example: See "Programming examples" on page 926

Manual operation: See "Phase Step" on page 257

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer:STEP <Step>

Sets the step width by which the starting power of the carriers in the defined carrier range is incremented.

Parameters:

<Step> float

Range: -80 to 80
Increment: 0.01
*RST: 0

Example: See "Programming examples" on page 926

Manual operation: See "Power Step" on page 257

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STARt <Start>
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STOP <Stop>

Defines the first/last carrier in the carrier range to which joint configuration applies.

Parameters:

<Stop> integer

Range: 0 to 8191
*RST: 0

Example: See "Programming examples" on page 926

Manual operation: See "Carrier Start/Stop" on page 256

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:STATe <State>

Switches all the carriers in the selected carrier range on or off.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Example: See "Programming examples" on page 926

Manual operation: See "Carrier State" on page 257

[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:EXECute

Adopts the settings for the carrier range.

Example: See "Programming examples" on page 926

Usage: Event

Manual operation: See "Accept" on page 257

Trigger commands

[:SOURce<hw>]:BB:MCCW[:TRIGger]:SEQuence....939
[:SOURce<hw>]:BB:MCCW:TRIGger:SOURce....939
[:SOURce<hw>]:BB:MCCW:TRIGger:RMODe?....939
[:SOURce<hw>]:BB:MCCW:TRIGger:TIME:DATE....940
[:SOURce<hw>]:BB:MCCW:TRIGger:TIME:TIME....940
[:SOURce<hw>]:BB:MCCW:TRIGger:TIME[:STATe]....941
[:SOURce<hw>]:BB:MCCW:TRIGger:SLENgth....941
[:SOURce<hw>]:BB:MCCW:TRIGger:ARM:EXECute....941
[:SOURce<hw>]:BB:MCCW:TRIGger:EXECute....941
[:SOURce<hw>]:BB:MCCW:TRIGger:EXTernal:SYNChronize:OUTPut....942
[:SOURce<hw>]:BB:MCCW:TRIGger[:EXTernal]:DELay....942
[:SOURce<hw>]:BB:MCCW:TRIGger[:EXTernal]:INHibit....942

[:SOURce<hw>]:BB:MCCW[:TRIGger]:SEQuence <Sequence>

Selects the trigger mode.

See also "About trigger modes" on page 93.

Parameters:

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGle

*RST: AUTO

Example: See "Programming examples" on page 926

Manual operation: See "Mode" on page 107

[:SOURce<hw>]:BB:MCCW:TRIGger:SOURce <Source>

Selects the trigger signal source and determines the way the triggering is executed. Provided are the following trigger sources:

- `INTernal`: Internal manual triggering of the instrument
- External trigger signal via one of the local or global connectors:
  - `EGT1|EGT2`: External global trigger
  - `EGC1|EGC2`: External global clock
- For secondary instruments (`SCONfiguration:MULTiinstrument:MODE SEC`), triggering via the external baseband synchronization signal of the primary instrument:
  `SOURce1:BB:ARB:TRIGger:SOURce BBSY`
- `OBASeband|BEXTernal|EXTernal`: Setting only
  Provided only for backward compatibility with other Rohde & Schwarz signal generators. The R&S SMM100A accepts these values and maps them automatically as follows:
  `OBASeband = INTA`, `BEXTernal = EGT2`, `EXTernal = EGT1`

Parameters:

<Source> INTernal|EGT1|EGT2|EGC1|EGC2|EXTernal|BBSY

*RST: INTernal

Example: See "Programming examples" on page 926

Manual operation: See "Source" on page 109

[:SOURce<hw>]:BB:MCCW:TRIGger:RMODe?

Queries the status of signal generation for all trigger mode, if multi-carrier CW generation is on.

Return values:

<RMode> STOP | RUN

Example: See "Programming examples" on page 926

Usage: Query only

Manual operation: See "Running/Stopped" on page 107

[:SOURce<hw>]:BB:MCCW:TRIGger:TIME:DATE <Year>, <Month>, <Day>

Sets the date for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this date via the following command:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Year> integer
Range: 1980 to 9999

<Month> integer
Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: See Example "Configure a time-based trigger signal" on page 916.

Manual operation: See "Trigger Time" on page 108

[:SOURce<hw>]:BB:MCCW:TRIGger:TIME:TIME <Hour>, <Minute>, <Second>

Sets the time for a time-based trigger signal. For trigger modes single or armed auto, you can activate triggering at this time via the following command:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:STATe`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<Hour> integer
Range: 0 to 23

<Minute> integer
Range: 0 to 59

<Second> integer
Range: 0 to 59

Example: See Example "Configure a time-based trigger signal" on page 916.

Manual operation: See "Trigger Time" on page 108

[:SOURce<hw>]:BB:MCCW:TRIGger:TIME[:STATe] <State>

Activates time-based triggering with a fixed time reference. If activated, the R&S SMM100A triggers signal generation when its operating system time matches a specified time.

Specify the trigger date and trigger time with the following commands:

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:DATE`

`SOURce<hw>:BB:<DigStd>:TRIGger:TIME:TIME`

`<DigStd>` is the mnemonic for the digital standard, for example, `ARB`. Time-based triggering behaves analogously for all digital standards that support this feature.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Configure a time-based trigger signal" on page 916.

Manual operation: See "Time Based Trigger" on page 108

[:SOURce<hw>]:BB:MCCW:TRIGger:SLENgth <SLength>

Defines the length of the signal sequence to be output in the "Single" trigger mode.

Parameters:

<SLength> integer

Range: 1 to 1000
*RST: 1
Default unit: samples

Example: See "Programming examples" on page 926

Manual operation: See "Signal Duration" on page 111

[:SOURce<hw>]:BB:MCCW:TRIGger:ARM:EXECute

Stops signal generation.

Example: See "Programming examples" on page 926

Usage: Event

Manual operation: See "Arm" on page 108

[:SOURce<hw>]:BB:MCCW:TRIGger:EXECute

Executes a trigger.

Example: See "Programming examples" on page 926

Usage: Event

Manual operation: See "Execute Trigger" on page 109

[:SOURce<hw>]:BB:MCCW:TRIGger:EXTernal:SYNChronize:OUTPut <Output>

Enables signal output synchronous to the trigger event.

Parameters:

<Output> 1 | ON | 0 | OFF

*RST: 1

Example: See "Programming examples" on page 926

Manual operation: See "Sync. Output to Ext. Trigger/Sync. Output to Trigger" on page 109

[:SOURce<hw>]:BB:MCCW:TRIGger[:EXTernal]:DELay <Delay>

Specifies the trigger delay in samples.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 98.

Parameters:

<Delay> float

Range: 0 to 2147483647
Increment: 0.01
*RST: 0
Default unit: samples

Example: See "Programming examples" on page 926.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 110

[:SOURce<hw>]:BB:MCCW:TRIGger[:EXTernal]:INHibit <Inhibit>

Specifies the number of samples, by which a restart is inhibited following an external trigger event.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "To set delay and inhibit values" on page 98.

Parameters:

<Inhibit> integer

Range: 0 to 21.47 * (clock frequency)
*RST: 0
Default unit: sample

Example: See "Programming examples" on page 926

Manual operation: See "External Inhibit/Trigger Inhibit" on page 109

Marker commands

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:MODE....943
[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:ONTime....943
[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:OFFTime....943
[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PATTern....943
[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:DIVider....944
[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:FREQuency?....944
[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:DELay....944

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:MODE <Mode>

Defines the signal for the selected marker output. For detailed description of the regular marker modes, refer to "Marker modes" on page 90.

Parameters:

<Mode> RESTart | PULSe | PATTern | RATio

*RST: RESTart

Example: See "Programming examples" on page 926

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:ONTime <OnTime>
[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the number of samples in the off period of the corresponding marker signal.

Parameters:

<OffTime> integer

Range: 1 to 16777215
*RST: 1

Example: see "Programming examples" on page 926

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PATTern <Pattern>, <BitCount>

Defines the bit pattern used to generate the marker signal.

Parameters:

<Pattern> numeric

*RST: #H2

<BitCount> integer

0 = marker off, 1 = marker on

Range: 1 to 64
*RST: 2

Example: See "Programming examples" on page 926.

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for pulse marker mode.

Parameters:

<Divider> integer

Range: 2 to 1024
*RST: 2

Example: See "Programming examples" on page 926

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal.

Return values:

<Frequency> float

Increment: 1E-3

Example: see "Programming examples" on page 926

Usage: Query only

Manual operation: See "Mode" on page 112

[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:DELay <Delay>

Defines the delay between the signal on the marker outputs and the start of the signals, expressed as number of samples.

Parameters:

<Delay> float

Range: 0 to 16777215
Increment: 1
*RST: 0

Example: See "Programming examples" on page 926.

Manual operation: See "Delay" on page 112

Clock commands

[:SOURce<hw>]:BB:MCCW:CLOCk:SOURce 944

[:SOURce<hw>]:BB:MCCW:CLOCk:SOURce <Source>

Selects the clock source:

- `INTernal`: Internal clock reference
- `ELCLock`: External local clock
- `EXTernal = ELCLock`: Setting only

Provided for backward compatibility with other Rohde & Schwarz signal generators

Parameters:

<Source> INTernal

*RST: INTernal

Example: See "Programming examples" on page 926.

Manual operation: See "Clock Source" on page 113

13.17.5.5 SOURce:BB:IMPairment subsystem

This subsystem contains the commands for the analog and digital I/Q impairments.

Suffixes

Suffix	Value range	Description
RF<ch>	1	Digital impairments for RF connector
IQOutput<ch>	1	IQ connector
BBMM<ch>	1	DIG IQ connector

Required options

See Section 5.2.1, "Required options", on page 280.

Commands:

[:SOURce]:BB:IMPairment:BBMM<ch>:DELay....946
[:SOURce]:BB:IMPairment:IQOutput<ch>:DELay....946
[:SOURce]:BB:IMPairment:RF<ch>:DELay....946
[:SOURce<hw>]:IQ:IMPairment:IQRatio[:MAGNitude]....946
[:SOURce]:BB:IMPairment:BBMM<ch>:IQRatio[:MAGNitude]....946
[:SOURce]:BB:IMPairment:IQOutput<ch>:IQRatio[:MAGNitude]....946
[:SOURce]:BB:IMPairment:RF<ch>:IQRatio[:MAGNitude]....946
[:SOURce<hw>]:IQ:IMPairment:LEAKage:I....947
[:SOURce<hw>]:IQ:IMPairment:LEAKage:Q....947
[:SOURce]:BB:IMPairment:BBMM<ch>:LEAKage:I....947
[:SOURce]:BB:IMPairment:BBMM<ch>:LEAKage:Q....947
[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:I....947
[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:Q....947
[:SOURce]:BB:IMPairment:RF<ch>:LEAKage:I....947
[:SOURce]:BB:IMPairment:RF<ch>:LEAKage:Q....947
[:SOURce<hw>]:IQ:IMPairment:QUADrature[:ANGLe]....947
[:SOURce]:BB:IMPairment:BBMM<ch>:QUADrature[:ANGLe]....947
[:SOURce]:BB:IMPairment:FADer<ch>:QUADrature[:ANGLe]....947
[:SOURce]:BB:IMPairment:IQOutput<ch>:QUADrature[:ANGLe]....947
[:SOURce]:BB:IMPairment:RF<ch>:QUADrature[:ANGLe]....947
[:SOURce]:BB:IMPairment:BBMM<ch>:SKEW....948
[:SOURce]:BB:IMPairment:IQOutput<ch>:SKEW....948
[:SOURce]:BB:IMPairment:RF<ch>:SKEW....948

[:SOURce<hw>]:IQ:IMPairment[:STATe] 948
[:SOURce]:BB:IMPairment:BBMM<ch>:STATe 948
[:SOURce]:BB:IMPairment:IQOutput<ch>:STATe 948
[:SOURce]:BB:IMPairment:RF<ch>:STATe 948
[:SOURce]:BB:IMPairment:BBMM<ch>:POFFset 949
[:SOURce]:BB:IMPairment:IQOutput<ch>:POFFset 949
[:SOURce]:BB:IMPairment:RF<ch>:POFFset 949
[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE 949

[:SOURce]:BB:IMPairment:BBMM<ch>:DELay <Delay>
[:SOURce]:BB:IMPairment:IQOutput<ch>:DELay <Delay>
[:SOURce]:BB:IMPairment:RF<ch>:DELay <Delay>

Defines the time delay of both I and Q vectors between the marker signal at the marker outputs relative to the signal generation start.

A positive value means that the I and Q vectors delay relative to the marker/trigger and vice versa.

Table 13-2: Value range

Output	Min /s	Max /s	Increment
RF<ch>	0	10E-6	1E-12
IQOutput<ch>	-500E-9	500E-9	1E-12
	-500E-9	500E-9	1E-12

Parameters:

<Delay> float

Range: 0 to 10E-6
Increment: 1E-12
*RST: 0

Example: `SOURce1:BB:IMPairment:RF1:DELay 32.0E-9`

Manual operation: See "IQ Delay" on page 286

[:SOURce<hw>]:IQ:IMPairment:IQRatio[:MAGNitude] <Magnitude>
[:SOURce]:BB:IMPairment:BBMM<ch>:IQRatio[:MAGNitude] <IqRatio>
[:SOURce]:BB:IMPairment:IQOutput<ch>:IQRatio[:MAGNitude] <IqRatio>
[:SOURce]:BB:IMPairment:RF<ch>:IQRatio[:MAGNitude] <IqRatio>

Sets the ratio of I modulation to Q modulation (amplification imbalance) of the corresponding digital channel.

Table 13-3: Value range

Impairments	Min /dB	Max /dB	Increment
Digital	-4	4	0.0001
Analog	-1	1	0.0001

Parameters:

<IqRatio> float

The setting value can be either in dB or %. An input in percent is rounded to the closest valid value in dB.

Range: -4 to 4
Increment: 1E-4
*RST: 0
Default unit: dB | PCT (setting command) / dB (result value)

Example:

```
SOURce:BB:IMPairment:RF1:IQRatio:MAGNitude 10 PCT
SOURce:BB:IMPairment:RF1:IQRatio:MAGNitude?
// 0.848
// the value is returned in dB
```

Manual operation: See "Gain Imbalance" on page 285

[:SOURce<hw>]:IQ:IMPairment:LEAKage:I <I>
[:SOURce<hw>]:IQ:IMPairment:LEAKage:Q <Q>
[:SOURce]:BB:IMPairment:BBMM<ch>:LEAKage:I <I>
[:SOURce]:BB:IMPairment:BBMM<ch>:LEAKage:Q <Q>
[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:I <I>
[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:Q <Q>
[:SOURce]:BB:IMPairment:RF<ch>:LEAKage:I <I>
[:SOURce]:BB:IMPairment:RF<ch>:LEAKage:Q <Q>

Determines the leakage amplitude of the I or Q signal component of the corresponding stream

Parameters:

<Q> float

Range: -10 to 10
Increment: 0.01
*RST: 0

Example:

```
SOURce:BB:IMPairment:RF1:LEAKage:Q 4 PCT
```

Sets the leakage for the Q-component to 4 percent.

Manual operation: See "I Offset/Q Offset" on page 285

[:SOURce<hw>]:IQ:IMPairment:QUADrature[:ANGLe] <Angle>
[:SOURce]:BB:IMPairment:BBMM<ch>:QUADrature[:ANGLe] <Angle>
[:SOURce]:BB:IMPairment:FADer<ch>:QUADrature[:ANGLe] <Angle>
[:SOURce]:BB:IMPairment:IQOutput<ch>:QUADrature[:ANGLe] <Angle>
[:SOURce]:BB:IMPairment:RF<ch>:QUADrature[:ANGLe] <Angle>

Sets a quadrature offset (phase angle) between the I and Q vectors deviating from the ideal 90 degrees.

A positive quadrature offset results in a phase angle greater than 90 degrees.

Table 13-4: Value range

Impairments	Min /dB	Max /dB	Increment
Digital	-30	30	0.01
Analog	-10	10	0.01

Parameters:

<Angle> float

Range: -30 to 30
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `SOURce:BB:IMPairment:RF1:QUADrature:ANGLe -5`
Sets the quadrature offset to -5 degrees.

Manual operation: See "Quadrature Offset" on page 285

[:SOURce]:BB:IMPairment:BBMM<ch>:SKEW <Skew>
[:SOURce]:BB:IMPairment:IQOutput<ch>:SKEW <Skew>
[:SOURce]:BB:IMPairment:RF<ch>:SKEW <Skew>

Sets a delay between the Q vector and the I vector of the corresponding stream.

Parameters:

<Skew> float

Range: -500E-9 to 500E-9
Increment: 1E-12
*RST: 0

Manual operation: See "Skew" on page 286

[:SOURce<hw>]:IQ:IMPairment[:STATe] <State>
[:SOURce]:BB:IMPairment:BBMM<ch>:STATe <State>
[:SOURce]:BB:IMPairment:IQOutput<ch>:STATe <State>
[:SOURce]:BB:IMPairment:RF<ch>:STATe <State>

Activates the impairment or correction values `LEAKage`, `QUADrature` and `IQRatio` for the corresponding stream.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: `SOURce1:BB:IMPairment:RF1:STATe ON`
Activates digital impairment.

Manual operation: See "State" on page 284

[:SOURce]:BB:IMPairment:BBMM<ch>:POFFset <PhaseOffset>
[:SOURce]:BB:IMPairment:IQOutput<ch>:POFFset <PhaseOffset>
[:SOURce]:BB:IMPairment:RF<ch>:POFFset <PhaseOffset>

Adds an additional phase offset after the stream mapper.

You can shift the phase at the different stages in the signal generation flow, see:

- `[:SOURce<hw>]:BB:POFFset` on page 844

Parameters:

<PhaseOffset> float

Range: -999.99 to 999.99
Increment: 0.01
*RST: 0

Example:
```
SOURce:BB:IMPairment:RF1:POFFset 0
```

Manual operation: See "Phase Offset" on page 286

[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE <Mode>

Sets the optimization mode for I/Q modulation.

If equipped with option R&S SMM-K544, the optimization mode applies for the I/Q modulation performance and for the user-defined frequency response corrections.

See the user manual "R&S SMM-K544 User-Defined Frequency Response Correction".

Parameters:

<Mode> FAST | | QHIGh | QHTable

FAST
Fast optimization with high switching speed by compensating for I/Q skew. This mode is suitable in time sensitive environments and for narrowband signals.

QHIGh
Optimization by compensating for I/Q skew and frequency response correction.
This mode interrupts the RF signal generation. Do not use it in combination with the uninterrupted level settings and strictly monotone modes RF level modes.
See `[:SOURce<hw>]:POWer:LBEHaviour` on page 1031.

QHTable
Improves the frequency response while maintaining setting time, there is no signal interruption.

*RST: FAST

Example:
```
:SOURce1:IQ:SOURce?
// Response: "BASeband"
// The I/Q signal source is the internal baseband signal.
:SOURce1:BB:IMPairment:OPTimization:MODE FAST
```

Manual operation: See "Optimization Mode" on page 301

13.17.5.6 SOURce:BB:GRAPhics subsystem

This subsystem contains the commands used to setup the graphical display.

Required options

See Section 8.1, "Required options", on page 454.

[:SOURce<hw>]:BB:GRAPhics:MODE 950
[:SOURce<hw>]:BB:GRAPhics:SRATe:MODE 950
[:SOURce<hw>]:BB:GRAPhics:SRATe:USER 951
[:SOURce]:BB:GRAPhics:CLOSe 951
[:SOURce]:BB:GRAPhics:ADD 951
[:SOURce]:BB:GRAPhics:SOURce 951
[:SOURce]:BB:GRAPhics:FFTLen 952
[:SOURce]:BB:GRAPhics:FFTFscale 952
[:SOURce<hw>]:BB:GRAPhics:TRIGger:SOURce 952

[:SOURce<hw>]:BB:GRAPhics:MODE <Mode>

Sets the graphics mode of the graphical signal display.

Parameters:

<Mode> | IQ | VECTor | CCDF | PSPectrum | CONStellation | EYEI | EYEQ

*RST: IQ

Example: `BB:GRAP:MODE PSP`
Sets the power spectrum graphics mode.

Manual operation: See "Mode" on page 464

[:SOURce<hw>]:BB:GRAPhics:SRATe:MODE <Mode>

Sets how the time resolution of the signal is determined. Maximum resolution corresponds to a diagram covering the entire signal bandwidth. The higher the resolution is, the shorter the length of the displayed signal segment will be for the specified recording depth.

Parameters:

<Mode> AUTO | FULL | USER

*RST: AUTO

Example: `BB:GRAP:SRAT:MODE FULL`
Sets the sample rate mode.

Manual operation: See "Sample Rate Mode" on page 465

[:SOURce<hw>]:BB:GRAPhics:SRATe:USER <User>

(Enabled for `BB:GRAPH:SRAT:MODE USER`)

Selects the signal bandwidth for the diagram. The setting range moves between the minimum and maximum bandwidth which is possible for the selected graphical signal display. The selection is made graphically by moving the pointer.

Parameters:

<User> float

Range: 0.01 to 100
Increment: 0.01
*RST: 10
Default unit: PCT

Example: `BB:GRAP:SRAT:USER 20`
sets the sample rate factor.

Example: `BB:GRAP:SRAT:MODE USER`
sets the sample rate mode.

Manual operation: See "Sample Rate" on page 465

[:SOURce]:BB:GRAPhics:CLOSe

Closes all graphical signal displays.

Usage: Event

Manual operation: See "Remove" on page 465

[:SOURce]:BB:GRAPhics:ADD <Size>

Adds a graphical signal display (according to the current `MODE`, `SOURce`, `SRATe:*` and `TRIGger:*` settings).

Setting parameters:

<Size> MAXimized | MINimized

Usage: Setting only

Manual operation: See "Add" on page 465

[:SOURce]:BB:GRAPhics:SOURce <Source>

Defines the signal acquisition point, that is the location in the signal flow where the displayed signal is tapped from.

See Section 8.2.2, "Signal acquisition points", on page 460.

Parameters:

<Source> STRA | BBA | RFA | BBIA | DO1 | IQO1 | STRA | BBA | RFA | BBIA | IQO1

STRA
Stream A; input stream of the "IQ Stream Mapper"

BBA
Baseband signal

BBIA
Digital baseband input signals

RFA
RF signal

IQO1
Analog I/Q output signal

*RST: STRA

Manual operation: See "Source" on page 464

[:SOURce]:BB:GRAPhics:FFTLen <Mode>

Sets the FFT size.

Parameters:
<Mode> LEN256 | LEN512 | LEN1024 | LEN2048 | LEN4096

*RST: LEN2048

Example:
```
SOURce:BB:GRAPhics:FFTLen LEN2048
```

Manual operation: See "FFT Length" on page 464

[:SOURce]:BB:GRAPhics:FFTFscale <State>

Defines the normalization of the power values in the power spectrum diagram.

Parameters:
<State> 1 | ON | 0 | OFF

1
Normalized power in dBFS

0
Shows power distribution in dB/Hz

*RST: 0

Example:
```
SOURce:BB:GRAPhics:FFTFscale PSPectrum
SOURce:BB:GRAPhics:FFTFscale 1
// the power spectrum shows the normalized power in dBFS
```

Manual operation: See "Full Scale (dBFS)" on page 464

[:SOURce<hw>]:BB:GRAPhics:TRIGger:SOURce <Source>

Defines the trigger for the starting time of the graphic recording.

Parameters:

<Source> | SOFTware | MARKer

*RST: SOFTware

Example: `SOURce1:BB:GRAPhics:TRIGger:SOURce MARKer`
Sets the trigger source.

Manual operation: See "Trigger Source" on page 464

13.17.5.7 SOURce:BB:PROGress subsystem

In the R&S SMM100A, some calculation processes take longer time. While operating the instrument manually, you can observe the status of an initiated process by the busy indicator. The following commands fulfill the same task in the remote control operation.

Example: Querying the status of the "Create Waveform"

The following example provides information on the status during the "Create Waveform" file processing. You can query progress information of this process.

```
:SOURce1:BB:EUTRa:SETTing:TMOD:DL "E-TM1_1__15MHz"
:SOURce1:BB:EUTRa:SLENgth 100
:SOURce1:BB:PROGress:MCODer?
// 100 (task completed)
:SOURce1:BB:EUTRa:STATe ON
:BB:PROGress:MCODer?
// 67 (task in progress)
:SOURce1:BB:EUTRa:WAVeform:CREate
:SOURce1:BB:PROGress:MCODer?
// 25 (task in progress)
```

[:SOURce<hw>]:BB:PROGress:MCODer?....953
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:MCARrier?....953
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:WSEGment?....953

[:SOURce<hw>]:BB:PROGress:MCODer?
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:MCARrier?
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:WSEGment?

Queries the status of an initiated process. This process can be, for example, the calculation of a signal in accordance to a digital standard, or the calculation of a multicarrier or multi-segment waveform file.

Return values:

<WSegment> integer

Indicates the task progress in percent

Range: 0 to 100
*RST: 100

Example: See Example "Querying the status of the "Create Waveform"" on page 953.

Usage: Query only

13.17.6 SOURce:CORRection subsystem

The `SOURce:CORRection` subsystem contains the commands for defining correction values for external test assemblies.

You can acquire the correction values anytime, regardless of the modulation settings of the generator. During correction, the R&S SMM100A adds the correction values to the output level of the respective RF frequency.

Determine the correction values in one of the following ways:

- Measure the RF output level at several frequency points and enter the value pairs manually in a table
- Connect an R&S NRP to the generator output signal and send the command `[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe` to fill the table automatically.

Save correction values to files with file extension `*.uco`.

Refer to Section 13.6.2, "Handling files in the default or in a specified directory", on page 721 for general information on file handling in the default and in a specific directory.

User-defined frequency response corrections

Using user-defined frequency response correction requires option R&S SMM-K544.

See the user manual "R&S SMM-K544 User-Defined Frequency Response Correction".

Programming examples

The examples in this section assume that:

- The files are stored in the default directory.
- `*RST` does not affect data lists.

Example: To create RF level correction values

The following example shows a command sequence to create and activate a list for assigning level correction values to arbitrary RF frequencies. Further hardware settings are not considered.

```
// Reset the instrument to start from an initial state
// Query the available user correction list files in the default
// directory. Select a file or create a file.
// ********************************************************************
*RST; *CLS
:SOURce1:CORRection:CSET:CATalog?
// Response: "ucor1"
// Select the file ucor1.uco.
:SOURce1:CORRection:CSET:SELect "/var/user/ucor1"
```

```
// Enter the frequency/level value pairs in the table; existing data
// is overwritten. Query the number of frequency/power entries.
:SOURce1:CORRection:CSET:DATA:FREQuency 100MHz,110MHz,120MHz,130MHz,140MHz,150MHz
:SOURce1:CORRection:CSET:DATA:POWer -10,-7.5,-5.0,-2.5,0,2.5
:SOURce1:CORRection:CSET:DATA:FREQuency:POINts?
// 6
:SOURce1:CORRection:CSET:DATA:POWer:POINTs?
// 6

// Enable user correction mode and RF output
:SOURce1:CORRection:STATe 1
:OUTPut1:STATe ON

// Query the currently used correction value
:SOURce1:CORRection:VALue?
// -2.5

// Delete a user correction file
:SOURce1:CORRection:CSET:DELEte "/var/user/ucor1.uco"
```

Example: To fill user correction data with a sensor

The following example shows a command sequence to fill a user correction list automatically supported by a connected R&S NRP.

```
// Fill a user correction list with the level values
// measured by an R&S NRP,
// store the data in a file and enable user correction.

*RST; *CLS

:SOURce1:CORRection:CSET:SELect "/var/user/Ucor1_AutoFill.uco"
:SOURce1:CORRection:CSET:DATA:FREQuency 100MHz,110MHz,120MHz,130MHz,140MHz,150MHz
:SOURce1:CORRection:ZERoing:STATe 1
:SOURce1:CORRection:CSET:DATA:SENSor1:POWer:SONCe
// Query the number of automatically filled correction level values
:SOURce1:CORRection:CSET:DATA:POWer:POINTs?
// 6
:SOURce1:CORRection:STATe 1

// Query the correction value at a certain frequency
:FREQ 120000000
:SOURce1:CORRection:VALue?
// -52.13
```

Example: To export user correction lists

The following example shows a command sequence to export a user correction list (here the list created with the example before) into an ASCII file. Further hardware settings are not considered.

```
// Select a user correction file for exporting to file in ASCII format
// Set ASCII data parameters
// Set the ASCII file extension, the decimal separator
// and the column separator for the ASCII data
:SOURce1:CORRection:DEXChange:AFILe:CATalog?
// my_ucor
:SOURce1:CORRection:CSET:CATalog?
// ucor1,Ucor1_AutoFill
:SOURce1:CORRection:CSET:SELect "/var/user/Ucor1_AutoFill.uco"
:SOURce1:CORRection:DEXChange:AFILe:EXTension CSV
:SOURce1:CORRection:DEXChange:AFILe:SEParator:DECimal DOT
:SOURce1:CORRection:DEXChange:AFILe:SEParator:COLumn COMMa

// Select source and destination
:SOURce1:CORRection:DEXChange:AFILe:SELect "/var/user/ucor2ASCII"

// Export the user correction data into the ASCII file
:SOURce1:CORRection:DEXChange:MODE EXPort
:SOURce1:CORRection:DEXChange:EXECute

// Query the available ASCII files with extension .csv
:SOURce1:CORRection:DEXChange:AFILe:CATalog?
// ucor2ASCII,my_ucor

// Import a user correction ASCII file
:SOURce1:CORRection:DEXChange:MODE IMPort
:SOURce1:CORRection:DEXChange:AFILE:SELect "/var/user/my_ucor"
:SOURce1:CORRection:DEXChange:EXECute
```

Commands:

- Correction settings....956
- Correction data exchange....959
- SOURce:CORRection:OPTimize subsystem....961

13.17.6.1 Correction settings

[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency <Frequency>

Enters the frequency value in the table selected with `[:SOURce<hw>]:CORRection:CSET[:SELect]`.

Parameters:

<Frequency> Frequency#1[, Frequency#2, ...]
String of values with default unit Hz.

Example: See Example "To create RF level correction values" on page 954 .

Manual operation: See "Frequency (Hz)" on page 412

[:SOURce<hw>]:CORRection:CSET:DATA:POWer <Power>

Enters the level values to the table selected with `[:SOURce<hw>]:CORRection:CSET[:SELect]`.

Parameters:

<Power> Power#1[, Power#2, ...]
String of values with default unit dB.
*RST: 0

Example: See Example "To create RF level correction values" on page 954 .

Manual operation: See "Correction Value (dB)" on page 413

[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency:POINts?
[:SOURce<hw>]:CORRection:CSET:DATA:POWer:POINts?

Queries the number of frequency/level values in the selected table.

Return values:

<Points> integer
Range: 0 to 10000
*RST: 0

Example: See Example "To create RF level correction values" on page 954 .

Usage: Query only

[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe

Fills the selected user correction table with the level values measured by the power sensor for the given frequencies.

To select the used power sensor set the suffix in key word `SENSe`.

Example: See Example "To fill user correction data with a sensor" on page 955.

Usage: Event

Manual operation: See "Fill User Correction Data with Sensor" on page 415

[:SOURce<hw>]:CORRection:CSET[:SELect] <Filename>

Selects or creates a file for the user correction data.

If the file with the selected name does not exist, a new file is created.

Parameters:

<Filename> string
Filename or complete file path; file extension can be omitted.

Example: See Example "To create RF level correction values" on page 954 .

Manual operation: See "UCOR Data" on page 411

[:SOURce<hw>]:CORRection:VALue?

Queries the current value for user correction.

Return values:

<Value> float

Range: -100 to 100
Increment: 0.01
*RST: 0

Example: See Example "To create RF level correction values" on page 954 .

Usage: Query only

Manual operation: See "User Correction" on page 411

[:SOURce<hw>]:CORRection:ZERoing:STATe <State>

Activates the zeroing procedure before filling the user correction data acquired by a sensor.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 1

Example: See Example "To fill user correction data with a sensor" on page 955.

Manual operation: See "Fill User Correction Data with Sensor" on page 415

[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe

Fills the selected user correction list with the level values measured by the power sensor for the given frequencies.

Suffix:

SENSor<ch> Defines the used power sensor, i.e. the sensor whose values are used.

Example: See Example "To fill user correction data with a sensor" on page 955.

Usage: Event

[:SOURce<hw>]:CORRection[:STATe] <State>

Activates user correction with the currently selected table.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "To create RF level correction values" on page 954 .

Manual operation: See "State" on page 410

[:SOURce]:CORRection:CSET:CATalog?

Queries a list of available user correction tables.

Return values:
<Catalog> string
List of list filenames, separated by commas

Example: See Example "To create RF level correction values" on page 954 .

Usage: Query only

Manual operation: See "UCOR Data" on page 411
See "Directory, File List and Filename" on page 531

[:SOURce]:CORRection:CSET:DELete <Filename>

Deletes the specified user correction list file.

Setting parameters:
<Filename> string
Filename or complete file path; file extension is optional.

Example: See Example "To create RF level correction values" on page 954 .

Usage: Setting only

Manual operation: See "UCOR Data" on page 411

13.17.6.2 Correction data exchange

With the following commands, you can configure user correction lists and export or import them accordingly.

[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog?

Queries the available ASCII files for export or import of user correction data in the current or specified directory.

Return values:
<Catalog> string
List of ASCII files `*.txt` or `*.csv`, separated by commas.

Example: See Example "To create RF level correction values" on page 954 .

Usage: Query only

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 365

[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension <Extension>

Determines the extension of the ASCII files for file import or export, or to query existing files.

Parameters:

<Extension> TXT | CSV

*RST: TXT

Example: See Example "To export user correction lists" on page 955 .

Manual operation: See "ASCII File Settings" on page 365

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect <Filename>

Selects the ASCII file to be imported or exported.

Parameters:

<Filename> string

Filename or complete file path; file extension can be omitted.

Example: See Example "To export user correction lists" on page 955 .

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 365

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn <Column>

Selects the separator between the frequency and level column of the ASCII table.

Parameters:

<Column> TABulator | SEMicolon | COMMa | SPACe

*RST: COMMa

Example: See Example "To export user correction lists" on page 955 .

Manual operation: See "ASCII File Settings" on page 365

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal <Decimal>

Sets the decimal separator used in the ASCII data between '.' (decimal point) and ',' (comma) with floating-point numerals.

Parameters:
<Decimal> DOT | COMMa
*RST: DOT

Example: See Example "To export user correction lists" on page 955 .

Manual operation: See "ASCII File Settings" on page 365

[:SOURce<hw>]:CORRection:DEXChange:EXECute

Executes the import or export of the selected correction list, according to the previously set transfer direction with command `[:SOURce<hw>]:CORRection:DEXChange:MODE`.

Example: See Example "To export user correction lists" on page 955 .

Usage: Event

Manual operation: See "Import / Export" on page 366

[:SOURce<hw>]:CORRection:DEXChange:MODE <Mode>

Determines import or export of a user correction list.

Specify the source or destination file with the command `[:SOURce<hw>]:CORRection:DEXChange:SELect`.

Parameters:
<Mode> IMPort | EXPort
*RST: IMPort

Example: See Example "To export user correction lists" on page 955 .

Manual operation: See "Mode" on page 365

[:SOURce<hw>]:CORRection:DEXChange:SELect <Filename>

Selects the ASCII file for import or export, containing a user correction list.

Parameters:
<Filename> string
Filename or complete file path; file extension can be omitted.

Example: See Example "To export user correction lists" on page 955 .

Manual operation: See "Select Source/Select ASCII Destination" on page 366

13.17.6.3 SOURce:CORRection:OPTimize subsystem

The `SOURce:CORRection:OPTimize` subsystem contains the commands for defining correction values for predefined digital predistortion to linearize the RF signal.

You can acquire the correction values anytime, regardless of the modulation settings of the generator. During correction, the R&S SMM100A adds the correction values to the output level of the respective RF frequency.

Example: Optimizing I/Q modulation for best EVM performance

```
// Select EVM optimization as the I/Q modulation method.
:SOURce1:CORRection:OPTimize:RF:CHARacteristics EVM

// Query the state of the I/Q modulator adjustments.
:SOURce1:CORRection:OPTimize:RF:IQModulator?
// Response: "1"
// Enabled are automatic I/Q modulator adjustments after each RF signal
// settings change.
:SOURce1:CORRection:OPTimize:RF:HEADroom?
// Response: "1"
// Enabled are automatic digital headroom adjustments after each RF signal
// settings change.
:SOURce1:CORRection:OPTimize:RF:LINearize?
// Response: "AUTO"
// Automatic RF linearizations requires option R&S SMM-K575.
// Response: "OFF"
// No RF linearizations enabled, that is the default mode without option R&S SMM-K575.
```

Example: Applying user-defined I/Q modulation optimizations

```
// Select user-defined optimization as the I/Q modulation method.
:SOURce1:CORRection:OPTimize:RF:CHARacteristics USER

// Query the state of the I/Q modulator adjustments.
:SOURce1:CORRection:OPTimize:RF:IQModulator?
// Response: "0"
// Disabled are automatic I/Q modulator adjustments after each RF signal
// settings change. To apply automatic I/Q modulator adjustments apply a manual
// adjustment first.
:SOURce1:CORRection:OPTimize:RF:IQModulator:ADJUst
:SOURce1:CORRection:OPTimize:RF:IQModulator 1
// Enabled are automatic I/Q modulator adjustments after each RF signal
// settings change.

// Query other automatic adjustment states.
:SOURce1:CORRection:OPTimize:RF:HEADroom?
// Response: "0"
// Disabled are automatic digital headroom adjustments after each RF signal
// settings change.
:SOURce1:CORRection:OPTimize:RF:LINearize?
// Response: "OFF"
// No RF linearizations enabled.

// Set a carrier offset.
:SOURce1:CORRection:OPTimize:RF:COFFset 1
// Query the current carrier offset.
```

```
:SOURce1:CORRection:OPTimize:RF:COFFset:VALue?
// Response in Hz: "-20050000"
// The current carrier offset is -20.05 MHz.

// Enable dithering.
:SOURce1:CORRection:OPTimize:RF:DITHering 1
```

Example: Linearizing the RF signal automatically

Option: R&S SMM-K575

```
// Enable I/Q modulation of the baseband signal.
:SOURce1:IQ:SOURce BAS
:SOURce1:IQ:STATe 1

:SOURce1:CORRection:OPTimize:RF:LINearize AUTO
// Uses the AM/AM and AM/PM predistortion data from a factory calibration to
// to linearize the RF output signal at high output powers.
```

Example: Linearizing the RF signal manually

```
// Enable I/Q modulation of the baseband signal.
:SOURce1:IQ:SOURce BAS
:SOURce1:IQ:STATe 1

:SOURce1:CORRection:OPTimize:RF:LINearize:ADJust
// Calculates AM/AM correction data for the current RF signal settings.
:SOURce1:CORRection:OPTimize:RF:LINearize MANual
// Applies the correction data to adjuast level and frequency of the RF signal.
// If equipped with option R&S SMM-K575, uses also AM/PM
// correction data from factory calibration.
```

Commands:

[:SOURce<hw>]:CORRection:OPTimize:RF:CHARacteristics 963
[:SOURce<hw>]:CORRection:OPTimize:RF:COFFset 964
[:SOURce<hw>]:CORRection:OPTimize:RF:COFFset:VALue? 964
[:SOURce<hw>]:CORRection:OPTimize:RF:DITHering 965
[:SOURce<hw>]:CORRection:OPTimize:RF:HEADroom 965
[:SOURce<hw>]:CORRection:OPTimize:RF:IQModulator 965
[:SOURce<hw>]:CORRection:OPTimize:RF:IQModulator:ADJust? 966
[:SOURce<hw>]:CORRection:OPTimize:RF:LINearize 966
[:SOURce<hw>]:CORRection:OPTimize:RF:LINearize:ADJust? 967

[:SOURce<hw>]:CORRection:OPTimize:RF:CHARacteristics <Characteristic>

Sets the method for optimizing the I/Q modulation.

Parameters:

<Characteristic> OFF | EVM | USER

OFF
No dedicated I/Q modulation optimization.

EVM
Optimizes I/Q modulation to achieve better EVM performance. This method reduces the wideband noise and improves the non-linear effects of amplifiers resulting in a linear gain.

USER
Sets a user-defined optimization as the I/Q modulation method.

*RST: OFF

Example: See Example "Optimizing I/Q modulation for best EVM performance" on page 962.

Example: See Example "Applying user-defined I/Q modulation optimizations" on page 962.

Manual operation: See "Optimization Characteristics" on page 303

[:SOURce<hw>]:CORRection:OPTimize:RF:COFFset <State>

If enabled, you can only route each stream to one output. Routing multiple streams to one output or one stream to multiple outputs is not allowed with an enabled carrier offset.

The carrier offset relates to the bandwidth b_{signal} of the I/Q signal as follows:

$f_{c_offset} = 20\ MHz + b_{signal}/2$

If no signal bandwidth is available, the carrier offset calculation uses the sample rate r_{sample} instead of the bandwidth:

$f_{c_offset} = 20\ MHz + r_{sample}/2$

Parameters:
<State> 0 | 1 | OFF | ON

*RST: OFF

Example: See Example "Applying user-defined I/Q modulation optimizations" on page 962.

Manual operation: See "Carrier Offset" on page 305

[:SOURce<hw>]:CORRection:OPTimize:RF:COFFset:VALue?

If a carrier offset is enabled, the command queries the value of the current carrier offset.

This value depends on the bandwidth b_{signal} of the I/Q signal or the baseband sample rate r_{sample}.

Return values:
<CurrentCarrOffs> float

Range: -1E9 to 1E9
Increment: 1e-6
*RST: 0

Example: See Example "Applying user-defined I/Q modulation optimizations" on page 962.

Usage: Query only

Manual operation: See "Current Carrier Offset" on page 305

[:SOURce<hw>]:CORRection:OPTimize:RF:DITHering <State>

Enables dithering of the I/Q signal to improve the spectral purity of the RF output signal.

Dithering does not lead to improvements of the EVM performance or ACLR performance of the RF output signal.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Applying user-defined I/Q modulation optimizations" on page 962.

Manual operation: See "Dithering (Common to all RF Paths)" on page 305

[:SOURce<hw>]:CORRection:OPTimize:RF:HEADroom <State>

Enables automatic adjustments of the I/Q modulator after each RF frequency change or RF level change.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Applying user-defined I/Q modulation optimizations" on page 962.

Manual operation: See "Digital Headroom" on page 304

[:SOURce<hw>]:CORRection:OPTimize:RF:IQModulator <State>

Enables adjustments of the I/Q modulator after each RF frequency change or RF level change.

Parameters:

<State> 1 | ON | 0 | OFF

1|ON
Adjusts the I/Q modulator during modulation after each RF frequency change or RF level change.

0|OFF
No adjustments of the I/Q modulator during modulation.

*RST: 0

Example: See Example "Applying user-defined I/Q modulation optimizations" on page 962.

Manual operation: See "I/Q Modulator" on page 304

[:SOURce<hw>]:CORRection:OPTimize:RF:IQModulator:ADJust?

Enables automatic adjustments of the I/Q modulator after each RF frequency change or RF level change.

Return values:

<AdjustError> 1 | ON | 0 | OFF

*RST: n.a. (no preset. default: 0)

Example: See Example "Applying user-defined I/Q modulation optimizations" on page 962.

Usage: Query only

Manual operation: See "Adjust I/Q Modulator for current settings" on page 306

[:SOURce<hw>]:CORRection:OPTimize:RF:LINearize <Linearize>

Requires R&S SMM-K541 or R&S SMM-K575.

Selects the mode to apply a predefined AM/AM digital predistortion (DPD) to the nonlinear RF chain to linearize the RF signal.

Parameters:

<Linearize> OFF | AUTO | ON | MANual

OFF
Disables applying the DPD to the nonlinear RF chain.

AUTO
Requires R&S SMM-K575.
Applies an automatic AM/AM predistortion of the nonlinear RF chain at high output powers. This mode requires correction data from "Linearize RF for current settings".

ON
Requires R&S SMM-K575.
Applies an AM/AM predistortion to the nonlinear RF chain over the whole RF level range. This mode requires correction data from "Linearize RF for current settings".

MANual
Requires R&S SMM-K541.
Applies an AM/AM predistortion of the nonlinear RF chain. This mode requires correction data from "Linearize RF for current settings".
To receive the correction data, use the following command before using the manual mode to linearize the RF signal.
`[:SOURce<hw>]:CORRection:OPTimize:RF:LINearize:ADJust?` on page 967

*RST: OFF

Example: See Example "Linearizing the RF signal automatically" on page 963.

Example: See Example "Linearizing the RF signal manually" on page 963.

Manual operation: See "Linearize RF" on page 305

[:SOURce<hw>]:CORRection:OPTimize:RF:LINearize:ADJust?

Measures the AM/AM nonlinearity on the RF chain for the current frequency. During the measurement, the instrument interrupts signal generation.

Return values:
<AdjustResult> 1 | ON | 0 | OFF
*RST: n.a. (no preset. default: 0)

Example: See Example "Linearizing the RF signal manually" on page 963.

Usage: Query only

Manual operation: See "Linearize RF for current settings" on page 307

13.17.7 SOURce:EFRontend subsystem

The `SOURce:EFRontend` subsystem contains the commands for configuring settings of an external frontend.

Example: Configuring external frontend frequency bands

Option: R&S SMM-K553:

```
// Load a frequency band configuration.
SOURce1:EFRontend:FREQuency:BAND1:CONFig:CATalog?
// Response: "IF Low,IF High"
SOURce1:EFRontend:FREQuency:BAND1:CONFig:SELect "IF Low"
// Query the corresponding intermediate frequency at the RF output of the R&S SMM100A.
SOURce1:EFRontend:IFRequency?
// Response in Hz: "3900000000" (= 3.9 GHz)

// Query information about operating frequency bands.
SOURce1:EFRontend:FREQuency:BAND:COUNt?
// Response: "2"
// The frontend operates in two frequency bands.
// Query ranges of the operating frequency bands.
SOURce1:EFRontend:FREQuency:BAND1:LOWer?
// Response in Hz: "24240000000" (= 24.24 GHz)
SOURce1:EFRontend:FREQuency:BAND1:UPPer?
// Response in Hz: "33400000000" (= 33.4 GHz)
SOURce1:EFRontend:FREQuency:BAND2:LOWer?
// Response in Hz: "37000000000" (= 37 GHz)
SOURce1:EFRontend:FREQuency:BAND2:UPPer?
// Response in Hz: "43500000000" (= 43.5 GHz)
```

Option: R&S SMM-K554:

```
SOURce1:EFRontend:FREQuency:IFRequency:VALue?
// Response in Hz: "18750000000" (= 18.75 GHz)
```

Example: Configuring external frontend connection settings

Option: R&S SMM-K553:

```
// Query information about the connected RF frontend.
SOURce1:EFRontend:INFO?
// Response: <SymbolicName> "FE170ST-123456", <RemoteChannel> "Frontend Connection"
// <IpAddress>/<HostName> "FE170ST-123456",<ConnectionState> "connected"
// Query all connected external frontends, including equipped options:
SOURce1:EFRontend:LIST?
// Response: "FE170ST-123456"
SOURce1:EFRontend:IDN?
// Response: "Rohde&Schwarz,FE170ST,1234.5678K00/123456,1.34.6"

// Specify and query frontend connection settings.
SOURce1:EFRontend:RFConnector?
// Response: "RFA"
SOURce1:EFRontend:CMODe?
// Response: "AUTO"
SOURce1:EFRontend:FREQuency:REFerence:LIST?
// Response: "10 MHz,640 MHz,1 GHz"
SOURce1:EFRontend:FREQuency:REFerence F1G
// Sets 1 GHz reference frequency.

//Example: Query of RF connector with connected R&S FE50DTR
SOURce1:EFRontend:RFConnector?
// Response: "RFB"
```

Option: R&S SMM-K554:

```
SOURce1:EFRontend:IDN?
// Response: "Rohde&Schwarz,SZM75,1443.5004K02/100001,1.34.6,1.2.1"

//Query the installed hardware options
SOURce1:EFRontend:OPT?
// Response: "SZM-E,SZM-I"
```

Example: Configuring external frontend cable correction

Option: R&S SMM-K553:

```
// Query available cable correction files.
SOURce1:EFRontend:ALIGnment:FILE:CATalog?
// Response: "CableCorrIF"
// Add cable correction data by loading the file CableCorrIF.s2p.
SOURce1:EFRontend:ALIGnment:FILE:SELect CableCorrIF
// Query upper and lower frequency range of the IF correction data.
SOURce1:EFRontend:ALIGnment:FILE:FREquency:RANGe:LOWer?
// Response in Hz: "4500000000" (4.5 GHz)
SOURce1:EFRontend:ALIGnment:FILE:FREquency:RANGe:UPPer?
// Response in Hz: "6820000000" (6.82 GHz)
SOURce1:EFRontend:ALIGnment:STATe 1
```

Option: R&S SMM-K554:

```
// Query available cable correction files.
SOURce1:EFRontend:ALIGnment:FILE:CATalog?
// Select a cable correction file stored on the instrument.
SOURce1:EFRontend:ALIGnment:FILE:SELect "/var/user/ExtFrontend/CableCorrectionFiles/
if_default_cable_1347_7552_00.s2p"
// Query upper and lower frequency range of the IF correction data.
SOURce1:EFRontend:ALIGnment:FILE:FREquency:RANGe:LOWer?
// Response in Hz: "12000000000" (12 GHz)
SOURce1:EFRontend:ALIGnment:FILE:FREquency:RANGe:UPPer?
// Response in Hz: "19250000000" (19.25 GHz)
SOURce1:EFRontend:ALIGnment:STATe 1
```

Commands:

[:SOURce<hw>]:EFRontend[:FREQuency]:IFRequency[:VALue]?....970
[:SOURce<hw>]:EFRontend:IDN?....971
[:SOURce<hw>]:EFRontend:OPT?....971
[:SOURce<hw>]:EFRontend:ALIGnment:FILE:FREQuency:RANGe:LOWer?....971
[:SOURce<hw>]:EFRontend:ALIGnment:FILE:FREQuency:RANGe:UPPer?....971
[:SOURce<hw>]:EFRontend:ALIGnment:FILE:CATalog?....971
[:SOURce<hw>]:EFRontend:ALIGnment:FILE[:SELect]....972
[:SOURce<hw>]:EFRontend:ALIGnment[:STATe]....972
[:SOURce<hw>]:EFRontend:SCRew:POSition?....972

[:SOURce<hw>]:EFRontend[:FREQuency]:IFRequency[:VALue]?

Queries the frequency of the IF signal, that is the frequency at the RF connector.

Return values:

<IntFrequency> float

Example: See Example "Configuring external frontend frequency bands" on page 968.

Usage: Query only

Manual operation: See "Intermediate Frequency" on page 449

[:SOURce<hw>]:EFRontend:IDN?

Identification

Returns the IDN string, i.e. the identification of the external frontend.

Return values:
<IdnString> string

Example: See Example "Configuring external frontend connection settings" on page 969.

Usage: Query only

Manual operation: See "Hardware Config" on page 450

[:SOURce<hw>]:EFRontend:OPT?

Option identification query

Queries the options included in the external frontend.

For more information, refer to the specifications document.

Return values:
<OptString> string

The query returns a list of options. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed.

Usage: Query only

Manual operation: See "Options" on page 451

[:SOURce<hw>]:EFRontend:ALIGnment:FILE:FREQuency:RANGe:LOWer?
[:SOURce<hw>]:EFRontend:ALIGnment:FILE:FREQuency:RANGe:UPPer?

Queries the upper/lower frequency range of IF values required at the connected external frontend.

We recommend that you cover this range in the cable correction file.

Return values:
<CableCorrFreqUp> float

Example: See Example "Configuring external frontend cable correction" on page 970.

Usage: Query only

Manual operation: See "Recommended Frequency Range" on page 453

[:SOURce<hw>]:EFRontend:ALIGnment:FILE:CATalog?

Queries the cable correction files with settings in the default directory.

Listed are cable correction files with extension *.s2p or *.uco.

Example: See Example "Configuring external frontend cable correction" on page 970.

Usage: Query only

Manual operation: See "Load Cable Correction File" on page 452

[:SOURce<hw>]:EFRontend:ALIGnment:FILE[:SELect] <CableCorrFileNa>

Selects an existing correction file to compensate for cable losses. Selectable files have file extension *.s2p or *.uco.

Parameters:
<Filename> string

Example: See Example "Configuring external frontend cable correction" on page 970.

Manual operation: See "Load Cable Correction File" on page 452

[:SOURce<hw>]:EFRontend:ALIGnment[:STATe] <CableCorrState>

Activates correction of the IF signal for different IF signal frequencies.

Parameters:
<CableCorrState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configuring external frontend cable correction" on page 970.

Manual operation: See "State" on page 452

[:SOURce<hw>]:EFRontend:SCRew:POSition?

Requires a connected external frequency multiplier with installed mechanically attenuator option.

Queries the value of the screw position required on the connected external frequency multiplier.

Return values:
<ScrewPosition> integer
Range: 0 to 150
*RST: 0

Usage: Query only

13.17.8 SOURce:FREQuency subsystem

The `SOURce:FREQuency` subsystem contains the commands used to define the frequency settings for the RF sources and sweeps.

Example: To configure RF frequency settings

```
:SOURce1:FREQuency:MODE CW
:SOURce1:FREQuency:CW 6000000000
:SOURce1:FREQuency:OFFSet 2000000000
:SOURce1:FREQuency:MULTiplier 1.5
:SOURce1:FREQuency:CW?
// Response in Hz: 11000000000

// Optionally, configure a user-defined frequency step mode.
:SOURce1:FREQuency:STEP:MODE USER
:SOURce1:FREQuency:STEP:INCRement 1000000
:SOURce1:FREQuency:CW UP

:SOURce1:PHASe 2
:SOURce1:PHASe:REFerence
```

Example: Set up of LO coupling and LO level adjustment with three Rohde & Schwarz signal generators

This example shows the command sequences for coupling the oscillator signal of three signal generators connected according to the setup on Figure 13-3.

Connect the instruments in a daisy-chain regarding the LO signal:

- Connect the LO Out of the first generator with LO In of the second
- Connect the LO Out of the second generator with LO In of the third.

The frequency is assumed to be 5 GHz.

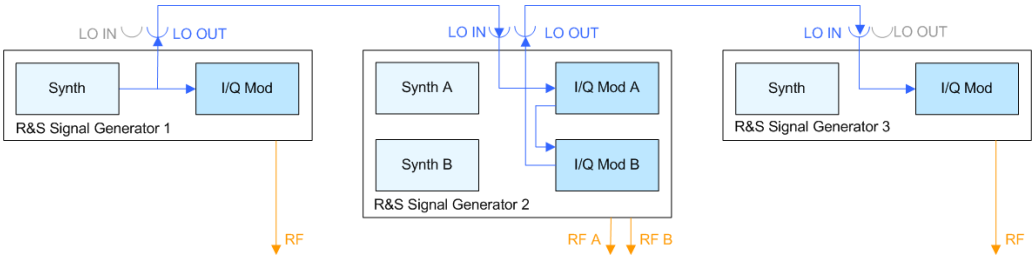

Figure 13-3: Set up of LO coupling with three Rohde & Schwarz signal generators

Signal generator#1 = One-path instrument, uses its internal oscillator signal.
Signal generator#1 = Two-paths instrument; receives the LO signal from the first instrument and assigns it to both paths
Signal generator#3 = One-path instrument; receives the LO signal from the second instrument

```
// ****************************************************************
// Address and reset the first instrument
// ****************************************************************
*RST; *CLS
```

```
// ****************************************************************
// Configure the oscillator signal of the first instrument
// ****************************************************************
SOURce:FREQuency 5 GHz
SOURce:FREQuency:LOSCillator:MODe INTernal
SOURce:FREQuency:LOSCillator:OUTPut:STATe ON
SOURce:FREQuency:LOSCillator:OUTPut:FREQuency?
// Response: 1000000000

// ****************************************************************
// Address and reset the second instrument, e.g. a R&S SMW
// ****************************************************************
*RST; *CLS

// ****************************************************************
// Configure the oscillator signal of the second instrument
// ****************************************************************
SOURce1:FREQuency 5 GHz
SOURce1:FREQuency:LOSCillator:MODe ECOupled
SOURce1:FREQuency:LOSCillator:OUTPut:STATe ON

// ****************************************************************
// If the attenuation between the interconnection LO OUT and LO IN is
// greater than 1 dB at the oscillator frequency,
// we recommend that you perform the LO level adjustment
// ****************************************************************
:CALibration:LOSCillator:Coupling:LOCAL?

// ****************************************************************
// Address and reset the third instrument
// ****************************************************************
*RST; *CLS

// ****************************************************************
// Configure the oscillator signal of the third next instrument
// ****************************************************************
SOURce:FREQuency 5 GHz
SOURce:FREQuency:LOSCillator:MODe EXTernal
SOURce:FREQuency:LOSCillator:OUTPut:STATe OFF
```

See also:

- "To configure LO coupling with cascaded instruments" on page 332

[:SOURce<hw>]:FREQuency:LOSCillator:INPut:FREQuency? 975
[:SOURce<hw>]:FREQuency:LOSCillator:MODE 975
[:SOURce<hw>]:FREQuency:LOSCillator:OUTPut:FREQuency? 975
[:SOURce<hw>]:FREQuency:LOSCillator:OUTPut:STATe 976
[:SOURce<hw>]:FREQuency:MODE 976
[:SOURce<hw>]:FREQuency[:CW|FIXed] 977
[:SOURce<hw>]:FREQuency[:CW|FIXed]:RCL 977
[:SOURce<hw>]:FREQuency:MANual 978

[:SOURce<hw>]:FREQuency:MULTiplier 978
[:SOURce<hw>]:FREQuency:OFFSet 978
[:SOURce<hw>]:FREQuency:CENTer 979
[:SOURce<hw>]:FREQuency:SPAN 979
[:SOURce<hw>]:FREQuency:STARt 980
[:SOURce<hw>]:FREQuency:STOP 980
[:SOURce<hw>]:FREQuency:STEP:MODE 980
[:SOURce<hw>]:FREQuency:STEP[:INCRement] 981

[:SOURce<hw>]:FREQuency:LOSCillator:INPut:FREQuency?

Queries the required external reference frequency.

Return values:

<Frequency> float

Range: 100E3 to 20E9
Increment: 0.01
*RST: 0

Example: See Example "Set up of LO coupling and LO level adjustment with three Rohde & Schwarz signal generators" on page 973.

Usage: Query only

Manual operation: See "Mandatory LO IN Frequency" on page 331

[:SOURce<hw>]:FREQuency:LOSCillator:MODE <Mode>

Selects the mode of the local oscillator coupling.

Parameters:

<Mode> INTernal | EXTernal

*RST: INTernal

Example: See Example "Set up of LO coupling and LO level adjustment with three Rohde & Schwarz signal generators" on page 973.

Manual operation: See "Mode" on page 331

[:SOURce<hw>]:FREQuency:LOSCillator:OUTPut:FREQuency?

Queries the current frequency of the local oscillator at the [LO Out] connector.

Return values:

<Frequency> float

Range: 100E3 to 20E9
Increment: 0.01
*RST: 0

Example: See Example "Set up of LO coupling and LO level adjustment with three Rohde & Schwarz signal generators" on page 973.

Usage: Query only

Manual operation: See "LO OUT Frequency" on page 331

[:SOURce<hw>]:FREQuency:LOSCillator:OUTPut:STATe <State>

Activates the LO output.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Set up of LO coupling and LO level adjustment with three Rohde & Schwarz signal generators" on page 973.

Manual operation: See "Out State" on page 331

[:SOURce<hw>]:FREQuency:MODE <Mode>

Sets the frequency mode for generating the RF output signal. The selected mode determines the parameters to be used for further frequency settings.

Parameters:

<Mode> CW | FIXed | SWEep | LIST

CW|FIXed
Sets the fixed frequency mode. `CW` and `FIXed` are synonyms.
The instrument operates at a defined frequency, set with command `[:SOURce<hw>]:FREQuency[:CW|FIXed]`.

SWEep
Sets sweep mode.
The instrument processes frequency (and level) settings in defined sweep steps.
Set the range and current frequency with the commands:
`[:SOURce<hw>]:FREQuency:STARt` on page 980 and `[:SOURce<hw>]:FREQuency:STOP` on page 980,
`[:SOURce<hw>]:FREQuency:CENTer` on page 979,
`[:SOURce<hw>]:FREQuency:SPAN` on page 979,
`[:SOURce<hw>]:FREQuency:MANual` on page 978

LIST
Sets list mode.
The instrument processes frequency and level settings by means of values loaded from a list.
To configure list mode settings, use the commands of the Section 13.17.13, "SOURce:LIST subsystem", on page 1004.

*RST: CW

Example: See Example "To configure RF frequency settings" on page 973,

Example: See Example "Setting up an RF frequency or power sweep" on page 1047

Manual operation: See "State (RF frequency sweep)" on page 352
See "State" on page 361

[:SOURce<hw>]:FREQuency[:CW|FIXed] <Fixed>

Sets the frequency of the RF output signal in the selected path.

The effect depends on the selected mode:

- In CW mode (`FREQ:MODE CW | FIXed`), the instrument operates at a fixed frequency.
- In sweep mode (`FREQ:MODE SWE`), the value applies to the sweep frequency. The instrument processes the frequency settings in defined sweep steps.
- In user mode (`FREQ:STEP:MODE USER`), you can vary the current frequency step by step.

For more information, refer to the specifications document.

Parameters:

<Fixed> float

The following settings influence the value range:
An offset set with the command `[:SOURce<hw>]:FREQuency:OFFSet`

Numerical value
Sets the frequency in CW and sweep mode

UP|DOWN
Varies the frequency step by step in user mode.
The frequency is increased or decreased by the value set with the command `[:SOURce<hw>]:FREQuency:STEP[:INCRement]`.

Range: (RFmin + OFFSet) to (RFmax + OFFSet)
Increment: depends on options
*RST: depends on options

Example: See Example "To configure RF frequency settings" on page 973

Example: See Example "Setting up an RF frequency or power sweep" on page 1047

Manual operation: See "Frequency" on page 313

[:SOURce<hw>]:FREQuency[:CW|FIXed]:RCL <Rcl>

Set whether the RF frequency value is retained or taken from a loaded instrument configuration, when you recall instrument settings with command `*RCL`.

Parameters:

<Rcl> INCLude | EXCLude

INCLude
Takes the frequency value of the loaded settings.

EXCLude
Retains the current frequency when an instrument configuration is loaded.

*RST: INCLude

Example: SOURce1:FREQuency:CW:RCL INCLude

Manual operation: See "Exclude Frequency" on page 533

[:SOURce<hw>]:FREQuency:MANual <Manual>

Sets the frequency and triggers a sweep step manually if SWEep:MODE MAN.

Parameters:

<Manual> float

You can select any frequency within the setting range, where:
STARt is set with [:SOURce<hw>]:FREQuency:STARt
STOP is set with [:SOURce<hw>]:FREQuency:STOP
OFFSet is set with [:SOURce<hw>]:FREQuency:OFFSet

Range: (STARt + OFFSet) to (STOP + OFFSet)
Increment: 0.01Hz
*RST: 100 MHz
Default unit: Hz

Example: See Example "Setting up an RF frequency or power sweep" on page 1047

Manual operation: See "Current Frequency" on page 353

[:SOURce<hw>]:FREQuency:MULTiplier <Multiplier>

Sets the multiplication factor $N_{FREQ:MULT}$ of a subsequent downstream instrument.

The parameters offset $f_{FREQ:OFFSer}$ and multiplier $N_{FREQ:MULT}$ affect the frequency value set with the command FREQ.

The query FREQ? returns the value corresponding to the formula:

$f_{FREQ} = f_{RFout} * N_{FREQ:MULT} + f_{FREQ:OFFSer}$

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Parameters:

<Multiplier> float

Range: -10000 to 10000
Increment: 0.001
*RST: 1

Example: See Example "To configure RF frequency settings" on page 973

Manual operation: See "Multiplier" on page 314

[:SOURce<hw>]:FREQuency:OFFSet <Offset>

Sets the frequency offset $f_{FREQ:OFFSet}$ of a downstream instrument.

The parameters offset $f_{FREQ:OFFSer}$ and multiplier $N_{FREQ:MULT}$ affect the frequency value set with the command FREQ.

The query FREQ? returns the value corresponding to the formula:

$f_{FREQ} = f_{RFout} * N_{FREQ:MULT} + f_{FREQ:OFFSer}$

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Note: The offset also affects RF frequency sweep.

Parameters:

<Offset> float

Increment: 0.01
*RST: 0

Example: See Example "To configure RF frequency settings" on page 973

Manual operation: See "Offset" on page 313

[:SOURce<hw>]:FREQuency:CENTer <Center>

Sets the center frequency of the sweep.

The maximum value depends on the installed hardware options.

For more information, refer to the specifications document.

Parameters:

<Center> float

Range: 300 kHz to depends on options
Increment: 0.01 Hz
*RST: 300E6
Default unit: Hz

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Center Frequency" on page 356

[:SOURce<hw>]:FREQuency:SPAN <Span>

Sets the span of the frequency sweep range.

Parameters:

<Span> float

Full frequency range

Increment: 0.01
*RST: 400E6

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Span" on page 356

[:SOURce<hw>]:FREQuency:STARt <Start>

Sets the start frequency for the RF sweep.

The maximum value depends on the installed hardware options.

For more information, refer to the specifications document.

Parameters:

<Start> float

Range: 300 kHz to depends on options
Increment: 0.01 Hz
*RST: 100 MHz

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Start Frequency/Stop Frequency" on page 356

[:SOURce<hw>]:FREQuency:STOP <Stop>

Sets the stop frequency range for the RF sweep.

The maximum value depends on the installed hardware options.

For more information, refer to the specifications document.

Parameters:

<Stop> float

Range: 300 kHz to depends on options
Increment: 0.01 Hz
*RST: 500 MHz
Default unit: Hz

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Start Frequency/Stop Frequency" on page 356

[:SOURce<hw>]:FREQuency:STEP:MODE <Mode>

Defines the type of step size to vary the RF frequency at discrete steps with the commands `FREQ UP or FREQ DOWN`.

Parameters:

<Mode> DECimal | USER

DECimal
Increases or decreases the level in steps of ten.

USER
Increases or decreases the level in increments, set with the command `FREQ:STEP[:INCR]`.

*RST: DECimal

Example: See Example "To configure RF frequency settings" on page 973.

Manual operation: See "Variation Active" on page 315

[:SOURce<hw>]:FREQuency:STEP[:INCRement] <Increment>

Sets the step width.

You can use this value to vary the RF frequency with command `FREQ UP or FREQ DOWN`.

If you have activated `FREQ:STEP:MODE USER`.

Note: This value also applies to the step width of the rotary knob on the instrument and, in user-defined step mode, increases or decreases the frequency.

Parameters:

<Increment> float

Range: 0 Hz to RFmax - 100 kHz
Increment: 0.01 Hz
*RST: 1E6

Example: See Example "To configure RF frequency settings" on page 973

Manual operation: See "Variation Step" on page 315

13.17.9 SOURce:INPut subsystem

The `SOURce:INPut` subsystem contains the commands for configuring the inputs for external modulation signals. The instrument trigger setting influences all sweeps and is effective in the List mode (Instrument Trigger).

[:SOURce<hw>]:INPut:MODext:COUPling<ch>....981
[:SOURce<hw>]:INPut:MODext:IMPedance<ch>....982
[:SOURce<hw>]:INPut:TRIGger:SLOPe....982

[:SOURce<hw>]:INPut:MODext:COUPling<ch> <Coupling>

Selects the coupling mode for an externally applied modulation signal.

Parameters:

<Coupling> AC | DC

AC
Passes the AC signal component of the modulation signal.

DC
Passes the modulation signal with both components, AC and DC.

*RST: AC

Example: `INP:MOD:COUP AC`
Selects the coupling mode AC for an externally applied modulation signal.

Manual operation: See "Coupling (AC/DC)" on page 393

[:SOURce<hw>]:INPut:MODext:IMPedance<ch> <Impedance>

Sets the impedance (50 kOhm or High = 100 kOhm to ground) for the externally supplied modulation signal.

Parameters:

<Impedance> G50 | HIGH

*RST: HIGH

Example: `INP:MOD:IMP 50`
sets 50 kOhm to ground.

Manual operation: See "Impedance" on page 393

[:SOURce<hw>]:INPut:TRIGger:SLOPe <Slope>

Sets the polarity of the active slope of an applied instrument trigger.

Parameters:

<Slope> NEGative | POSitive

*RST: POSitive

Manual operation: See "Trigger Slope" on page 355

13.17.10 SOURce:IQ subsystem

The `SOURce:IQ` subsystem contains the commands for configuring the I/Q modulation.

Required options

See Section 6.1, "Required options", on page 289.

[:SOURce<hw>]:IQ:SOURce 982
[:SOURce<hw>]:IQ:STATe 983
[:SOURce<hw>]:IQ:GAIN 983
[:SOURce<hw>]:BB:IQGain 983
[:SOURce<hw>]:IQ:CRESTfactor 984
[:SOURce<hw>]:IQ:SWAP[:STATe] 985
[:SOURce<hw>]:IQ:WBSTate 985

[:SOURce<hw>]:IQ:SOURce <Source>

Selects the input signal source for the I/Q modulator.

Parameters:

<Source> BASeband | | ANALog

BASeband
Internal baseband signal

ANALog
External analog wideband I/Q signal
Enabling the I/Q modulator disables an enabled amplitude modulation of the RF output signal.

Differential
External analog wideband I/Q signal
Enabling the I/Q modulator disables an enabled amplitude modulation of the RF output signal.

*RST: BASeband

Example: `SOURce1:IQ:SOURce BASeband`
Sets the internal baseband signal as I/Q modulator source signal, for example an ARB signal.

Manual operation: See "Source" on page 299

[:SOURce<hw>]:IQ:STATe <State>

Enables the I/Q modulation.

Note: Interdependencies

The following functions cannot be activated simultaneously. **They deactivate each other**.

- The internal baseband generator (`[:SOURce<hw>]:BB:<DigStd>:STATe`) and the external digital baseband input (`[:SOURce<hw>]:BBIN:STATe`)

Parameters:
<State> 1 | ON | 0 | OFF

*RST: 0

Example: `IQ:STAT ON`
Enables the I/Q modulation.

Manual operation: See "State" on page 299

[:SOURce<hw>]:IQ:GAIN <Gain>
[:SOURce<hw>]:BB:IQGain <IqGain>

Sets the baseband gain for a wide dynamic range.

You can amplify the baseband signal power level (positive gain) or attenuate this level (negative gain) to optimize the I/Q modulation performance. The optimization is a trade-off between signal distortion and signal-to-noise ratio (SNR).

Parameters:
<IqGain> DBM4 | DBM2 | DB0 | DB2 | DB4 | DB8 | DB6 | DBM3 | DB3 | AUTO

Dynamic range of 16 dB divided into 2 dB steps.

DBM2|DBM4
"-4 dB"/"-2 dB"
Attenuates the baseband signal internally to minimize signal distortions and optimize the intermodulation characteristics of the modulated signal. But the SNR decreases, the signal noise increases.

DB0
0 dB
No changes on the baseband signal, applies no optimization.

DB2|DB4|DB6|DB8
"2 dB"/"4 dB"/"6 dB"/"8 dB"
Amplifies the baseband signal internally to maximize the SNR while minimizing the signal noise is minimized. But the signal distortions increase.

DBM3|DB3
(Setting only)
Provided only for backward compatibility with other Rohde & Schwarz signal generators.
The R&S SMM100A accepts these values and maps them automatically as follows:
DBM3 = DBM2, DB3 = DB2

AUTO
Requires a connected R&S SZU. The R&S SMM100A automatically sets the gain with optimized adjustment data from the R&S SZU.

*RST: DB4

Example:
```
SOURce1:BB:IQGain DB2
SOURce1:IQGain DB2
```

Manual operation: See "Baseband Gain" on page 301

[:SOURce<hw>]:IQ:CREStfactor <CrestFactor>

Specifies the crest factor for the external analog signal.

Parameters:
<CrestFactor> float

Range: 0 to 35
Increment: 0.01
*RST: 0
Default unit: dB

Example:
```
IQ:CRES 10
```
specifies 10 dB crest factor for the external analog signal.

Manual operation: See "Crest Factor" on page 301

[:SOURce<hw>]:IQ:SWAP[:STATe] <State>

Swaps the I and Q channel.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example: `IQ:SWAP ON`
swaps the I and Q channel.

Manual operation: See "I/Q Swap" on page 300

[:SOURce<hw>]:IQ:WBSTate <WbState>

Activates I/Q wideband mode.

Activation automatically optimizes the settings for wideband modulation signals with a bandwidth that is higher then 5 MHz.

Parameters:

<WbState> 1 | ON | 0 | OFF
*RST:
`*RST: 0` (R&S SMM-K524) / `1` (R&S SMM-K525)

Example: `:SOURce1:IQ:WBST 1`
Activates I/Q wideband mode.

Manual operation: See "I/Q Wideband" on page 300

13.17.11 SOURce:IQ:OUTPut subsystem

The `SOURce:IQ:OUTPut` subsystem contains the commands for configuring I/Q output signals.

Required options

See the following sections:

- Section 9.7, "I/Q analog output settings", on page 511

I/Q connectors and interfaces

For information on the analog and digital I/Q connectors and interfaces, see:

Section 9.4.4, "Overview of the input and output signals and interfaces", on page 485

- SOURce:IQ:OUTPut:ANALog commands 985

13.17.11.1 SOURce:IQ:OUTPut:ANALog commands

This section describes the commands of the output of an analog I/Q signal.

Example: Enabling and configuring the analog output

```
SCONfiguration:OUTPut:MAPPing:IQOutput1:STReam1:STATe 1

SOURce1:IQ:OUTPut:ANALog:PRESet
SOURce1:IQ:OUTPut:ANALog:TYPE DIFF
SOURce1:IQ:OUTPut:ANALog:MODE VAR
SOURce1:IQ:OUTPut:LEVel 2
SOURce1:IQ:OUTPut:ANALog:BIAS:COUPling:STATe 1
SOURce1:IQ:OUTPut:ANALog:BIAS:I 1
SOURce1:IQ:OUTPut:ANALog:BIAS:Q?
// 1
SOURce1:IQ:OUTPut:ANALog:OFFSet:I 2
SOURce1:IQ:OUTPut:ANALog:OFFSet:Q 2.5
SOURce1:IQ:OUTPut:ANALog:STATe 1
```

Example: To enable a high precision marker output signal

This example illustrates how to configure and enable the high precision marker signals at the I/Q analog output connectors.

```
// Set an output voltage of 2.5 V for the marker signals for path A.
:SOURce1:IQ:OUTPut:ANALog:HPMarker:VOLTage O2V5
// Delay the I/Q components of the high precision marker signal individually.
:SOURce1:IQ:OUTPut:ANALog:HPMarker:ADELay:I 0.000000000001
:SOURce1:IQ:OUTPut:ANALog:HPMarker:ADELay:Q 0.000000000002
// Delays the I component (marker 1) by 1 ps and the Q component (marker 2) by
// 2 ps.
:SOURce1:IQ:OUTPut:ANALog:HPMarker:STATe 1
```

Commands:

[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe....987
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet....987
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog?....987
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:STORe....987
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:LOAD....988
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:DELete....988
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE....988
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:MODE....988
[:SOURce<hw>]:IQ:OUTPut:LEVel....989
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:COUPling[:STATe]....989
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:I....989
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:Q....989
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:I....990
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:Q....990
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker:ADELay:I....990
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker:ADELay:Q....991
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker:VOLTage....991
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker[:STATe]....991

[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe <State>

Activates the specified analog I/Q output.

Note: Interdependencies

The following functions cannot be activated simultaneously. **They deactivate each other**.

- The internal baseband generator (`[:SOURce<hw>]:BB:<DigStd>:STATe`) and the external digital baseband input (`[:SOURce<hw>]:BBIN:STATe`)

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: `SOURce:IQ:OUTPut:ANALog:STATe ON`
Activates the output of the analog I/Q signal on the [I/Q Out 1] connectors.

Manual operation: See "State" on page 513

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet

Sets the default settings (`*RST` values specified for the commands).

Not affected are:

- The state set with the command `[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe`.
- If `SCONfiguration:EXTernal:PBEHaviour 1`, the I/Q ouptput type set with the command `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE`.

Example: See Example "Enabling and configuring the analog output" on page 986.

Usage: Event

Manual operation: See "Set To Default" on page 514

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog?

Queries the files with I/Q output settings in the default directory. Listed are files with the file extension `*.iqout`.

Return values:

<Catalog> string

Usage: Query only

Manual operation: See "Save/Recall" on page 514

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:STORe <Filename>

Stores the current settings into the selected file; the file extension (`*.iqout`) is assigned automatically.

Setting parameters:
<Filename> "<filename>"
Filename or complete file path

Usage: Setting only

Manual operation: See "Save/Recall" on page 514

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.iqout`.

Setting parameters:
<Filename> "<filename>"
Filename or complete file path

Usage: Setting only

Manual operation: See "Save/Recall" on page 514

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:DELete <Filename>

Deletes the selected file from the default or specified directory. Deleted are files with the file extension `*.iqout`.

Setting parameters:
<Filename> "<filename>"
Filename or complete file path

Usage: Setting only

Manual operation: See "Save/Recall" on page 514

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE <Type>

Sets the type of the analog signal.

Example: `SOURce1:IQ:OUTPut:ANALog:TYPE DIFFerential`

Options: DIFFerential requires R&S SMM-K17

Manual operation: See "I/Q Output Type" on page 515

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:MODE <Mode>

Determines the mode for setting the output parameters.

Parameters:
<Mode> FIXed | VARiable

FIXed
Locks the I/Q output settings

VARiable
Unlocks the settings
*RST: FIXed

Example: See Example "Enabling and configuring the analog output" on page 986.

Manual operation: See "Mode" on page 516

[:SOURce<hw>]:IQ:OUTPut:LEVel <Level>

Sets the voltage V_p (EMF) of the analog I/Q output signal.

The value range depends on instrument settings, for example the analog I/Q output signal type or the signal bandwidth.

For more information, refer to the specifications document.

To keep the I/Q analog output power levels below the maximum input power level at your DUT, see "Maximum overall output voltage" on page 490.

Parameters:
<Level> float
Range: depends on settings
Increment: 1E-4
*RST: 1 V
Default unit: V

Example: See Example "Enabling and configuring the analog output" on page 986.

Manual operation: See "I/Q Level Vp (EMF)" on page 516

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:COUPling[:STATe] <State>

Couples the bias setting of the I and Q signal components.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Enabling and configuring the analog output" on page 986.

Manual operation: See "Couple I/Q Bias" on page 516

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:I <I>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:Q <Q>

Sets the amplifier bias V_{bias} of the I component or Q component.

To keep the I/Q analog output power levels below the maximum input power level at your DUT, see "Maximum overall output voltage" on page 490.

For more information, refer to the specifications document.

Parameters:

<Q> float

Range: -0.2 V to 2.5 V
Increment: 1E-4
*RST: 0
Default unit: V

Example: See Example "Enabling and configuring the analog output" on page 986.

Manual operation: See "Bias (EMF)" on page 516

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:I <I>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:Q <Q>

Sets an offset V_{offset} between the inverting and non-inverting input of the differential analog I/Q output signal.

To keep the I/Q analog output power levels below the maximum input power level at your DUT, see "Maximum overall output voltage" on page 490.

For more information, refer to the specifications document.

Parameters:

<Q> float

Range: -2 V to 2 V
Increment: 1E-4
*RST: 0
Default unit: V

Example: See Example "Enabling and configuring the analog output" on page 986.

Manual operation: See "Offset (EMF)" on page 517

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker:ADELay:I <AdditionalDelay>

Sets an additional delay for I component (marker 1) of the high precision marker signal.

Parameters:

<AdditionalDelay> float

Range: 0 to 10E-6
Increment: 1E-12
*RST: 0

Example: See Example "To enable a high precision marker output signal" on page 986.

Manual operation: See "Additional Delay" on page 515

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker:ADELay:Q <AdditionalDelay>

Sets an additional delay for Q component (marker 2) of the high precision marker signal.

Parameters:

<AdditionalDelay> float

Range: 0 to 10E-6
Increment: 1E-12
*RST: 0

Example: See Example "To enable a high precision marker output signal" on page 986.

Manual operation: See "Additional Delay" on page 515

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker:VOLTage <OutputVoltage>

Sets the level of the high precision marker signals at the analog I/Q output connectors.

Applying this level requires enabling the high precision marker signals:

```
:SOURce1:IQ:OUTPut:ANALog:HPMarker:STATe 1
```

Parameters:

<OutputVoltage> O1V2 | O1V5 | O1V8 | O2V5

*RST: O1V8

Example: See Example "To enable a high precision marker output signal" on page 986.

Manual operation: See "Output Voltage (EMF)" on page 515

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:HPMarker[:STATe] <State>

Enables the output of high precision marker signals at the analog I/Q output connectors "I/Q".

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "To enable a high precision marker output signal" on page 986.

Manual operation: See "High Precision Marker" on page 515

13.17.12 SOURce:LFOutput subsystem

The `SOURce:LFOutput` subsystem contains the commands for setting the LF signal source in CW and Sweep mode and for analog modulation.

Example: Setting up an LF sweep

The following example shows a command sequence to set up an LF sweep.

```
// Reset the instrument to start from an initial state
*RST; *CLS

// Set the trigger mode, the sweep mode and the sweep range
TRIGger1:LFFSweep:SOURce SINGle
SOURce1:LFOutput1:SWEep:FREQuency:MODE AUTO
SOURce1:LFOutput1:FREQuency:STARt 1 kHz
SOURce1:LFOutput1:FREQuency:STOP 7 kHz

// Select linear spacing
// Select the waveform shape for the frequency sweep cycle
// Set the step width and the dwell time.
SOURce1:LFOutput1:SWEep:FREQuency:SPACing LINear
SOURce1:LFOutput1:SWEep:FREQuency:SHAPe SAWtooth
SOURce1:LFOutput1:SWEep:FREQuency:STEP:LINear 100 Hz
SOURce1:LFOutput1:SWEep:FREQuency:DWELl 150 ms
// Alternatively to the step width set the number of steps
SOURce1:LFOutput1:SWEep:FREQuency:POINts 61

// Activate change to start frequency while waiting for next trigger
// Prerequisites: sweep mode single and sweep waveform sawtooth
SOURce1:LFOutput:SWEep:FREQuency:RETRace 1

// Activate the LF frequency sweep
SOURce1:LFOutput:FREQuency:MODE SWE

// Trigger the sweep(depending on the set mode) and query the status
// Perform a one-off LF sweep
SOURce1:LFOutput1:SWEep:FREQuency:EXECute
SOURce1:LFOutput1:SWEep:FREQuency:RUNNing?
// 1
// the sweep is running

// ************************************************
// For manual step LF sweep use the following commands
*RST; *CLS
SOURce1:LFOutput:SWEep:FREQuency:MODE MANual
// Activate the LF frequency sweep
SOURce1:LFOutput:FREQuency:MODE SWEep
// Activate LF Output1.
SOURce1:LFOutput1:STATe 1
// Input the frequency manually for each step
SOURce1:LFOutput1:FREQuency:MANual 2 kHz
SOURce1:LFOutput1:FREQuency:MANual 2.1 kHz
// Alternatively use UP or DOWN parameter with set step width.
SOURce1:LFOutput1:SWEep:FREQuency:STEP:LINear 60000 Hz
```

```
// SOURce1:LFOutput1:SWEep:FREQuency:STEP:LOGarithmic 10 PCT
SOURce1:LFOutput1:FREQuency:MANual UP
```

Example: Configuring the LF generator

The following is a simple example on how to configure the LF generator and output the generated signal.

```
// configure the signal of the LF1 generator
SOURce1:LFOutput1:SHAPe SQU
SOURce1:LFOutput1:SHAPe:PULSe:PERiod 0.001
SOURce1:LFOutput1:SHAPe:PULSe:WIDTh 0.0005
SOURce1:LFOutput1:SHAPe:PULSe:DCYCle 0.5
// configure the signal of the LF1 generator
SOURce1:LFOutput2:SHAPe SINE
SOURce1:LFOutput2:FREQuency 1000000
SOURce1:LFOutput2:PERiod?
// 0.000001

// changing the LF signal shape
// SOURce1:LFOutput2:SHAPe TRAP
// SOURce1:LFOutput2:SHAPe:PULSe:PERiod 0.2
// SOURce1:LFOutput2:SHAPe:TRAPeze:RISE 0.0001
// SOURce1:LFOutput2:SHAPe:TRAPeze:FALL 0.001
// SOURce1:LFOutput2:SHAPe:TRAPeze:FALL 0.0001
// SOURce1:LFOutput2:SHAPe:TRAPeze:HIGH 0.0005
// SOURce1:LFOutput2:SHAPe TRI
// SOURce1:LFOutput2:SHAPe:PULSe:PERiod 0.1
// SOURce1:LFOutput2:SHAPe:TRIangle:RISE 0.0001

// activate the LF output and select the LF1 as signal source
// configure the LF output signal
SOURce1:LFOutput1:FREQuency:MODE CW
SOURce1:LFOutput1:STATe 1
SOURce1:LFOutput1:SOURce LF1
SOURce1:LFOutput1:VOLTage 1
SOURce1:LFOutput1:OFFSet 0.001
```


- LF generator settings 993
- LF sweep settings 1000

13.17.12.1 LF generator settings

With the commands described in this section, you can configure the LF signal source.

[:SOURce]:LFOutput<ch>:BANDwidth? 994
[:SOURce<hw>]:LFOutput<ch>:FREQuency 994
[:SOURce<hw>]:LFOutput<ch>:PERiod? 995
[:SOURce<hw>]:LFOutput:FREQuency:MANual 995
[:SOURce<hw>]:LFOutput:FREQuency:MODE 995
[:SOURce<hw>]:LFOutput:FREQuency:STOP 996

[:SOURce<hw>]:LFOutput:FREQuency:STARt....996
[:SOURce]:LFOutput<ch>[:STATe]....996
[:SOURce]:LFOutput<ch>:OFFSet....996
[:SOURce]:LFOutput<ch>:SOURce....997
[:SOURce]:LFOutput<ch>:SOURce:PATH....997
[:SOURce]:LFOutput<ch>:VOLTage....997
[:SOURce<hw>]:LFOutput<ch>:SHAPe....997
[:SOURce<hw>]:LFOutput<ch>:SHAPe:PULSe:DCYCle....998
[:SOURce<hw>]:LFOutput<ch>:SHAPe:PULSe:PERiod....998
[:SOURce<hw>]:LFOutput<ch>:SHAPe:PULSe:WIDTh....998
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:FALL....998
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:HIGH....999
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:PERiod....999
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:RISE....999
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRIangle:PERiod....1000
[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRIangle:RISE....1000

[:SOURce]:LFOutput<ch>:BANDwidth?

Queries the bandwidth of the external LF signal.

Return values:

<Bandwidth> BW0M2 | BW10m

*RST: BW10m

Example:

```
LFO:BAND?
// BW10m
// the bandwidth of the externally supplied LF signal is 10 MHz
```

Usage: Query only

Manual operation: See "Bandwidth" on page 393

[:SOURce<hw>]:LFOutput<ch>:FREQuency <Frequency>

Sets the frequency of the LF signal in `[:SOURce<hw>]:LFOutput:FREQuency:MODE CW|FIXed` mode.

Note:

- If the LF generator is used as a signal source, the instrument performs the analog modulations (AM/FM/ΦM/PM) with this frequency.
- In sweep mode (`[:SOURce<hw>]:LFOutput:FREQuency:MODE SWE`), the frequency is coupled with the sweep frequency.

Parameters:

<Frequency> float

Range: 0.1 to depends on options (R&S SMM-K24)
Increment: 0.01
*RST: 1000
Default unit: Hz

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Frequency" on page 391

[:SOURce<hw>]:LFOutput<ch>:PERiod?

Queries the repetition frequency of the sine signal.

Return values:

<LfSinePeriod> float

Range: 1E-6 to 100
Increment: 10E-9
*RST: 0.001
Default unit: s

Example: See Example "Configuring the LF generator" on page 993.

Usage: Query only

[:SOURce<hw>]:LFOutput:FREQuency:MANual <Manual>

Sets the frequency of the subsequent sweep step if `LFO:SWE:MODE MAN`.

Use a separate command for each sweep step.

Parameters:

<Manual> float

You can select any value within the setting range, where:
`STARt` is set with `[:SOURce<hw>]:LFOutput:FREQuency:STARt`
`STOP` is set with `[:SOURce<hw>]:LFOutput:FREQuency:STOP`

Range: STARt to STOP
Increment: 0.1
*RST: 1000

Example: See Example "Setting up an LF sweep" on page 992.

Manual operation: See "Current Frequency" on page 353

[:SOURce<hw>]:LFOutput:FREQuency:MODE <Mode>

Sets the mode for the output of the LF generator frequency, and determines the commands to be used for frequency settings.

Parameters:

<Mode> CW | FIXed | SWEep

CW|FIXed
Sets the fixed-frequency mode. `CW` and `FIXed` are synonyms.

SWEep
Sets sweep mode.
To set the frequency, use the commands:
`[:SOURce<hw>]:LFOutput:FREQuency:STARt` and `[:SOURce<hw>]:LFOutput:FREQuency:STOP`
Or `[:SOURce<hw>]:LFOutput:FREQuency:MANual`
*RST: CW

Example: See Example "Setting up an LF sweep" on page 992.

Manual operation: See "State (LF frequency sweep)" on page 352

[:SOURce<hw>]:LFOutput:FREQuency:STOP <Stop>
[:SOURce<hw>]:LFOutput:FREQuency:STARt <Start>

Sets the start/stop frequency for `[:SOURce<hw>]:LFOutput:FREQuency:MODE SWEep`.

Parameters:
<Start> float
Range: 0.1 Hz to 1 MHz
Increment: 0.1
*RST: 1 KHz

Example: See Example "Setting up an LF sweep" on page 992.

Manual operation: See "Start Frequency/Stop Frequency" on page 356

[:SOURce]:LFOutput<ch>[:STATe] <State>

Activates LF signal output.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "State" on page 395

[:SOURce]:LFOutput<ch>:OFFSet <Offset>

Sets a DC offset at the selected LF Output.

Parameters:
<Offset> float
Range: -3.6 to 3.6
Increment: 2E-3
*RST: 0
Default unit: V

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "DC-Offset" on page 395

[:SOURce]:LFOutput<ch>:SOURce <Source>

Determines the LF signal to be synchronized, when monitoring is enabled.

Parameters:
<Source> LF1 | LF2 | NOISe | AM | FMPM | EXT1
*RST: LF1

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Source" on page 395

[:SOURce]:LFOutput<ch>:SOURce:PATH <SourPath>

Determines the path of the LF output source.

Parameters:
<SourPath> A | B
*RST: A

Example: `LFO:SOUR:PATH?`
Queries the currently set path for the LF output signal source.

[:SOURce]:LFOutput<ch>:VOLTage <Voltage>

Sets the output voltage of the selected LF output.

You can use this parameter when you have two LF generators activated.

Parameters:
<Voltage> float
Range: dynamic (see data sheet)
Increment: 0.001
*RST: 1
Default unit: V

Example: `SOURce:LFOutput1:VOLTage 1.5`

Manual operation: See "Output Voltage" on page 395

[:SOURce<hw>]:LFOutput<ch>:SHAPe <Shape>

Selects the waveform shape of the LF signal.

Parameters:
<Shape> SINE | SQUare | PULSe | TRIangle | TRAPeze
*RST: SINE

Example: See Example "Configuring the LF generator" on page 993.

Options: R&S SMM-K24

Manual operation: See "Shape" on page 391

[:SOURce<hw>]:LFOutput<ch>:SHAPe:PULSe:DCYCle <DCycle>

Sets the duty cycle for the shape pulse.

Parameters:

<DCycle> float

Range: 1E-6 to 100
Increment: 1E-6
*RST: 50
Default unit: PCT

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Pulse Duty Cycle" on page 391

[:SOURce<hw>]:LFOutput<ch>:SHAPe:PULSe:PERiod <Period>

Sets the period of the generated pulse. The period determines the repetition frequency of the internal signal.

Parameters:

<Period> float

Range: 1E-6 to 100
Increment: 1E-8
*RST: 1E-3

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Period" on page 391

[:SOURce<hw>]:LFOutput<ch>:SHAPe:PULSe:WIDTh <Width>

Sets the pulse width of the generated pulse.

Parameters:

<Width> float

Range: 1E-6 to 100
Increment: 1E-8
*RST: 5E-4

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Pulse Width" on page 391

[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:FALL <Fall>

Selects the fall time for the trapezoid shape of the LF generator.

Parameters:

<Fall> float

Range: 1E-6 to 100
Increment: 10E-9
*RST: 250E-6

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Trapezoid Rise / Fall" on page 392

[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:HIGH <High>

Sets the high time for the trapezoid signal of the LF generator.

Parameters:

<High> float

Range: 1E-6 to 100
Increment: 10E-9
*RST: 250E-6

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Trapezoid High" on page 392

[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:PERiod <Period>

Sets the period of the generated trapezoid shape. The period determines the repetition frequency of the internal signal.

Parameters:

<Period> float

Range: 1E-6 to 100
Increment: 1E-8
*RST: 1E-3

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Period" on page 391

[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRAPeze:RISE <Rise>

Selects the rise time for the trapezoid shape of the LF generator.

Parameters:

<Rise> float

Range: 1E-6 to 100
Increment: 10E-9
*RST: 250E-6

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Trapezoid Rise / Fall" on page 392

[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRIangle:PERiod <Period>

Sets the period of the generated pulse. The period determines the repetition frequency of the internal signal.

Parameters:

<Period> float

Range: 1E-6 to 100
Increment: 10E-9
*RST: 0.001

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Period" on page 391

[:SOURce<hw>]:LFOutput<ch>:SHAPe:TRIangle:RISE <Rise>

Selects the rise time for the triangle single of the LF generator.

Parameters:

<Rise> float

Range: 1E-6 to 100
Increment: 10E-9
*RST: 0.5E-3

Example: See Example "Configuring the LF generator" on page 993.

Manual operation: See "Triangle Rise" on page 392

13.17.12.2 LF sweep settings

With the commands described in this section, you can configure the sweep of the LF signal.

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:DWELl 1000
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:EXECute 1001
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:MODE 1001
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:POINts 1002
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:RETRace 1002
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:RUNNing? 1002
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:SHAPe 1002
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:SPACing 1003
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP:LOGarithmic 1003
[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP[:LINear] 1003

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:DWELl <Dwell>

Sets the dwell time for each frequency step of the sweep.

Parameters:

<Dwell> float

Range: 0.001 to 100
Increment: 100E-6
*RST: 0.01
Default unit: s

Example: See Example "Setting up an LF sweep" on page 992.

Manual operation: See "Dwell Time" on page 354

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:EXECute

Immediately starts an LF sweep.

`[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:MODE` determines which sweep is executed, e.g. `SOURce:LFOutput:SWEep:FREQuency:MODE STEP`.

Example: See Example "Setting up an LF sweep" on page 992.

Usage: Event

Manual operation: See "Execute Single Sweep" on page 355

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:MODE <Mode>

Sets the cycle mode of the LF sweep.

Parameters:

<Mode> AUTO | MANual | STEP

AUTO
Performs a complete sweep cycle from the start to the end value when a trigger event occurs.
The dwell time determines the time period until the signal switches to the next step.

MANual
Performs a single sweep step when a manual trigger event occurs.
The trigger system is not active. To trigger each frequency step of the sweep individually, use the command `[:SOURce<hw>]:LFOutput:FREQuency:MANual` on page 995.

STEP
Each trigger command triggers one sweep step only.
The frequency increases by the value set with the coammnds:
`[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP[:LINear]` (linear spacing)
`[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP:LOGarithmic`(logarithmic spacing)

*RST: AUTO

Example: See Example "Setting up an LF sweep" on page 992.

Manual operation: See "Mode" on page 353

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:POINts <Points>

Sets the number of steps in an LF sweep.

For information on how the value is calculated and the interdependency with other parameters, see Section 7.10.2.1, "Correlating parameters in sweep mode", on page 344

Parameters:

<Points> integer

Range: 2 to POINts
*RST: 50

Example: See Example "Setting up an LF sweep" on page 992.

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:RETRace <State>

Activates that the signal changes to the start frequency value while it is waiting for the next trigger event.

You can enable this feature, when you are working with sawtooth shapes in sweep mode "Single" or "External Single".

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Manual operation: See "Retrace" on page 354

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:RUNNing?

Queries the current status of the LF frequency sweep mode.

Return values:

<State> 1 | ON | 0 | OFF

Example: See Example "Setting up an LF sweep" on page 992.

Usage: Query only

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:SHAPe <Shape>

Sets the cycle mode for a sweep sequence (shape).

Parameters:

<Shape> SAWTooth | TRIangle

*RST: SAWTooth

Example: See Example "Setting up an LF sweep" on page 992.

Manual operation: See "Shape" on page 354

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:SPACing <Spacing>

Selects linear or logarithmic sweep spacing.

Parameters:

<Spacing> LINear | LOGarithmic

*RST: LINear

Example: See Example "Setting up an LF sweep" on page 992.

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP:LOGarithmic <Logarithmic>

Sets the step width factor for logarithmic sweeps to calculate the frequencies of the steps.

For information on how the value is calculated and the interdependency with other parameters, see Section 7.10.2.1, "Correlating parameters in sweep mode", on page 344

Parameters:

<Logarithmic> float

The unit is mandatory

Range: 0.01 to 100
Increment: 0.01
*RST: 1
Default unit: PCT

Example: See Example "Setting up an LF sweep" on page 992.

Manual operation: See "Step Linear/Step Logarithmic" on page 357

[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP[:LINear] <Linear>

Sets the step width for the linear sweep.

For information on how the value is calculated and the interdependency with other parameters, see Section 7.10.2.1, "Correlating parameters in sweep mode", on page 344

Parameters:

<Linear> float

Range: 0.1 to STOP-STARt
Increment: 0.1
*RST: 1000

Example: See Example "Setting up an LF sweep" on page 992.

Manual operation: See "Step Linear/Step Logarithmic" on page 357

13.17.13 SOURce:LIST subsystem

The `SOURce:LIST` subsystem contains all commands for defining lists and for handling of list files.

List files have the predefined file extension `*.lsw`.

Refer to Section 13.6.2, "Handling files in the default or in a specified directory", on page 721 for general information on file handling in the default and in a specific directory.

- `*RST` does not affect data lists.
- SCPI refers to the individual lists as segments.

Example: Create an RF list and activate the list mode

The following example shows a command sequence to create an RF list and to activate the list mode. Further hardware settings are not considered.

```
// Reset the instrument to start from an initial state
// Query the available list files in the default
// directory /var/user
// Select the list file or create it (if not existing)
*RST; *CLS
:SOURce1:LIST:CAT?
// Response:- shows the name of available list files (if applicable)
:SOURce1:LIST:SEL "/var/user/list1.lsw"

// Write the frequency/level/dwell time values in the selected list file
// existing data is overwritten
// Query the number of frequency/power/dwell time entries in the selected list
// Query the amount of free memory (in bytes) for list mode lists
:SOURce1:LIST:FREQ 58 MHz, 61 MHz, 73 MHz, 86 MHz, 91 MHz, 92 MHz, 98 MHz
:SOURce1:LIST:POW 13 dBm, 12 dBm, 5 dBm, 3 dBm, 0 dBm, 4 dBm, 6 dBm
:SOURce1:LIST:DWEL:LIST 10000, 100000, 200000, 19000, 10000, 150000, 220000
:SOURce1:LIST:FREQ:POIN?
// 7
:SOURce1:LIST:POW:POINT?
// 7
:SOURce1:LIST:DWEL:LIST:POIN?
// 7
:SOURce1:LIST:FREE?
// 2147483647 (bytes of free memory)

// Use dwell times from list
// Configure the list mode parameters
// Enable RF output
:SOURce1:LIST:MODE AUTO
:SOURce1:LIST:TRIG:SOUR AUTO
:SOURce1:LIST:DWEL:MODE "LIST"
```

```
:OUTPut1:STAT ON

// Use global dwell time
// Set only a part of the list (value pairs 3 to 5) to be processed
// Configure the list mode parameters using global dwell time
// Enable RF output
:SOURce1:LIST:IND:START 2
:SOURce1:LIST:IND:STOP 4
:SOURce1:LIST:MODE AUTO
:SOURce1:LIST:TRIG:SOUR AUTO
:SOURce1:LIST:DWEL:LIST 500 ms
:OUTPut1:STAT ON

// Enable the list mode
// Trigger the list (depending on the mode, not needed with trigger
// mode AUTO); query the current index
// Reset the list to the starting point
:SOURce1:FREQ:MODE LIST
:SOURce1:LIST:TRIG:EXEC
:SOURce1:LIST:RUNN?
:SOURce1:LIST:IND?
// 3
// value changes when the value is queried again
:SOURce1:LIST:RES

// For list mode STEP use the following commands
*RST; *CLS
// Change list mode to STEP
:SOURce1:LIST:MODE STEP
// Activate RF Output1
:OUTPut1:STAT 1
// Activate the list mode
:SOURce1:FREQ:MODE LIST
// For each step: select frequency/powerlevel pair as index from the list
:SOURce1:LIST:IND 2
:SOURce1:LIST:IND 3
:SOURce1:LIST:IND 4

// Use the selected list for path B (with List Mode B default settings)
:SOURce2:LIST:SEL "/var/user/list1.lsw"
:OUTPut2:STAT ON
:SOURce2:FREQ:MODE LIST
:SOURce2:LIST:IND?
// 2
// value canges when the value is queried again

// Deactivate the list mode
:SOURce1:FREQ:MODE CW
```

Example: List mode data exchange

The following example shows a command sequence to export a list (here the RF list created with the example before) into an ASCII file. Further hardware settings are not considered.

```
*RST; *CLS
LIST:DEXC:MODE EXP

// Set ASCII data parameters
// Set the ASCII file extension, the decimal separator
// and the column separator for the ASCII data
:SOURce1:LIST:DEXC:AFIL:EXT CSV
:SOURce1:LIST:DEXC:AFIL:SEP:DEC DOT
:SOURce1:LIST:DEXC:AFIL:SEP:COL COMM

// Select source and destination path/directory
// Query available listfiles in default directory "/var/user"
:SOURce1:LIST:CAT?
// list1
:SOURce1:LIST:DEXC:AFIL:SEL "/var/user/list1ASCII"
:SOURce1:LIST:DEXC:SEL "/var/user/list1"

// Export the list file data into the ASCII file
:SOURce1:LIST:DEXC:EXEC

// Query the available ASCII files with extension .csv
:SOURce1:LIST:DEXC:AFIL:CAT?
// Response: "list1ASCII"

// Deactivate the list mode
:SOURce1:FREQ:MODE CW
```


- List mode settings 1006
- List mode file operation 1012
- List mode data exchange 1015

13.17.13.1 List mode settings

With the following commands, you can create list mode data, select the trigger mode and determine the dwell time.

[:SOURce<hw>]:LIST:DWELl 1007
[:SOURce<hw>]:LIST:DWELl:MODE 1007
[:SOURce<hw>]:LIST:DWELl:LIST 1007
[:SOURce<hw>]:LIST:DWELl:LIST:POINts? 1008
[:SOURce<hw>]:LIST:FREQuency 1008
[:SOURce<hw>]:LIST:FREQuency:POINts? 1008
[:SOURce<hw>]:LIST:INDex 1009
[:SOURce<hw>]:LIST:INDex:STARt 1009
[:SOURce<hw>]:LIST:INDex:STOP 1009

[:SOURce<hw>]:LIST:RMODe....1009
[:SOURce<hw>]:LIST:LEARn....1010
[:SOURce<hw>]:LIST:MODE....1010
[:SOURce<hw>]:LIST:POWer....1011
[:SOURce<hw>]:LIST:POWer:POINts?....1011
[:SOURce<hw>]:LIST:TRIGger:EXECute....1011
[:SOURce<hw>]:LIST:TRIGger:SOURce....1011
[:SOURce<hw>]:LIST:RUNNing?....1012

[:SOURce<hw>]:LIST:DWELl <Dwell>

Sets the global dwell time. The instrument generates the signal with the frequency / power value pairs of each list entry for that particular period.

See also Significant parameters and functions.

Parameters:

<Dwell> float

Range: 0.5E-3 to 100
Increment: 1E-6
*RST: 0.01

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "Global Dwell Time" on page 362

[:SOURce<hw>]:LIST:DWELl:MODE <DwelMode>

Selects the dwell time mode.

Parameters:

<DwelMode> LIST | GLOBal

LIST
Uses the dwell time, specified in the data table for each value pair individually.

GLOBal
Uses a constant dwell time, set with command `[:SOURce<hw>]:LIST:DWELl`.

*RST: GLOBal

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "Dwell Time Mode" on page 362

[:SOURce<hw>]:LIST:DWELl:LIST <Dwell>

Enters the dwell time values in the selected list in µs.

Parameters:

<Dwell> <Dwell#1>{, <Dwell#2>, ...} | block data

You can either enter the data as a list of numbers, or as binary block data. The list of numbers can be of any length, with the list entries separated by commas.
In binary block format, 8 (4) bytes are always interpreted as a floating-point number with double accuracy. See also `:FORMat[:DATA]` on page 754 for more details.

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "Dwell Time (s)" on page 367

[:SOURce<hw>]:LIST:DWELI:LIST:POINts?

Queries the number (points) of dwell time entries in the selected list.

Return values:

<Points> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Usage: Query only

[:SOURce<hw>]:LIST:FREQuency <Frequency>

Enters the frequency values in the selected list.

Parameters:

<Frequency> <Frequency#1>{, <Frequency#2>, ...} | block data

You can either enter the data as a list of numbers, or as binary block data.
The list of numbers can be of any length, with the list entries separated by commas.
In binary block format, 8 (4) bytes are always interpreted as a floating-point number with double accuracy.
See also `:FORMat[:DATA]`.

Range: 300 kHz to RFmax (depends on options)

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "Frequency (Hz)" on page 367

[:SOURce<hw>]:LIST:FREQuency:POINts?

Queries the number (points) of frequency entries in the seleced list.

Return values:
<Points> integer
Range: 0 to INT_MAX
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Usage: Query only

[:SOURce<hw>]:LIST:INDex <Index>

Sets the list index in `LIST:MODE STEP`.

After the trigger signal, the instrument processes the frequency and level settings of the selected index.

Parameters:
<Index> integer
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "Current Index" on page 361

[:SOURce<hw>]:LIST:INDex:STARt <Start>
[:SOURce<hw>]:LIST:INDex:STOP <Stop>

Sets the start and stop index of the index range which defines a subgroup of frequency/level value pairs in the current list.

Parameters:
<Stop> integer
Index range
Only values inside this range are processed in list mode
Range: 0 to list length
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "List Range from/to" on page 364

[:SOURce<hw>]:LIST:RMODe <RMode>

Selects the run mode for processing the list.

Parameters:
<RMode> LEARned | LIVE

LEARned
Generates the signal by replaying the previously learned and saved data from the temporary memory.

LIVE
Generates the signal by processing the list directly.

*RST: LIVE

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "Run Mode" on page 362

[:SOURce<hw>]:LIST:LEARn

Learns the selected list to determine the hardware setting for all list entries. The results are saved with the list.

See also "Learn List Mode Data list processing mode" on page 350.

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Usage: Event

Manual operation: See "Learn List Mode Data" on page 362

[:SOURce<hw>]:LIST:MODE <Mode>

Sets the list mode.

The instrument processes the list according to the selected mode and trigger source. See `LIST:TRIG:SOUR AUTO, SING or EXT` for the description of the trigger source settings.

Parameters:

<Mode> AUTO | STEP

AUTO
Each trigger event triggers a complete list cycle.

STEP
Each trigger event triggers only one step in the list processing cycle. The list is processed in ascending order.

*RST: AUTO

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "Mode" on page 361

[:SOURce<hw>]:LIST:POWer <Power>

Enters the level values in the selected list. The number of level values must correspond to the number of frequency values. Existing data is overwritten.

Parameters:

<Power> <Power#1>{, <Power#2>, ...} | block data

You can either enter the data as a list of numbers, or as binary block data.
The list of numbers can be of any length, with the list entries separated by commas.
In binary block format, 8 (4) bytes are always interpreted as a floating-point number with double accuracy.
See also `:FORMat[:DATA]`.

Range: depends on options
Default unit: dBm

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "Power (dBm)" on page 367

[:SOURce<hw>]:LIST:POWer:POINts?

Queries the number (points) of level entries in the selected list.

Return values:

<Points> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Usage: Query only

[:SOURce<hw>]:LIST:TRIGger:EXECute

Starts the processing of a list in list mode.

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Usage: Event

Manual operation: See "Execute Single" on page 363

[:SOURce<hw>]:LIST:TRIGger:SOURce <Source>

Selects the trigger source for processing lists.

The designation of the parameters correspond to those in sweep mode. SCPI standard uses other designations for the parameters, which are also accepted by the instrument. The SCPI designation should be used if compatibility is an important consideration. For an overview, see the following table:

Rohde & Schwarz parameter	SCPI parameter	Applies to the list mode parameters:
AUTO	IMMediate	[:SOURce<hw>]:LIST:MODE AUTO
SINGle	BUS	[:SOURce<hw>]:LIST:MODE AUTO or [:SOURce<hw>]:LIST:MODE STEP
EXTernal	EXTernal	[:SOURce<hw>]:LIST:MODE AUTO or [:SOURce<hw>]:LIST:MODE STEP

Parameters:

<Source> AUTO | IMMediate | SINGle | BUS | EXTernal

AUTO|IMMediate
The trigger is free-running, i.e. the trigger condition is fulfilled continuously. The selected list is restarted as soon as it is finished.

SINGle|BUS
The list is triggered by the command [:SOURce<hw>]:LIST:TRIGger:EXECute. The list is executed once.

EXTernal
The list is triggered externally and executed once.

*RST: AUTO

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "Mode" on page 361

[:SOURce<hw>]:LIST:RUNNing?

Queries the current state of the list mode.

Return values:

<State> 1 | ON | 0 | OFF

1
Signal generation based on the list mode is active.

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Usage: Query only

13.17.13.2 List mode file operation

The following section covers basic commands to file handling in list mode.

[:SOURce<hw>]:LIST:CATalog? 1013
[:SOURce<hw>]:LIST:DELete 1013
[:SOURce<hw>]:LIST:DELete:ALL 1013
[:SOURce<hw>]:LIST:FREE? 1014
[:SOURce<hw>]:LIST:RESet 1014
[:SOURce<hw>]:LIST:SELect 1014

[:SOURce<hw>]:LIST:CATalog?

Queries the available list files in the specified directory.

Return values:

<Catalog> string

List of list filenames, separated by commas

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Usage: Query only

Manual operation: See "List Mode Data" on page 364

[:SOURce<hw>]:LIST:DELete <Filename>

Deletes the specified list.

Setting parameters:

<Filename> string

Filename or complete file path; file extension is optional.

Example: See `[:SOURce<hw>]:LIST:DELete:ALL` on page 1013.

Usage: Setting only

Manual operation: See "List Mode Data" on page 364

[:SOURce<hw>]:LIST:DELete:ALL

Deletes all lists in the set directory.

This command can only be executed, if:

- No list file is selected.
- List mode is disabled.

Example:

```
SOUR1:LIST:CAT?
// list,my_list
SOUR1:LIST:DEL "/var/user/list1"
SOUR1:LIST:CAT?
// my_list
SOUR1:FREQ:MODE?
// LIST
SOUR1:LIST:SEL?
// /var/user/my_list.lsw
//deactivate list mode
SOUR1:FREQ:MODE CW
SOUR1:LIST:DELete:ALL
SOUR1:LIST:CAT?
// -
// all list files are deleted
```

Usage: Event

Manual operation: See "List Mode Data" on page 364

[:SOURce<hw>]:LIST:FREE?

Queries the amount of free memory (in bytes) for list mode lists.

Return values:

<Free> integer

Range: 0 to INT_MAX
*RST: 0

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Usage: Query only

[:SOURce<hw>]:LIST:RESet

Jumps to the beginning of the list.

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Usage: Event

Manual operation: See "Reset" on page 363

[:SOURce<hw>]:LIST:SELect <Filename>

Selects or creates a data list in list mode.

If the list with the selected name does not exist, a new list is created.

Parameters:

<Filename> string

Filename or complete file path; file extension can be omitted.

Example: See Example "Create an RF list and activate the list mode" on page 1004.

Manual operation: See "List Mode Data" on page 364

13.17.13.3 List mode data exchange

With the following commands, you can configure lists in ASCII format and export or import them accordingly.

[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog? 1015
[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension 1015
[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect 1016
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn 1016
[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal 1016
[:SOURce<hw>]:LIST:DEXChange:EXECute 1016
[:SOURce<hw>]:LIST:DEXChange:MODE 1016
[:SOURce<hw>]:LIST:DEXChange:SELect 1017

[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog?

Queries the available ASCII files for export or import of list mode data in the current or specified directory.

Return values:

<Catalog> string

List of ASCII files `*.txt` or `*.csv`, separated by commas.

Example: See Example "List mode data exchange" on page 1006.

Usage: Query only

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 365

[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension <Extension>

Determines the extension of the ASCII file for import or export, or to query existing files.

Parameters:

<Extension> TXT | CSV

*RST: TXT

Example: See Example "List mode data exchange" on page 1006.

Manual operation: See "ASCII File Settings" on page 365

[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect <Filename>

Selects the ASCII file to be imported or exported.

Parameters:
<Filename> string
Filename or complete file path; file extension can be omitted.

Example: See Example "List mode data exchange" on page 1006.

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 365

[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn <Column>

Selects the separator between the frequency and level column of the ASCII table.

Parameters:
<Column> TABulator | SEMicolon | COMMa | SPACe
*RST: COMMa

Example: See Example "List mode data exchange" on page 1006.

Manual operation: See "ASCII File Settings" on page 365

[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal <Decimal>

Sets "." (decimal point) or "," (comma) as the decimal separator used in the ASCII data with floating-point numerals.

Parameters:
<Decimal> DOT | COMMa
*RST: DOT

Example: See Example "List mode data exchange" on page 1006.

Manual operation: See "ASCII File Settings" on page 365

[:SOURce<hw>]:LIST:DEXChange:EXECute

Executes the import or export of the selected list file, according to the previously set transfer direction with command `[:SOURce<hw>]:LIST:DEXChange:MODE`

Example: See Example "List mode data exchange" on page 1006.

Usage: Event

Manual operation: See "Import / Export" on page 366

[:SOURce<hw>]:LIST:DEXChange:MODE <Mode>

Determines the import or export of a list.

Specify the source or destination file with the command `[:SOURce<hw>]:LIST:DEXChange:SELect`.

Parameters:

<Mode> IMPort | EXPort
*RST: IMPort

Example: See Example "List mode data exchange" on page 1006.

Manual operation: See "Mode" on page 365

[:SOURce<hw>]:LIST:DEXChange:SELect <Filename>

Selects the ASCII file for import or export, containing a list.

Parameters:

<Filename> string
Filename or complete file path; file extension can be omitted.

Example: See Example "List mode data exchange" on page 1006.

Manual operation: See "Select Source/Select ASCII Destination" on page 366

13.17.14 SOURce:NOISe subsystem

The `SOURce:NOISe` subsystem contains the commands for:

- Setting the noise modulation signal. The noise generator is optional.

Example: To configure the noise generator

```
:SOURce1:NOISe:DISTribution GAUSs
:SOURce1:NOISe:BANDwidth 10000000

:SOURce1:LFOutput1:SOURce NOIS
:SOURce1:LFOutput1:STATe 1

:SOURce1:NOISe:LEVel:RELative?
// Response in dB: -83.86
:SOURce1:NOISe:LEVel:ABSolute?
// Response in dB: -13.86
```

- Noise generator....1017

13.17.14.1 Noise generator

[:SOURce<hw>]:NOISe:BANDwidth|BWIDth....1018
[:SOURce<hw>]:NOISe:DISTribution....1018
[:SOURce<hw>]:NOISe:LEVel:RELative?....1018
[:SOURce<hw>]:NOISe:LEVel[:ABSolute]?....1018

[:SOURce<hw>]:NOISe:BANDwidth|BWIDth <BWidth>

Sets the noise level in the system bandwidth when bandwidth limitation is enabled.

Parameters:

<BWidth> float

Range: 100E3 to 10E6
Increment: 100E3
*RST: 100E3

Example: See Example "To configure the noise generator" on page 1017.

Manual operation: See "Bandwidth" on page 394

[:SOURce<hw>]:NOISe:DISTribution <Distribution>

Sets the distribution of the noise power density.

Parameters:

<Distribution> GAUSs | EQUal

*RST: GAUSs

Example: See Example "To configure the noise generator" on page 1017.

Manual operation: See "Distribution" on page 393

[:SOURce<hw>]:NOISe:LEVel:RELative?

Queries the level of the noise signal per Hz in the total bandwidth.

Return values:

<Relative> float

Range: -149.18 to -52.67
Increment: 0.1
*RST: -69.84

Example: See Example "To configure the noise generator" on page 1017.

Usage: Query only

Manual operation: See "Noise Density" on page 396

[:SOURce<hw>]:NOISe:LEVel[:ABSolute]?

Queries the level of the noise signal in the system bandwidth within the enabled bandwidth limitation.

Return values:

<Absolute> float

Noise level within the bandwidth limitation

*RST: 3.84 MHz

Example: See Example "To configure the noise generator" on page 1017.

Usage: Query only

Manual operation: See "Noise Level" on page 396

13.17.15 SOURce:OCCupy subsystem

The `SOURce:OCCupy` subsystem contains the commands for selecting licenses and setting the occupation period.

Example: To occupy a license

This example illustrates how to occupy a license for the LTE option R&S SMW-K55. Also, it shows how to configure the occupation period. Occupying licenses for other instruments and their options is analogous.

```
// Query the number of occupied options and the time periods.
:SOURce:OCCupy:OPTion:CATalog?
// Response: "SMW-K55;LTE Release 8;6d, 3h
// SMW-K62;Additive White Gaussian Noise;7d, 23h"

// Query details of occupied licences for option R&S SMW-K55.
:SOURce:OCCupy:OPTion:CATalog? "SMW-K55"
// Response: "SMW-K55;LTE Release 8;6d, 3d"
// Occupy two licenses for two options R&S SMW-K55 for 3 days.
:SOURce:OCCupy:OPTion "SMW-K55",3,2
// Extend the occupation period for the first license to 5 days.
:SOURce:OCCupy:OPTion:RENew1 "SMW-K55",5
```

Commands:

[:SOURce]:OCCupy:OPTion 1019
[:SOURce]:OCCupy:OPTion:CATalog? 1019
[:SOURce]:OCCupy:OPTion:RENew<ch> 1020

[:SOURce]:OCCupy:OPTion

Occupies the selected option.

You can determine the option string, the time period and the number of licenses for the occupancy.

Example: See Example "To occupy a license" on page 1019.

Usage: Event

Manual operation: See "Occupy" on page 592

[:SOURce]:OCCupy:OPTion:CATalog?

Queries the availability of borrowable licenses on all license servers accessible for the R&S SMM100A.

Return values:
<OccLicensesCat> string
Comma-separated list of strings for available options.

Example: See Example "To occupy a license" on page 1019.

Usage: Query only

Manual operation: See "Occupy Licenses" on page 592

[:SOURce]:OCCupy:OPTion:RENew<ch>

Extends the occupation period of the selected license.

Example: See Example "To occupy a license" on page 1019.

Usage: Event

Manual operation: See "Renew" on page 593

13.17.16 SOURce:PGEN subsystem

The PGEN subsystem contains the commands for setting output of the pulse modulation signal.

Example: Using pulse generator as source for pulse modulation

```
// select pulse generator as source for pulse modulation
// enable pulse modulation
SOURce1:PULM:SOURce INT
SOURce1:PULM:STATe 1
// pulse generator and signal output are also activated
SOURce1:PGENerator:STATe?
// 1
SOURce1:PGENerator:OUTPut:STATe?
// 1
PGENerator:OUTPut:POLarity NORMal
// to disable pulse generator
SOURce1:PGENerator:STATe 0
// activate the pulse modulation of the RF carrier
SOURce1:PULM:STATe 1
```

Example: Assigning the pulse input and pulse output signal to the default global user connectors

```
// preset the user connectors 4, 5 and 6
:SOURce<hw>:PGENerator:SET:GLB:CONNectors
```

:SOURce<hw>:PGENerator:SET:GLB:CONNectors....1021
[:SOURce<hw>]:PGENerator:OUTPut:POLarity....1021
[:SOURce<hw>]:PGENerator:OUTPut[:STATe]....1021
[:SOURce<hw>]:PGENerator:STATe....1021

:SOURce<hw>:PGENerator:SET:GLB:CONNectors

Routes the pulse input signal and the pulse output signal to a global connector.

By default, routes the pulse input to "User 4" ("Signal" > "Pulse In") and the pulse output to "User 5" ("Signal" > "Pulse Out").

Example: See Example "Assigning the pulse input and pulse output signal to the default global user connectors" on page 1020.

Usage: Event

Manual operation: See "Set Global Connectors for Pulse Modulation" on page 387

[:SOURce<hw>]:PGENerator:OUTPut:POLarity <Polarity>

Sets the polarity of the pulse output signal.

Parameters:

<Polarity> NORMal | INVerted

NORMal
Outputs the pulse signal during the pulse width, that means during the high state.

INVerted
Inverts the pulse output signal polarity. The pulse output signal is suppressed during the pulse width, but provided during the low state.

*RST: NORMal

Example: See Example "Using pulse generator as source for pulse modulation" on page 1020.

Manual operation: See "Pulse Output Polarity" on page 387

[:SOURce<hw>]:PGENerator:OUTPut[:STATe] <State>

Activates the output of the pulse modulation signal.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Using pulse generator as source for pulse modulation" on page 1020.

Manual operation: See "Pulse Output State" on page 387

[:SOURce<hw>]:PGENerator:STATe <State>

Enables the output of the video/sync signal.

If the pulse generator is the current modulation source, activating the pulse modulation automatically activates the signal output and the pulse generator.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Using pulse generator as source for pulse modulation" on page 1020.

13.17.17 SOURce:PHASe subsystem

This subsystem contains the commands for adjusting the phase of the RF output signal relative to a reference signal of the same frequency.

Example: Programming Example

```
// change the phase relative to the current phase
SOURce1:PHASe 2 DEG
// adopt the setting as the current phase
SOURce1:PHASe:REFerence
```

The following commands are available:

[:SOURce<hw>]:PHASe 1022
[:SOURce<hw>]:PHASe:REFerence 1022

[:SOURce<hw>]:PHASe <Phase>

Sets the phase variation relative to the current phase.

Parameters:
<Phase> float
Range: -720 to 720
Increment: 0.1
*RST: 0
Default unit: DEG

Example: See Example "Programming Example" on page 1022.

Manual operation: See "Delta Phase" on page 320

[:SOURce<hw>]:PHASe:REFerence

Example: See Example "Programming Example" on page 1022.

Usage: Event

Manual operation: See "Reset Delta Phase Display" on page 320

13.17.18 SOURce:POWer subsystem

The `SOURce:POWer` subsystem contains the commands for setting the output level, level control and level correction of the RF signal.

The default units are dBm. To change the units, perform one of the following:

- Enter the unit after the numerical value
  Example: `:POW 0.5V`
- Set the unit with the command `:UNIT:POWer`.

Example: Configuring the RF output power

```
:SOURce1:POWer;CW?
// Response -30
:SOURce1:POWer:CW -25
:SOURce1:POWer:OFFSet?
// Response 0
:SOURce1:POWer:OFFSet 2

:SOURce1:POWer:STEP:MODE?
// Response: DEC
:SOURce1:POWer:STEP:MODE USER
:SOURce1:POWer:STEP:INCRement 2
:SOURce1:POWer:LEVel:IMMediate:AMPLitude UP
```

Example: Configure the settings for NRP power control

The example shows a command sequence to configure a closed loop power control setup.

It is assumed that you have set up the measurement with the amplifier, external coupler, the power sensor and the R&S SMM100A as described in Section 7.12.4.3, "NRP power control", on page 423.

```
// Reset the instrument to start from an initial state
*RST; *CLS

// Select the sensor used for nrp power control
// that is e.g., connected to a second USB interface

:SOURce1:POWer:SPC:SELect SENS2

// Configure the nrp power control settings
// use the measured peak power for power control
// set the unit dBm for the target level value
// set the target level, e.g. - 10 dBmM
// use the measured target level as reference level
// select single measurement mode to acquire one level value
// set the capture range for the control loop, e.g.  +/- 15 dB
// set a time delay between the sensor readings, e.g. 2 ms

:SOURce1:POWer:SPC:PEAK ON
:SENSe1:UNIT:POWer DMB
:SOURce1:POWer:SPC:TARGet -10
:SOURce1:POWer:SPC:MEASure
:SOURce1:POWer:SPC:MODE SINGle
:SOURce1:POWer:SPC:CRANge 15
:SOURce1:POWer:SPC:DELay 2 ms

// Enable NRP power control measurement
// switch on RF output
// start the single measurement manually

:Output1:STATe 1
:SOURce1:POWer:SPC:STATe ON
:SOURce1:POWer:SPC:SINGle

// Query if the power control works properly
:SOURce1:POWer:SPC:WARNing?
// Response: 1 -> power conrol doew not work as expected
```

Example: Configuring the level attenuator settings

```
SOURce1:POWer:ATTenuation 20dB
// set the level attenuation manually

SOURce1:POWer:ATTuation:RFOF:MODE FATTenuation
// set maximum attenuation when the RF output is turned off

SOURce:POWer:ATTenuation:VSWR?
// query the level value of the VSWR output

SOURce1:POWer:AATTenuation?
// query the currently active attenuation
// Response: 100
```

Example: Configuring the attenuator mode at the RF output

```
// Adjust the level settings automatically.
OUTPut1:AMODe AUTO

// Use fixed attenuator and amplifier stages at the current position.
// Requires automatic level control enabled and
// RF OFF mode unchanged (full attenuation disabled)
SOURce1:POWer:ALC:STATe 1
SOURce1:POWer:ATTenuation:RFOF:MODE UNCHanged
OUTPut1:AMODe FIXed

// Query the calculated value range in FIXed mode
OUTPut1:AFIXed:RANGe:UPPer?
// Response: -27
OUTPut1:AFIXed:RANGe:LOWer?
// Response: -50

// Adjust the level manually.
// Requires automatic level control disabled and
// RF OFF mode unchanged (full attenuation disabled)

OUTPut1:AMODe MANual
// Requires protection level 1 unlocked.
// Step width for manual adjustement is 10 dB steps.
```

Example: Setting a digital attenuation

Requires protection level 1 unlocked.

```
// Unlock protection level 1.
SYSTem:PROTect1:STATe 1,<password>

// Set an attenuation for the baseband signal.
SOURce1:POWer:ATTenuation:DIGital 7.2
```

[:SOURce<hw>]:POWer:ALC:MODE? 1027
[:SOURce<hw>]:POWer:ALC[:STATe] 1027
[:SOURce<hw>]:POWer:ALC:DAMPlifier 1028
[:SOURce<hw>]:POWer:ALC:DSENsitivity 1028
[:SOURce<hw>]:POWer:ALC:SONCe 1028
[:SOURce<hw>]:POWer:ALC:SLEVel 1029
[:SOURce<hw>]:POWer:AATTenuation? 1029
[:SOURce<hw>]:POWer:ATTenuation 1029
[:SOURce<hw>]:POWer:ATTenuation:INACtive:INDices 1029
[:SOURce<hw>]:POWer:ATTenuation:DIGital 1030
[:SOURce<hw>]:POWer:ATTenuation:RFOFf:MODE 1030
[:SOURce<hw>]:POWer:EMF:STATe 1030
[:SOURce<hw>]:POWer:LBEHaviour 1031
[:SOURce<hw>]:POWer:LIMit[:AMPLitude] 1031
[:SOURce<hw>]:POWer:LMODe 1031
[:SOURce<hw>]:POWer:MANual 1032
[:SOURce<hw>]:POWer:MODE 1032
[:SOURce<hw>]:POWer:PEP? 1033
[:SOURce<hw>]:POWer:POWer 1033
[:SOURce<hw>]:POWer:STARt 1034
[:SOURce<hw>]:POWer:STOP 1034
[:SOURce<hw>]:POWer:SPC:CRANge 1034
[:SOURce<hw>]:POWer:SPC:DELay 1034
[:SOURce<hw>]:POWer:SPC:MEASure 1035
[:SOURce<hw>]:POWer:SPC:MODE 1035
[:SOURce<hw>]:POWer:SPC:PEAK 1035
[:SOURce<hw>]:POWer:SPC:SELect 1035
[:SOURce<hw>]:POWer:SPC:SINGle 1036
[:SOURce<hw>]:POWer:SPC:STATe 1036
[:SOURce<hw>]:POWer:SPC:TARGet 1036
[:SOURce<hw>]:POWer:SPC:WARNing? 1036
[:SOURce<hw>]:POWer:STEP:MODE 1037
[:SOURce<hw>]:POWer:STEP[:INCRement] 1037
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet 1038
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:RCL 1038
[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude] 1038
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:REFLevel 1039
[:SOURce<hw>]:POWer:RANGe:LOWer? 1039
[:SOURce<hw>]:POWer:RANGe:UPPer? 1039
[:SOURce]:POWer:WIGNore 1040

[:SOURce<hw>]:POWer:ALC:MODE?

Queries the currently set ALC mode.

See [:SOURce<hw>]:POWer:ALC[:STATe] on page 1027.

Return values:

<PowAlcMode> 0 | AUTO | 1 | PRESet | OFFTable | ON | OFF | ONSample | ONTable

Example: POW:ALC:MODE?
Response: ONTable"Table and On" is set automatically.

Usage: Query only

Manual operation: See "Mode" on page 405

[:SOURce<hw>]:POWer:ALC[:STATe] <State>

Activates automatic level control in the selected mode.

How to: See Section 7.12.2.2, "How to enable the ALC", on page 406.

Parameters:

<State> AUTO | OFFTable | ON | ONSample | ONTable | OFF

AUTO
Adjusts the output level to the operating conditions automatically.

OFFTable
Controls the level with the attenuation values of the internal ALC table.

ON
Activates internal level control permanently.

OFF
Deactivates internal level control, "Sample & Hold" mode is active.

ONSample
Starts the internal level control with the first change.

ONTable
Starts with the attenuation setting from the table and continues with automatic level control.

*RST: AUTO
For more details on the individual settings, an overview of the functionality and details on what is to be considered, see "ALC states and their effects" on page 403.

Example: POW:ALC ON
Activates internal level control.

Manual operation: See "State" on page 404

[:SOURce<hw>]:POWer:ALC:DAMPlifier <Amplifier>

Selects the driver amplifier switching state.

Parameters:

<Amplifier> OFF | ON | AUTO | FIX | ONMG

AUTO
Switches the attenuator automatically.

ON|OFF
Switches on or off the driver amplifier.

FIXed
Fixes the last setting.

ONMG
Supplies maximum level at the output.

*RST: AUTO

Example: `POW:ALC:DAMP AUTO`
Provides automatic switching of the attenuator.

Manual operation: See "Driver Amplifier" on page 405

[:SOURce<hw>]:POWer:ALC:DSENsitivity <Sensitivity>

Sets the sensitivity of the ALC detector.

Parameters:

<Sensitivity> AUTO | FIXed

AUTO
Selects the optimum sensitivity automatically.

FIXed
Fixes the internal level detector.

*RST: AUTO

Example: `POW:ALC:DSEN FIX`

Manual operation: See "Detector Sensitivity" on page 405

[:SOURce<hw>]:POWer:ALC:SONCe

Activates level control for correction purposes temporarily.

Example: `POW:ALC OFF`
Deactivates automatic level control at the RF output.
`POW:ALC:SONC`
Executes level control (once).

Usage: Event

Manual operation: See "Readjust" on page 319

[:SOURce<hw>]:POWer:ALC:SLEVel <SampLevel>

Sets the sample level of automatic level control (ALC).

How To: See Section 7.12.2.2, "How to enable the ALC", on page 406.

Parameters:

<SampLevel> FULL | MINimum | ATTenuated
*RST: FULL

Example: `POW:ALC:SLEV MIN`
Sets the maximum attenuation.

Manual operation: See "Sample Level" on page 406

[:SOURce<hw>]:POWer:AATTenuation?

Queries the currently active level attenuation.

Return values:

<ActiveAtt> float
Range: 0 to 110
Increment: 10
*RST: 0

Example:
```
SOURce1:POWer:AATTenuation?
// Response: 100
```

Usage: Query only

Manual operation: See "Attenuation Active" on page 401

[:SOURce<hw>]:POWer:ATTenuation <Attenuation>

Sets the attenuation value of the RF signal in manual mode.

Configure the manual mode via the following command:

`:OUTPut1:AMODe MANual`

Parameters:

<Attenuation> integer
Range: depends on options
Increment: 4|5|6
*RST: 0

Example:
```
:OUTPut1:AMODe MANual
:SOURce1:POWer:ATTenuation 20dB
```

Manual operation: See "Attenuation" on page 401

[:SOURce<hw>]:POWer:ATTenuation:INACtive:INDices <InactiveIndices>

Queries inactive attenuations.

Queries inactive attenuations. The response of the query returns the indices of the attenuations.

Parameters:
<InactiveIndices>

Example: `SOURce1:POWer:ATTenuation:INACtive:INDices?`

[:SOURce<hw>]:POWer:ATTenuation:DIGital <AttDigital>

Sets a relative attenuation value for the baseband signal.

Parameters:
<AttDigital> float

Range: -3.522 to 80
Increment: 1E-3
*RST: 0

Manual operation: See "Digital Attenuation" on page 317

[:SOURce<hw>]:POWer:ATTenuation:RFOFf:MODE <Mode>

Selects the state the attenuator is to assume if the RF signal is switched off.

Parameters:
<Mode> UNCHanged | FATTenuation

FATTenuation
The step attenuator switches to maximum attenuation when RF is off.
Note: This setting overrides the RF level modes : `OUTPut<hw>:AMODeFIXed|MANual`.

UNCHanged
Freezes the current setting to keep the output impedance constant during RF off.

*RST: n.a. (preset & factory preset depends on option)
RFmax ≤12.75 GHz: FATTenuation,
RFmax >12.75 GHz: UNChanged

Example: `SOUR:POW:ATT:RFOF:MODE FATT`
uses maximum attenuation when the RF output is turned off.

Manual operation: See "RF OFF Mode" on page 402

[:SOURce<hw>]:POWer:EMF:STATe <State>

Displays the signal level as voltage of the EMF. The displayed value represents the voltage over a 50 Ohm load.

Parameters:
<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 0)

Example: `POW:EMF:STAT 1`
Activates voltage level display.

Manual operation: See "Display Level as Voltage of EMF" on page 561

[:SOURce<hw>]:POWer:LBEHaviour <Behaviour>

Selects the level behavior at the RF output over time.

Parameters:
<Behaviour> AUTO | UNINterrupted | MONotone | CVSWr | CPHase

UNINterrupted|MONotone
Do not use the uninterrupted level settings and strictly monotone modes in combination with the high-quality optimization mode (see `[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE` on page 949)

CVSWr
Constant VSWR

CPHase
Continuous phase

CONStant
Constant phase

*RST: AUTO

Example: `SOURce1:POWer:LBEHaviour AUTO`

Manual operation: See "Setting Characteristics" on page 317

[:SOURce<hw>]:POWer:LIMit[:AMPLitude] <Amplitude>

Limits the maximum RF output level in CW and sweep mode.

It does not influence the "Level" display or the response to the query `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]`.

Parameters:
<Amplitude> float

Range: depends on options
Increment: 0.01
*RST: n.a. (factory preset: 30)

Example: `SOURce1:POWer:LIMit:AMPLitude 10`

Manual operation: See "Limit" on page 319

[:SOURce<hw>]:POWer:LMODe <LevMode>

Sets the RF level mode.

Parameters:
<LevMode> NORMal | LOWNoise | LOWDistortion

NORMal
Supplies the RF signal with the standard power level of the instrument.

LOWNoise
Supplies a very low noise sinewave signal.

LOWDistortion
Supplies a very pure sinewave signal.

*RST: NORMal

Example: `SOURce1:POWer:LMODe LOWD`
Sets low distortion mode. The instrument reduces distortions of the RF signal to a minimum.

Manual operation: See "Mode" on page 317

[:SOURce<hw>]:POWer:MANual <Manual>

Sets the level for the subsequent sweep step if `SWE:POW:MODE MAN`.

Use a separate command for each sweep step.

Parameters:
<Manual> float

You can select any level within the setting range, where:
`STARt` is set with `[:SOURce<hw>]:POWer:STARt`
`STOP` is set with `[:SOURce<hw>]:POWer:STOP`
`OFFSet` is set with `[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet`

Range: (STARt + OFFSet) to (STOP + OFFSet)
Increment: 0.01
Default unit: dBm

Example: See Example "Setting up an RF frequency or power sweep" on page 1047

Manual operation: See "Current Level" on page 353

[:SOURce<hw>]:POWer:MODE <Mode>

Selects the operating mode of the instrument to set the output level.

Parameters:
<Mode> CW | FIXed | SWEep

CW|FIXed
Operates at a constant level.
`CW` and `FIXed` are synonyms.
To set the output level value, use the command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]`.

SWEep
Sets sweep mode.
Set the range and current level with the commands:
`[:SOURce<hw>]:POWer:STARt` and `[:SOURce<hw>]:POWer:STOP`,
`[:SOURce<hw>]:POWer:MANual`.

*RST: CW

Example: See Example "Setting up an RF frequency or power sweep" on page 1047

Manual operation: See "State (RF level sweep)" on page 352

[:SOURce<hw>]:POWer:PEP?

Queries the PEP "**P**eak **E**nvelope **P**ower) of digital modulation or digital standards at the RF output. This value corresponds to the level specification, displayed in the status bar (header).

Return values:
<Pep> float

Example:
```
POW:PEP?
```
Response: `"4"`
The PEP value of digital modulation is 4 dBm at the RF output.

Usage: Query only

Manual operation: See "PEP" on page 310

[:SOURce<hw>]:POWer:POWer <Power>

Sets the level **at the RF output** connector.

This value does not consider a specified offset.

The command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]` sets the level of the "Level" display, that means the level containing offset.

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Parameters:
<Power> float

Level at the RF output, without level offset

Range: See specifications document.
Increment: 0.01
Default unit: dBm

Example:
```
SOURce1:POWer:POWer 15
// sets the level at the RF output.
```

Manual operation: See "Amplitude" on page 316
See "Generator Settings used for Measurement" on page 415

[:SOURce<hw>]:POWer:STARt <Start>
[:SOURce<hw>]:POWer:STOP <Stop>

Sets the RF start/stop level in sweep mode.

Parameters:

<Stop> float

Sets the setting range calculated as follows:
`(Level_min + OFFSet) to (Level_max + OFFSet)`
Where the values are set with the commands:
`[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet`
`[:SOURce<hw>]:POWer:STARt`
`[:SOURce<hw>]:POWer:STOP`

Range: Minimum level to maximum level
*RST: -30 (Start)/ -10 (Stop)
Default unit: dBm

Example: See Example "Setting up an RF frequency or power sweep" on page 1047

Manual operation: See "Start Level/Stop Level" on page 358

[:SOURce<hw>]:POWer:SPC:CRANge <PowCntrlCRange>

Defines the capture range of the power control system.

Within the range:

Target Level +/- Catch Range

the power control locks and tries to achieve the target level. Readings outside the range are not considered.

Parameters:

<PowCntrlCRange> float

Range: 0 to 50
Increment: 0.01
*RST: 30

Example: See Example "Configure the settings for NRP power control" on page 1024

Manual operation: See "Catch Range +/-" on page 425

[:SOURce<hw>]:POWer:SPC:DELay <PowCntrlDelay>

Sets a waiting time for the generator to adjust the output level. After the delay time has elapsed, the power sensor measures the next value.

Parameters:

<PowCntrlDelay> integer

Range: 0 to 1000
*RST: 0

Example: See Example "Configure the settings for NRP power control" on page 1024

Manual operation: See "Delay Time" on page 426

[:SOURce<hw>]:POWer:SPC:MEASure

Sets the measured power value as reference level.

Example: See Example "Configure the settings for NRP power control" on page 1024

Usage: Event

Manual operation: See "Take Measurement as Target Level" on page 425

[:SOURce<hw>]:POWer:SPC:MODE <ControlMode>

Selects the measurement mode for the power sensor.

Parameters:

<ControlMode> AUTO | SINGle

AUTO
Measures the level values continuously.

SINGle
Executes one measurement, triggered by the command `[:SOURce<hw>]:POWer:SPC:SINGle` on page 1036.

*RST: AUTO

Example: See Example "Configure the settings for NRP power control" on page 1024

Manual operation: See "Mode" on page 425

[:SOURce<hw>]:POWer:SPC:PEAK <PowCntrlPeak>

Activates power control by means of the peak power values, provided the power sensor supports this function.

Parameters:

<PowCntrlPeak> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Configure the settings for NRP power control" on page 1024

[:SOURce<hw>]:POWer:SPC:SELect <PowCntrlSelect>

Selects the power sensor used for power control.

Parameters:

<PowCntrlSelect> SENS1 | SENS2 | SENS3 | SENS4 | SENSor1 | SENSor2 | SENSor3 | SENSor4

*RST: SENS1

Example: See Example "Configure the settings for NRP power control" on page 1024

Manual operation: See "Sensor" on page 424

[:SOURce<hw>]:POWer:SPC:SINGle

Triggers the power sensor to measure the power value once.

Usage: Event

Manual operation: See "Execute Single" on page 425

[:SOURce<hw>]:POWer:SPC:STATe <PowCntrlState>

Starts power control using the selected sensor. The control loop periodically adjusts the output level of the signal generator. After switching off, the running loop is completed.

Parameters:

<PowCntrlState> 1 | ON | 0 | OFF

*RST: 0

Example: See Example "Configure the settings for NRP power control" on page 1024

Manual operation: See "State" on page 424

[:SOURce<hw>]:POWer:SPC:TARGet <PowCntrlTarget>

Sets the target level required at the DUT. To define the unit of the power value, use command `:UNIT:POWer` on page 1099.

Parameters:

<PowCntrlTarget> float

Range: -50 to 30
Increment: 0.01
*RST: -10

Example: See Example "Configure the settings for NRP power control" on page 1024

Manual operation: See "Target Level" on page 425

[:SOURce<hw>]:POWer:SPC:WARNing?

Queries if the activated power control works properly.

If the power control does not work, the query returns warning state 1. On the screen, the R&S SMM100A indicates a warning icon.

Return values:
<WarningState> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Configure the settings for NRP power control" on page 1024.

Usage: Query only

[:SOURce<hw>]:POWer:STEP:MODE <Mode>

Defines the type of step width to vary the RF output power step-by-step with the commands `POW UP or POW DOWN`.

Parameters:
<Mode> DECimal | USER

DECimal
Increases or decreases the level in steps of ten.

USER
Increases or decreases the level in increments, determined with the command `[:SOURce<hw>]:POWer:STEP[:INCRement]`.

*RST: DECimal

Example: See Example "Configuring the RF output power" on page 1023.

Manual operation: See "Variation Active" on page 315

[:SOURce<hw>]:POWer:STEP[:INCRement] <Increment>

Specifies the step width in the appropriate path for `POW:STEP:MODE USER`.

To adjust the level step-by-step with this increment value, use the command `POW UP, or POW DOWN`.

Note: The command also sets "Variation Step" in the manual control, that means the user-defined step width for setting the level with the rotary knob or the [Up/Down] arrow keys.

Parameters:
<Increment> float

Range: 0 to 200
Increment: 0.01
*RST: 1
Default unit: dB

Example: See Example "Configuring the RF output power" on page 1023.

Manual operation: See "Variation Step" on page 315

[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet <Offset>

Sets the level offset of a downstream instrument.

The level at the RF output is not changed.

To query the resulting level, as it is at the output of the downstream instrument, use the command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]`.

See Section 7.4.1.1, "Displayed RF frequency and level values with downstream instruments", on page 311.

Note: The level offset also affects the RF level sweep.

Parameters:

<Offset> float

Range: -200 to 200
Increment: 0.01
*RST: 0
Default unit: dB
Level offset is always expreced in dB; linear units (V, W, etc.) are not supported

Example: `POWer:OFFSet 10`
Sets the RF level offset to 10 dB

Manual operation: See "Offset" on page 319
See "Generator Settings used for Measurement" on page 415

[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:RCL <Rcl>

Determines whether the current level is retained or if the stored level setting is adopted when an instrument configuration is loaded.

Parameters:

<Rcl> INCLude | EXCLude

INCLude
Takes the current level when an instrument configuration is loaded.

EXCLude
Retains the current level when an instrument configuration is loaded.

*RST: INCLude

Example: `POW:RCL INCL`
Takes the level value from an instrument configuration loaded with command `*RCL`.

Manual operation: See "Exclude Level" on page 533

[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude] <Amplitude>

Sets the RF level applied to the DUT.

To activate the RF output use command `:OUTPut<hw>[:STATe]` ("RF On"/"RF Off").

The following applies `POWer = RF output level + OFFSet`, where:

- `POWer` is the values set with `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]`
- RF output level is set with `[:SOURce<hw>]:POWer:POWer` on page 1033
- `OFFSet` is set with `[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet`

Parameters:

<Amplitude> float

The following settings influence the value range:
`OFFSet` set with the command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet`

Numerical value
Sets the level

UP|DOWN
Varies the level step by step.
The level is increased or decreased by the value set with the command `[:SOURce<hw>]:POWer:STEP[:INCRement]`.

Range: (Level_min + OFFSet) to (Level_max + OFFStet)
*RST: -30
Default unit: dBm

Example: `POWer -30`
Sets the RF level

Example: See also `[:SOURce<hw>]:POWer:STEP:MODE` on page 1037.

Manual operation: See "Amplitude" on page 316

[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:REFLevel <ReferenceLevel>

Queries the reference level of the user correction.

The reference level is the sum of the amplitude and the level offset, set with the commands `[:SOURce<hw>]:POWer:POWer [:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet`.

Parameters:

<ReferenceLevel> float

Range: -245 to 120
Increment: 0.01
*RST: -30

Manual operation: See "Generator Settings used for Measurement" on page 415

[:SOURce<hw>]:POWer:RANGe:LOWer?
[:SOURce<hw>]:POWer:RANGe:UPPer?

Queries the current interruption-free range of the level.

Return values:

<Upper> float

Increment: 0.01
Default unit: dBm

Example:

```
SOURce1:POWer:RANGe:UPPer?
// -15
SOURce1:POWer:RANGe:LOW?
// -50
```

Usage: Query only

Manual operation: See "Level Range" on page 360

[:SOURce]:POWer:WIGNore <State>

Ignores level range warnings.

Parameters:

<State> 1 | ON | 0 | OFF

*RST: n.a. (factory preset: 0)

Example:

```
SOURce:POWer:WIGNore 1
```

13.17.19 SOURce:ROSCillator subsystem

The `SOURce:ROSCillator` subsystem contains the commands for setting the external and internal reference frequency.

Example: Configuring the reference oscillator

```
// Using 100 MHz external reference source
SOURce:ROSCillator:PRESet
SOURce:ROSCillator:SOURce EXT
SOURce:ROSCillator:EXTernal:RFOFf:STATe 1
SOURce:ROSCillator:EXTernal:FREQuency 100MHZ
SOURce:ROSCillator:EXTernal:SBANdwidth WIDE
// 100 MHz (loop through) and 1 GHz output
SOURce:ROSCillator:OUTPut:FREQuency:MODE LOOP
SOURce:ROSCillator:OUTPut:ALTernate:FREQuency:MODE DER1G
SOURce:ROSCillator:INTernal:ADJust:STATe 0


// Variable external reference frequency
// SOURce:ROSCillator:EXTernal:FREQuency VAR
// SOURce:ROSCillator:EXTernal:FREQuency:VARiable 100000000

// Using the internal reference frequency
SOURce:ROSCillator:SOURce INT
SOURce:ROSCillator:INTernal:TUNing:STATe 1
SOURce:ROSCillator:INTernal:TUNing:SLOPe LOW
// 10 MHz and 1 GHz output
SOURce:ROSCillator:OUTPut:FREQuency:MODE DER10M
SOURce:ROSCillator:OUTPut:ALTernate:FREQuency:MODE DER1G

// Using 10 MHz external reference source
SOURce:ROSCillator:SOURce EXT
SOURce:ROSCillator:EXTernal:RFOFf:STATe 1
SOURce:ROSCillator:EXTernal:FREQuency?
// Response: 10MHZ
SOURce:ROSCillator:EXTernal:SBANdwidth WIDE
SOURce:ROSCillator:INTernal:ADJust:STATe 0

// Query calibration value
CALibration:ROSCillator?
// 32767
// Set an internal source
// Activate user-defined adjustment value of 1000
SOURce:ROSCillator:SOURce INT
SOURce:ROSCillator:INTernal:ADJust:STATe 1
SOURce:ROSCillator:INTernal:ADJust:VALue 1000

// query calibration value
CALibration:ROSCillator:DATA?
// 32767
// change the calibration value
CALibration:ROSCillator:DATA 20000
SOURce:ROSCillator:INTernal:ADJust:VALue?
// 13767
// i.e. CalValue_Def - CalValue_User = 32767 - 20000 = 13767

SOURce:ROSCillator:INTernal:ADJust:VALue 0
```

```
CALibration:ROSCillator:DATA?
// 20000
// user-defined adjustment value is 0
// i.e. user-defined adjustment is acivated
// but the calibration value is used
// and the calibration value is the user-defined value
*RST
SOURce:ROSCillator:INTernal:ADJust:VALue?
// -12767
// user-defined adjustment value is not affected by preset
// the adjustment value is calculated as
// - (CalValue_Def - CalValue_User - AdjValue_User)
CALibration:ROSCillator:DATA?
// 32767
// calibration value is preset

// to resume calibrated state
SOURce:ROSCillator:INTernal:ADJust:VALue 0
SOURce:ROSCillator:INTernal:ADJust:STATe 0
// or
// SYSTem:FPRest
```

[:SOURce]:ROSCillator:SOURce 1042
[:SOURce]:ROSCillator:EXTernal:RFOFf[:STATe] 1042
[:SOURce]:ROSCillator:EXTernal:FREQuency 1043
[:SOURce]:ROSCillator:EXTernal:FREQuency:VARiable 1043
[:SOURce]:ROSCillator:EXTernal:SBANdwidth 1043
[:SOURce]:ROSCillator:EXTernal:MLRange? 1044
[:SOURce]:ROSCillator:EXTernal:NSBandwidth? 1044
[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE 1044
[:SOURce]:ROSCillator:OUTPut:ALTernate:FREQuency:MODE 1045
[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue 1045
[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe] 1046

[:SOURce]:ROSCillator:SOURce <Source>

Selects between internal or external reference frequency.

Parameters:

<Source> INTernal | EXTernal

*RST: n.a. (factory preset: INTernal)

Example: See Example "Configuring the reference oscillator" on page 1041.

Manual operation: See "Source" on page 322

[:SOURce]:ROSCillator:EXTernal:RFOFf[:STATe] <State>

Determines that the RF output is turned off when the external reference signal is selected, but missing.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example: See Example "Configuring the reference oscillator" on page 1041.

Manual operation: See "Deactivate RF Output (if external reference is missing)" on page 323

[:SOURce]:ROSCillator:EXTernal:FREQuency <Frequency>

Sets the frequency of the external reference.

Parameters:
<Frequency> 100MHZ | 1GHZ | VARiable | 10MHZ
*RST: n.a. (factory preset: 10MHZ)

Example: See Example "Configuring the reference oscillator" on page 1041.

Options: VARiable requires R&S SMM-K704

Manual operation: See "External Reference Frequency" on page 323

[:SOURce]:ROSCillator:EXTernal:FREQuency:VARiable <Frequency>

Specifies the user-defined external reference frequency.

Parameters:
<Frequency> float
Range: 1E6 to 100E6
Increment: 0.1
*RST: n.a. (factory preset: 1E7)
Default unit: Hz

Example: See Example "Configuring the reference oscillator" on page 1041.

Manual operation: See "Variable Reference Frequency" on page 323

[:SOURce]:ROSCillator:EXTernal:SBANdwidth <SBandwidth>

Selects the synchronization bandwidth for the external reference signal.

Depending on the RF hardware version and the installed options, the synchronization bandwidth varies.

For more information, refer to the specifications document.

Parameters:
<SBandwidth> WIDE | NARRow

NARRow
The synchronization bandwidth is a few Hz.

WIDE
Uses the widest possible synchronization bandwidth.

*RST: n.a. (factory preset: WIDE)

Example: See Example "Configuring the reference oscillator" on page 1041.

Manual operation: See "Synchronization Bandwidth" on page 323

[:SOURce]:ROSCillator:EXTernal:MLRange?

Queries the minimum locking range for the selected external reference frequency.

Depending on the RF hardware version, and the installed options, the minimum locking range vaies.

For more information, refer to the specifications document.

Return values:
<MinLockRange> string

Example: `SOUR:ROSC:EXT:MLR?`

Usage: Query only

Manual operation: See "Minimum Locking Range" on page 324

[:SOURce]:ROSCillator:EXTernal:NSBandwidth?

Queries the nominal synchronization bandwidth for the selected external reference frequency and synchronization bandwidth.

Return values:
<NomBandwidth> string

Example: `SOUR:ROSC:EXT:NSB?`

Usage: Query only

Manual operation: See "Nominal Synchronization Bandwidth" on page 324

[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE <OutpFreqMode>

Selects the mode for the output reference frequency.

Parameters:
<OutpFreqMode> DER10M | OFF | LOOPthrough

OFF
Disables the output.

DER10M
Sets the output reference frequency to 10 MHz.
The reference frequency is derived from the internal reference frequency.

LOOPthrough
This setting is unavailable for `ROSCillator:EXTernal:FREQuency 1GHZ`.
Forwards the input reference frequency to the reference frequency output.

*RST: n.a. (factory preset: DER10M)

Example: See Example "Configuring the reference oscillator" on page 1041.

Manual operation: See "Reference Output/1 GHz Reference Output" on page 325

[:SOURce]:ROSCillator:OUTPut:ALTernate:FREQuency:MODE <OutpFreqMode>

Sets the output reference frequency.

Parameters:
<OutpFreqMode> LOOPthrough | DER1G | OFF

OFF
Disables the output.

DER1G
Sets the output reference frequency to 1 GHz.
The reference frequency is derived from the internal reference frequency.

LOOPthrough
If `[:SOURce]:ROSCillator:EXTernal:FREQuency 1GHZ`, forwards the input reference frequency to the reference frequency output.

*RST: n.a. (factory preset: OFF)

Example: See Example "Configuring the reference oscillator" on page 1041.

Manual operation: See "Reference Output/1 GHz Reference Output" on page 325

[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue <Value>

Specifies the frequency correction value (adjustment value).

Parameters:
<Value> integer

*RST: 0

Example: See `[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe]` on page 1046

Manual operation: See "Adjustment Value" on page 326

[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe] <State>

Determines whether the calibrated (off) or a user-defined (on) **adjustment value** is used for fine adjustment of the frequency.

Parameters:

<State> 1 | ON | 0 | OFF

0
Fine adjustment with the calibrated frequency value

1
User-defined adjustment value.
The instrument is no longer in the calibrated state.
The calibration value is, however, not changed. The instrument resumes the calibrated state if you send `SOURce:ROSCillator:INTernal:ADJust:STATe 0`.

*RST: n.a. (factory preset: 0)

Manual operation: See "Adjustment Active" on page 325

13.17.20 SOURce:SWEep subsystem

The `SOURce:SWEep` subsystem contains the commands for configuring RF sweep signals.

- The keyword `[:FREQuency]` can be omitted, then the commands are SCPI-compliant.
- To activate an RF sweep mode, use the following commands:
  - RF frequency sweep: `SOURce:FREQuency:MODE SWEep` (`SOURce:FREQuency:MODE CW` (off))
  - RF level sweep:`SOURce:POWer:MODE SWEep` (`SOURce:POWer:MODE CW` (off))
- All sweeps can be set independently of each other.

See Section 7.10.1, "Signal generation and triggering in the sweep and list modes", on page 336.

Example: Setting up an RF frequency or power sweep

The following example shows a command sequence to set up an RF frequency sweep, triggered by the execute command. For an RF power sweep, replace `FREQuency` in the `SWEep` commands with `POWer`.

Exceptions are the power spacing (defined with `LINear` only) and the power step width (defined with `LOGarithmic` only).

```
// Reset the instrument to start from an initial state
// Switch off display update to improve performance
// (especially with short dwell times)
// Set the sweep mode (first two commands) and the sweep range
// Select linear spacing
// Select the waveform shape for the frequency sweep
*RST; *CLS
SYSTem:DISPlay:UPDate OFF
// Select sweep mode
SOURce:FREquency:MODe SWEep

TRIGger1:FSWeep:SOURce SINGle
SOURce1:SWEep:FREQuency:MODE AUTO
SOURce1:FREQuency:SPAN 300 MHz
SOURce1:FREQuency:CENTer 200 MHz
// Alternatively use
// SOURce1:FREQuency:STARt 50 MHz
// SOURce1:FREQuency:STOP 350 MHz
SOURce1:SWEep:FREQuency:SPACing LINear
SOURce1:SWEep:FREQuency:SHAPe SAWTooth

// Initiate an LF frequency sweep
TRIGger1:FSWeep:SOURce SINGle
SOURce1:SWEep:FREQuency:MODE AUTO
TRIGger:LFFSweep

// Activate change to start frequency while waiting for next trigger
// Prerequisites: sweep mode single and sweep waveform sawtooth
SOURce1:SWEep:FREQuency:RETRace 1
// Alternatively reset all sweeps to their initial value
SOURce1:SWEep:RESet:ALL

// Set the step width and dwell time
SOURce1:SWEep:FREQuency:STEP:LINear 1 MHz
// Alternatively set the number of steps, then the sweep step width is
// set automatically
SOURce1:SWEep:FREQuency:POINts 301
SOURce1:SWEep:FREQuency:DWELl 500 ms
// With logarithmic spacing select the step width as follows
// (steps of 10 percent of the previous frequency in each instance)
SOURce1:SWEep:FREQuency:SPACing LOG
SOURce1:SWEep:FREQuency:STEP:LOGarithmic 10PCT
```

```
// Activate the sweep
// Trigger the sweep (depending on the set mode) and query the status
SOURce1:FREQuency:MODE SWEep
// Perform a one-off RF frequency sweep
SOURce1:SWEep:FREQuency:EXECute
SOURce1:SWEep:FREQuency:RUNNing?
// 1
// the frequency sweep is running

// For manual step RF sweep use the following commands
*RST; *CLS
// Set the frequency range
SOURce1:FREQuency:STARt 50 MHz
SOURce1:FREQuency:STOP 350 MHz
SOURce1:FREQuency:MANual 30 MHz
// Activate manual step RF sweep
SOURce1:SWEep:FREQuency:MODE MANual
// Activate the RF frequency sweep.
SOURce1:FREQuency:MODE SWEep
// Activate RF Output1.
Output1:STATe 1
// Set the frequency manually for each step
SOURce1:FREQuency:MANual 200 MHz
SOURce1:FREQuency:MANual 201 MHz
// Alternatively use the UP or DOWN commands with the set step width.
SOURce1:SWEep:FREQuency:STEP:LINear 1 MHz
SOURce1:FREQuency:MANual UP

// Trigger an enabled sweep immediately
TRIGger1:FSWeep:SOURce SINGle
SOURce1:SWEep:FREQuency:MODE AUTO
TRIGger<hw>[:SWEep][:IMMediate]


// Query the interruption-free level range
SOURce1:POWer:RANGe:LOWer?
// Response: -50
SOURce1:POWer:RANGe:UPPer?
// Response: -15
```

[:SOURce<hw>]:SWEep:POWer:DWELl....1049
[:SOURce<hw>]:SWEep:POWer:MODE....1049
[:SOURce<hw>]:SWEep:POWer:POINts....1050
[:SOURce<hw>]:SWEep:POWer:SPACing:MODE?....1050
[:SOURce<hw>]:SWEep:POWer:STEP[:LOGarithmic]....1050
[:SOURce<hw>]:SWEep[:FREQuency]:DWELl....1050
[:SOURce<hw>]:SWEep[:FREQuency]:MODE....1051
[:SOURce<hw>]:SWEep[:FREQuency]:POINts....1051
[:SOURce<hw>]:SWEep[:FREQuency]:SPACing....1052

[:SOURce<hw>]:SWEep:POWer:SHAPe 1052
[:SOURce<hw>]:SWEep[:FREQuency]:SHAPe 1052
[:SOURce<hw>]:SWEep:POWer:EXECute 1052
[:SOURce<hw>]:SWEep[:FREQuency]:EXECute 1052
[:SOURce<hw>]:SWEep:POWer:RETRace 1053
[:SOURce<hw>]:SWEep[:FREQuency]:RETRace 1053
[:SOURce<hw>]:SWEep:POWer:RUNNing? 1053
[:SOURce<hw>]:SWEep[:FREQuency]:RUNNing? 1053
[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic 1053
[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear] 1053
[:SOURce<hw>]:SWEep:RESet[:ALL] 1054

[:SOURce<hw>]:SWEep:POWer:DWELl <Dwell>

Sets the dwell time for a level sweep step.

Parameters:

<Dwell> float

Range: 0.001 to 100
Increment: 100E-6
*RST: 0.01

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Dwell Time" on page 354

[:SOURce<hw>]:SWEep:POWer:MODE <Mode>

Sets the cycle mode for the level sweep.

Parameters:

<Mode> AUTO | MANual | STEP

AUTO
Each trigger triggers exactly one complete sweep.

MANual
The trigger system is not active. You can trigger every step individually with the command `[:SOURce<hw>]:POWer:MANual`. The level value increases at each step by the value that you define with `[:SOURce<hw>]:POWer:STEP[:INCRement]`. Values directly entered with the command `[:SOURce<hw>]:POWer:MANual` are not taken into account.

STEP
Each trigger triggers one sweep step only. The level increases by the value entered with `[:SOURce<hw>]:POWer:STEP[:INCRement]`.

*RST: AUTO

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Mode" on page 353

[:SOURce<hw>]:SWEep:POWer:POINts <Points>

Sets the number of steps within the RF level sweep range.

Parameters:

<Points> integer

Range: 2 to Max

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

[:SOURce<hw>]:SWEep:POWer:SPACing:MODE?

Queries the level sweep spacing. The sweep spacing for level sweeps is always linear.

Return values:

<Mode> LINear

*RST: LINear

Example: `SWE:POW:SPAC:MODE?`
queries the sweep spacing for a level sweep at RF output.
Result: `"LIN"`
linear spacing

Usage: Query only

[:SOURce<hw>]:SWEep:POWer:STEP[:LOGarithmic] <Logarithmic>

Sets a logarithmically determined step size for the RF level sweep. The level is increased by a logarithmically calculated fraction of the current level.

Parameters:

<Logarithmic> float

The unit `dB` is mandatory.

Range: 0.01 to 139
Increment: 0.01
*RST: 1
Default unit: dB

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Step" on page 358

[:SOURce<hw>]:SWEep[:FREQuency]:DWELl <Dwell>

Sets the dwell time for a frequency sweep step.

Parameters:

<Dwell> float

Range: 0.001 to 100
Increment: 100E-6
*RST: 0.01

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Dwell Time" on page 354

[:SOURce<hw>]:SWEep[:FREQuency]:MODE <Mode>

Sets the cycle mode for the frequency sweep.

Parameters:

<Mode> AUTO | MANual | STEP

AUTO
Each trigger event triggers exactly one complete sweep.

MANual
The trigger system is not active. You can trigger every step individually by input of the frequencies with the command `[:SOURce<hw>]:FREQuency:MANual`.

STEP
Each trigger event triggers one sweep step. The frequency increases by the value entered with `[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear]` (linear spacing) or `[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic` (logarithmic spacing).

*RST: AUTO

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Mode" on page 353

[:SOURce<hw>]:SWEep[:FREQuency]:POINts <Points>

Sets the number of steps within the RF frequency sweep range.

Two separate `POINts` values are used for linear or logarithmic sweep spacing. This command always affects the currently set sweep spacing that you can set via the following command:

`:SOURce<hw>:SWEep:FREQuency:SPACing LINear|LOGarithmic`

Parameters:

<Points> integer

Range: 2 to Max

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

[:SOURce<hw>]:SWEep[:FREQuency]:SPACing <Spacing>

Selects the mode for the calculation of the frequency intervals, with which the current frequency at each step is increased or decreased.

The keyword `[:FREQuency]` can be omitted; then the command is SCPI-compliant.

Parameters:

<Spacing> LINear | LOGarithmic

LINear
Sets a fixed frequency value as step width and adds it to the current frequency.
The linear step width is entered in Hz, see `[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear]`.

LOGarithmic
Sets a constant fraction of the current frequency as step width and adds it to the current frequency.
The logarithmic step width is entered in %, see `[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic`.

*RST: LINear

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Spacing" on page 354

[:SOURce<hw>]:SWEep:POWer:SHAPe <Shape>
[:SOURce<hw>]:SWEep[:FREQuency]:SHAPe <Shape>

Determines the waveform shape for a frequency sweep sequence.

Parameters:

<Shape> SAWTooth | TRIangle

*RST: SAWTooth

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Shape" on page 354

[:SOURce<hw>]:SWEep:POWer:EXECute
[:SOURce<hw>]:SWEep[:FREQuency]:EXECute

Executes an RF frequency sweep.

The command performs a single sweep and is therefore only effective in manual sweep mode.

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Usage: Event

Manual operation: See "Execute Single Sweep" on page 355

[:SOURce<hw>]:SWEep:POWer:RETRace <State>
[:SOURce<hw>]:SWEep[:FREQuency]:RETRace <State>

Activates that the signal changes to the start frequency value while it is waiting for the next trigger event.

You can enable this feature, when you are working with sawtooth shapes in sweep mode "Single" or "External Single".

Parameters:
<State> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Retrace" on page 354

[:SOURce<hw>]:SWEep:POWer:RUNNing?
[:SOURce<hw>]:SWEep[:FREQuency]:RUNNing?

Queries the current sweep state.

Return values:
<State> 1 | ON | 0 | OFF

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Usage: Query only

[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic <Logarithmic>

Sets a logarithmically determined step width for the RF frequency sweep. The value is added at each sweep step to the current frequency.

Parameters:
<Logarithmic> float
The unit is mandatory.
Range: 0.01 to 100
Increment: 1E-3
*RST: 1
Default unit: PCT

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Step Linear/Step Logarithmic" on page 357

[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear] <Linear>

Sets the step width for linear sweeps.

Parameters:

<Linear> float

Range: 0.001 Hz to (STOP - STARt)
Increment: 0.01

Example: See Example "Setting up an RF frequency or power sweep" on page 1047.

Manual operation: See "Step Linear/Step Logarithmic" on page 357

[:SOURce<hw>]:SWEep:RESet[:ALL]

Resets all active sweeps to the starting point.

Usage: Event

Manual operation: See "Reset Sweep" on page 355

13.18 SYSTem subsystem

The SYSTem subsystem contains a series of commands for general functions which do not directly affect signal generation.

Example: To check the instrument specifications

```
// Check information on specifications document versions.
// Query all versions saved on the instrument:
:SYSTem:SPECification:VERSion:CATalog?
"04.03,04.02,04.01,04.00,03.04,03.03,03.02,03.01,03.00,02.96,02.95,02.94,
02.02,02.01,02.00,01.03,01.02,01.01,01.00"

// Query the initial version of your delivery.
:SYSTem:SPECification:VERSion:FACTory?
// Response: "04.00"

// Select a specific version:
:SYSTem:SPECification:VERSion "04.01"

// Check information of a particular specifications document.
// Query the IDs of all parameters listed in the selected version:
:SYSTem:SPECification:VERSion "04.03"
:SYSTem:SPECification:IDENtification:CATalog?
"ID_RF_FREQ_SETTING_TIME_ALC_ON_MS,ID_RF_FREQ_SETTING_TIME_MS,..."

// Query specification information on a specific parameter by its ID.
:SYSTem:SPECification? "ID_RF_FREQ_SETTING_TIME_ALC_ON_MS"
// Returns the specified value of the parameter.
```

Example: To check network-related settings

```
:SYSTem:COMMunicate:NETWork:STATus?
// Response: "1"
:SYSTem:PROTection1:STATe 0,123456

:SYSTem:COMMunicate:NETWork:IPADdress:MODE STAT
:SYSTem:COMMunicate:NETWork:IPADdress "10.113.0.104"
:SYSTem:COMMunicate:NETWork:IPADdress:DNS "10.0.2.166"
:SYSTem:COMMunicate:NETWork:COMMon:HOSTname?
// Response: "SMM100A-102030"
:SYSTem:COMMunicate:NETWork:COMMon:WORKgroup "instrument"
:SYSTem:COMMunicate:NETWork:COMMon:DOMain "rsint.net"
:SYSTem:COMMunicate:NETWork:IPADdress:GATeway "10.113.0.1"
:SYSTem:COMMunicate:NETWork:IPADdress:SUBNet:MASK "255.255.252.0"
:SYSTem:COMMunicate:NETWork:MACaddress "08 00 27 a3 a1 70"
:SYSTem:PROTection1:STATe 1
```

Example: To restart the network

```
:SYSTem:COMMunicate:NETWork:RESTart
// terminates the network connection and sets it up again
```

Example: To find out VISA resource strings

```
:SYSTem:COMMunicate:NETWork:RESource?
// Response: "TCPIP::10.113.0.104::inst0::INSTR"

:SYSTem:COMMunicate:HISLip:RESource?
// Response: "TCPIP::10.113.0.104::hislip0::INSTR"

:SYSTem:COMMunicate:SOCKet:RESource?
// Response: "TCPIP::10.113.0.104::5025::SOCKET"

:SYSTem:COMMunicate:USB:RESource?
// "USB::0x0AAD::0x0277::100001::INSTR"

:SYSTem:COMMunicate:GPIB:RESource?
// Response: "GPIB::28::INSTR"
:SYSTem:COMMunicate:GPIB:SELF:ADDRess?
// Response: 28
:SYSTem:COMMunicate:GPIB:LTERminator?
// Response: STAN

:SYSTem:COMMunicate:SERial:RESource?
// Response: "ASRL1::INSTR"
:SYSTem:COMMunicate:SERial:SBITs?
// Response: 1
:SYSTem:COMMunicate:SERial:BAUD?
// Response: 115200
:SYSTem:COMMunicate:SERial:PARity?
// Response: NONE
```

Disabling LAN services

► **NOTICE!** Risk of loosing access over LAN. Disabling the LAN interface or the common services "LAN", "SCPI over LAN", "VNC" and "HTTP" locks the remote access to the instrument.

Use the commands in Example "To disable the LAN interface and LAN services" on page 1056 to disable or enable the LAN interface and LAN interface services individually.

a) For the first parameter of the command, enter the security password of your instrument.
The default password is 123456.
b) For the second parameter of the command, enter the state: 1 (ON), 0 (OFF)

Example: To disable the LAN interface and LAN services

```
// ******************************************************************************
// Disable the LAN interface.
// ******************************************************************************
SYSTem:SECurity:NETWork:STATe "<password>", 0

// ******************************************************************************
// Disable the LAN services individually.
// ******************************************************************************
SYSTem:SECurity:NETWork:RAW:STATe "<password>", 0
// Disables remote access over raw socket.
SYSTem:SECurity:NETWork:SOE:STATe "<password>", 0
// Disables SCPI over Ethernet/LAN communication.
SYSTem:SECurity:NETWork:VNC:STATe "<password>", 0
// Disables remote access over VNC.
SYSTem:SECurity:NETWork:HTTP:STATe "<password>", 0
// Disables remote access over HTTP.
SYSTem:SECurity:NETWork:RPC:STATe "<password>", 0
// Disables remote access over remote procedure call (RPC).
SYSTem:SECurity:NETWork:SSH:STATe "<password>", 0
// Disables SSH network protocol that is used for service purposes.
SYSTem:SECurity:NETWork:FTP:STATe "<password>", 0
//    Disables FTP for file transfer.
SYSTem:SECurity:NETWork:SMB:STATe "<password>", 0
// Disables shared access over SMB.
SYSTem:SECurity:NETWork:AVAHi:STATe "<password>", 0
// Disables Avahi service for automatic instrument configuration in the network.
SYSTem:SECurity:NETWork:SWUPdate:STATe "<password>", 0
// Disables software updates over LAN.
```

Example: To query the error queue

```
:SYSTem:ERRor:STATic?
// Response: -221,"Settings conflict", 153,"Input voltage out of range", ...
// Returns all static errors that are collected in the error queue.
:SYSTem:ERRor:HISTory?
// 90,"Info;(*)Instrument startup... (Mar\-13\-2017/ 10:25:16\-601 ms)", ...
// returns all entries of the error queue
:SYSTem:ERRor:HISTory:ClEar
// Deletes the history entries.
```

Example: To configure date and time

```
// Query the date and time settings of the instrument.
:SYSTem:DATE?
// Response: 2023,1,16;1
:SYSTem:TIME?
// Response: 18,15,17;1
:SYSTem:TIME:ZONE?
// Response: "";1  //default UTC setting
:SYSTem:TIME:PROTocol?
// Response: "OFF";1
// No protocol selected.
:SYSTem:NTP:STATe?
// Response: 0;1
// NTP is disabled.

// Setting the timezone and NTP time protocol
:SYSTem:TIME:ZONE:CATalog?
// Response: "UTC,leap-seconds.list,leapseconds,Africa/Abidjan,..."
:SYSTem:TIME:ZONE "Europe/Berlin"
// Set the NTP server address.
:SYSTem:NTP:HOST "timesource.net"
:SYSTem:NTP:STATe?
// Response: "1"
// The NTP time server is enabled.
```

Commands:

:SYSTem:ERRor:ALL?....1059
:SYSTem:ERRor:CODE:ALL?....1060
:SYSTem:ERRor:CODE[:NEXT]?....1060
:SYSTem:ERRor:COUNt?....1060
:SYSTem:ERRor[:NEXT]?....1061
:SYSTem:ERRor:GNEXt?....1061
:SYSTem:ERRor:HISTory:CLEar....1062
:SYSTem:ERRor:STATic?....1062
:SYSTem:DLOCk....1062
:SYSTem:KLOCk....1062
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:SYSTem:ERRor:ALL?

Queries the error/event queue for all unread items and removes them from the queue.

Return values:

<All> string

Error/event_number,"Error/event_description>[;Device-dependent info]"
A comma separated list of error number and a short description of the error in FIFO order.
If the queue is empty, the response is `0,"No error"`
Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.
Volatile errors are reported once, at the time they appear. Identical errors are reported repeatedly only if the original error has already been retrieved from (and hence not any more present in) the error queue.

Example:

```
SYSTem:ERRor:ALL?
// queries all entries in the error queue.
Response: 0, 'no error'
// no errors have occurred since the error queue was last read out.
```

Usage: Query only

Manual operation: See "Clear History" on page 1104

:SYSTem:ERRor:CODE:ALL?

Queries the error numbers of all entries in the error queue and then deletes them.

Return values:

<All> string

Returns the error numbers. To retrieve the entire error text, send the command `:SYSTem:ERRor:ALL?`.

0
"No error", i.e. the error queue is empty

Positive value
Positive error numbers denote device-specific errors

Negative value
Negative error numbers denote error messages defined by SCPI.

Example:

```
SYSTem:ERRor:CODE:ALL?
// queries all entries in the error queue.
Response: 0
// no errors have occurred since the error queue was last read out.
```

Usage: Query only

:SYSTem:ERRor:CODE[:NEXT]?

Queries the error number of the oldest entry in the error queue and then deletes it.

Return values:

<Next> string

Returns the error number. To retrieve the entire error text, send the command `:SYSTem:ERRor:ALL?`.

0
"No error", i.e. the error queue is empty

Positive value
Positive error numbers denote device-specific errors

Negative value
Negative error numbers denote error messages defined by SCPI.

Example:

```
SYSTem:ERRor:CODE:NEXT?
// queries the oldest entry in the error queue.
Response: 0
// no errors have occurred since the error queue was last read out.
```

Usage: Query only

:SYSTem:ERRor:COUNt?

Queries the number of entries in the error queue.

Return values:

<Count> integer

0
The error queue is empty.

Example:
```
SYSTem:ERRor:COUNt?
// queries the number of entries in the error queue.
Response: 1
// one error has occurred since the error queue was last read out.
```

Usage: Query only

:SYSTem:ERRor[:NEXT]?

Queries the error/event queue for the oldest item and removes it from the queue.

Return values:

<Next> string

Error/event_number,"Error/event_description>[;Device-dependent info]"
Error number and a short description of the error.
If the queue is empty, the response is `0,"No error"`
Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.
Volatile errors are reported once, at the time they appear. Identical errors are reported repeatedly only if the original error has already been retrieved from (and hence not any more present in) the error queue.

Example:
```
SYSTem:ERRor:NEXT?
// queries the oldest entry in the error queue.
Response: 0, 'no error'
// no errors have occurred since the error queue was last read out.
```

Usage: Query only

Manual operation: See "Static Notifications/History" on page 1104

:SYSTem:ERRor:GNEXt?

Similar to `:SYSTem:ERRor[:NEXT]?`, but queries the next entry from the global persistant error/event queue.

Return values:

<NextGlobalError> string

Error/event number, "Error/event description> [;Device dependent info]"
An error number and a short description of the error.
Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

Example: `SYSTem:ERRor:GNEXt?`
`// queries the next error message from the global error queue.`

Usage: Query only

:SYSTem:ERRor:HISTory:CLEar

Clears the error history.

Example: See Example "To query the error queue" on page 1057

Usage: Event

Manual operation: See "Clear History" on page 1104

:SYSTem:ERRor:STATic?

Returns a list of all errors existing at the time when the query is started. This list corresponds to the display on the info page under manual control.

Return values:
<StaticErrors> string

Example: See Example "To query the error queue" on page 1057

Usage: Query only

Manual operation: See "Static Notifications/History" on page 1104

:SYSTem:DLOCk <DispLockStat>

Disables the manual operation over the display, including the front panel keyboard of the instrument.

Parameters:
<DispLockStat> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example: `SYST:DLOC ON`
Activates the display lock. The instrument cannot be operated via the display until it has been enabled with `SYST:DLOC OFF`.

Manual operation: See "User Interface" on page 610
See "Enabling a locked user interface for manual operation" on page 611

:SYSTem:KLOCk <State>

Disables the front panel keyboard of the instrument.

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example: `SYST:KLOC ON`
Locks the front panel and external controls.
To enable the controls, send `SYST:KLOC OFF`.

Manual operation: See "User Interface" on page 610
See "Enabling a locked user interface for manual operation" on page 611

:SYSTem:NINFormation?

Queries the oldest information message ("Error History > Level > Info") in the error/ event queue.

Return values:
<NextInfo> string

Example: `:SYSTem:NINFormation?`
Queries the oldest entry in the info message queue.
`Response: 90,"Info;=== Instrument startup... ==="`
Information message containing error number 90, that states, that the instrument startup is complete.

Usage: Query only

:SYSTem:ULOCk <SecPassWord>, <Mode>

Locks or unlocks the user interface of the instrument.

Parameters:
<Mode> ENABled | DONLy | DISabled | TOFF | VNConly

ENABled
Unlocks the display, the touchscreen and all controls for the manual operation.

DONLy
Locks the touchscreen and controls for the manual operation of the instrument. The display shows the current settings.

VNConly
Locks the touchscreen and controls for the manual operation, and enables remote operation over VNC. The display shows the current settings.

TOFF
Locks the touchscreen for the manual operation of the instrument. The display shows the current settings.

DISabled
Locks the display, the touchscreen and all controls for the manual operation.

*RST: n.a. (factory preset: ENABled)

Setting parameters:
<SecPassWord> string

Example: `:SYST:ULOC "<password>", DIS`
Activates the user interface lock, including display and controls.

Manual operation: See "User Interface" on page 610
See "Enabling a locked user interface for manual operation" on page 611

:SYSTem:LOCK:OWNer?

Queries the sessions that have locked the instrument currently.

If an exclusive lock is set, the query returns the owner of this exclusive lock, otherwise it returns `NONE`.

Return values:
<Owner> string

Example: `SYST:LOCK:OWN?`
Returns the owner of locking.
Response: `NONE`
The instrument is not locked.

Usage: Query only

:SYSTem:LOCK:RELease:ALL

Revokes the exclusive access to the instrument.

Usage: Setting only

:SYSTem:LOCK:REQuest[:EXCLusive]?

Queries whether a lock for exclusive access to the instrument via ethernet exists. If successful, the query returns a 1, otherwise 0.

Return values:
<Success> integer

Example: `SYST:LOCK:REQ?`
Queries the state of exclusive locking.
Response: `1`
The exclusive locking is active.

Usage: Query only

:SYSTem:SAV <Pathname>

Saves the current R&S SMM100A settings in a file. To deteremine the file name and storage location, enter the directory and file name with the command. According to the file type, the R&S SMM100A assigns the extension (`*.savrcltxt`) automatically.

Setting parameters:
<Pathname> string

Example:
```
SYSTem:SAV "/var/user/temp/Test"
// saves the file "Test.savrcltxt" in the directory /var/user/temp/.
```

Usage: Setting only

:SYSTem:RCL <Pathname>

Selects and uploads a `*.savrcltxt` file with previously saved R&S SMM100A settings from the default or a specified directory.

Setting parameters:
<Pathname> string

Example:
```
SYSTem:RCL "/var/user/temp/Test"
// loads the "Test.savrcltxt" file from the directory /var/user/temp/.
```

Usage: Setting only

:SYSTem:PROTect<ch>[:STATe] <State>[, <Key>]

Activates and deactivates the specified protection level.

Suffix:
<ch> Indicates the protection level.
See also "Protection" on page 606

Parameters:
<State> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 1)

Setting parameters:
<Key> integer
The respective functions are disabled when the protection level is activated. No password is required for activation of a level.
A password must be entered to deactivate the protection level.
The default password for the first level is 123456.
This protection level is required to unlock internal adjustments for example.

Example: To activate protection level:
```
SYSTem:PROTect1:STATe 1
```
Internal adjustments or hostname cannot be changed.
To unlock protection level 1:
```
SYSTem:PROTect1:STATe 0,123456
```
Internal adjustments are accessible.

Manual operation: See "Protection Level/Password" on page 612

:SYSTem:COMMunicate:GPIB:LTERminator <LTerminator>

Sets the terminator recognition for remote control via GPIB interface.

Parameters:

<LTerminator> STANdard | EOI

EOI
Recognizes an LF (Line Feed) as the terminator only when it is sent with the line message EOI (End of Line). This setting is recommended particularly for binary block transmissions, as binary blocks may coincidentally contain a characater with value LF (Line Feed), although it is not determined as a terminator.

STANdard
Recognizes an LF (Line Feed) as the terminator regardless of whether it is sent with or without EOI.

*RST: n.a. (factory preset: STANdard)

Example: See Example "To find out VISA resource strings" on page 1055.

:SYSTem:COMMunicate:GPIB:RESource?

Queries the visa resource string for remote control via the GPIB interface.

To change the GPIB address, use the command `:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess`.

Return values:

<Resource> string

Example: See Example "To find out VISA resource strings" on page 1055.

Usage: Query only

:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <Address>

Sets the GPIB address.

Parameters:

<Address> integer

Range: 0 to 30
*RST: n.a. (factory preset: 28)

Example: See Example "To find out VISA resource strings" on page 1055.

Manual operation: See "GPIB Channel Address" on page 644

:SYSTem:COMMunicate:HISLip:RESource?

Queries the VISA resource string. This string is used for remote control of the instrument with HiSLIP protocol.

Return values:
<Resource> string

Example: See Example "To find out VISA resource strings" on page 1055.

Usage: Query only

Manual operation: See "HISLIP" on page 642
See "GPIB" on page 643

:SYSTem:COMMunicate:NETWork:IPADdress <IpAddress>

Sets the IP address.

Parameters:
<IpAddress> string
Range: 0.0.0.0. to ff.ff.ff.ff

Example: See Example "To check network-related settings" on page 1055.

Manual operation: See "IP Address" on page 640

:SYSTem:COMMunicate:NETWork:IPADdress:MODE <Mode>

Selects manual or automatic setting of the IP address.

Parameters:
<Mode> AUTO | STATic
*RST: n.a. (factory preset: AUTO)

Example: See Example "To check network-related settings" on page 1055.

Manual operation: See "Address Mode" on page 640

:SYSTem:COMMunicate:NETWork:MACaddress <MacAddress>

Queries the MAC address of the network adapter.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:
<MacAddress> string

Example: See Example "To check network-related settings" on page 1055.

Manual operation: See "MAC Address" on page 641

:SYSTem:COMMunicate:NETWork:RESource?

Queries the visa resource string for Ethernet instruments.

Return values:
<Resource> string

Example: See Example "To find out VISA resource strings" on page 1055.

Usage: Query only

Manual operation: See "VXI11" on page 642

:SYSTem:COMMunicate:NETWork:RESTart

Restarts the network.

Example: See Example "To restart the network" on page 1055.

Usage: Event

Manual operation: See "Restart Network" on page 639

:SYSTem:COMMunicate:NETWork:STATus?

Queries the network configuration state.

Return values:
<State> 1 | ON | 0 | OFF

Example: See Example "To check network-related settings" on page 1055.

Usage: Query only

Manual operation: See "Network Status" on page 639

:SYSTem:COMMunicate:NETWork[:COMMon]:DOMain <Domain>

Determines the primary suffix of the network domain.

Parameters:
<Domain> string

Example: See Example "To check network-related settings" on page 1055.

Manual operation: See "DNS Suffix" on page 641

:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname <Hostname>

Sets an individual hostname for the R&S SMM100A.

Note: We recommend that you do not change the hostname to avoid problems with the network connection. If you change the hostname, be sure to use a unique name.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:
<Hostname> string

Example: See Example "To check network-related settings" on page 1055.

Manual operation: See "Hostname" on page 640

:SYSTem:COMMunicate:NETWork[:COMMon]:WORKgroup <Workgroup>

Sets an individual workgroup name for the instrument.

Parameters:
<Workgroup> string

Example: See Example "To check network-related settings" on page 1055.

Manual operation: See "Workgroup" on page 640

:SYSTem:COMMunicate:NETWork[:IPADdress]:DNS <DNS>

Determines or queries the network DNS server to resolve the name.

Parameters:
<DNS> string

Example: See Example "To check network-related settings" on page 1055.

Manual operation: See "DNS Server" on page 641

:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway <Gateway>

Sets the IP address of the default gateway.

Parameters:
<Gateway> string
Range: 0.0.0.0 to ff.ff.ff.ff

Example: See Example "To check network-related settings" on page 1055.

Manual operation: See "Default Gateway" on page 641

:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK <Mask>

Sets the subnet mask.

Parameters:
<Mask> string

Example: See Example "To check network-related settings" on page 1055.

Manual operation: See "Subnet Mask" on page 640

:SYSTem:COMMunicate:SERial:BAUD <Baud>

Defines the baudrate for the serial remote control interface.

Parameters:
<Baud> 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200
*RST: n.a. (factory preset: 115200)

Example: See Example "To find out VISA resource strings" on page 1055.

Manual operation: See "Baud Rate" on page 644

:SYSTem:COMMunicate:SERial:PARity <Parity>

Enters the parity for the serial remote control interface.

Parameters:
<Parity> NONE | ODD | EVEN
*RST: n.a. (factory preset: NONE)

Example: See Example "To find out VISA resource strings" on page 1055.

Manual operation: See "Parity" on page 644

:SYSTem:COMMunicate:SERial:RESource?

Queries the visa resource string for the serial remote control interface. This string is used for remote control of the instrument.

Return values:
<Resource> string

Example: See Example "To find out VISA resource strings" on page 1055.

Usage: Query only

Manual operation: See "SERIAL" on page 643

:SYSTem:COMMunicate:SERial:SBITs <SBits>

Defines the number of stop bits for the serial remote control interface.

Parameters:
<SBits> 1 | 2
*RST: n.a. (factory preset: 1)

Example: See Example "To find out VISA resource strings" on page 1055.

Manual operation: See "Stop Bits" on page 644

:SYSTem:COMMunicate:SOCKet:RESource?

Queries the visa resource string for remote control via LAN interface, using TCP/IP socket protocol.

Return values:
<Resource> string

Example: See Example "To find out VISA resource strings" on page 1055.

Usage: Query only

Manual operation: See "Socket" on page 643

:SYSTem:COMMunicate:USB:RESource?

Queries the visa resource string for remote control via the USB interface.

Return values:
<Resource> string

Example: See Example "To find out VISA resource strings" on page 1055.

Usage: Query only

Manual operation: See "USB" on page 643

:SYSTem:HELP:EXPort

Saves the online help as zip archive in the user directory.

Example:
```
:SYSTem:HELP:EXPort
MMEM:CDIR?
// "/var/user"
MMEM:CAT?
// ..,"Log,DIR,4096","help.tgz,BIN,69836600"
// confirms that help zip archive is saved.
```

Usage: Event

Manual operation:: "Setup > Help > Export Help to User Path"

:SYSTem:IDENtification <Identification>

Selects the mode to determine the "IDN String" and the "OPT String" for the instrument, selected with command `:SYSTem:LANGuage`.

Note: While working in an emulation mode, the R&S SMM100A specific command set is disabled, that is, the SCPI command `SYST:IDEN` is discarded.

Parameters:
<Identification> AUTO | USER

AUTO
Automatically determines the strings.

USER
User-defined strings can be selected.

*RST: n.a. (factory preset: AUTO)

Example: `SYST:IDEN AUTO`
Automatically assigns the OPT and IDN strings according to the selected instrument language.

Manual operation: See "Mode" on page 646

:SYSTem:IDENtification:PRESet

Sets the `*IDN` and `*OPT` strings in user defined mode to default values.

Example:
```
SYST:IDEN USER
SYST:IDEN:PRES
```

Usage: Event

Manual operation: See "Set to Default" on page 646

:SYSTem:IRESponse <IdnResponse>

Defines the user defined identification string for `*IDN`.

Note: While working in an emulation mode, the instrument's specific command set is disabled, i.e. the SCPI command `SYST:IRES` is discarded.

Parameters:
<IdnResponse> string

Example:
```
SYST:IDEN USER
// Selects a user-defined identification
SYST:IRES "Test Device"
// Defines identification string 'test device'
*IDN?
// Response: 'test device'
```

Manual operation: See "IDN String" on page 647

:SYSTem:ORESponse <OResponse>

Defines the user defined response string for `*OPT`.

Note: While working in an emulation mode, the instrument's specific command set is disabled, i.e. the SCPI command `SYST:ORES` is discarded.

Parameters:
<OResponse> string

Example:
```
SYST:IDEN USER
// Selects a user-defined identification
SYST:ORES "Test Option"
// Defines the OPT string 'test option'
*OPT?
// Response: 'test option'
```

Manual operation: See "OPT String" on page 647

:SYSTem:LANGuage <Language>

Sets the remote control command set.

Parameters:
<Language> string

Example:
```
SYSTem:LANGuage "SCPI"
// selects SCPI command set
```

Manual operation: See "Language" on page 646

:SYSTem:INFormation:SCPI <InfoString>

Inserts system information in recorded SCPI command lists, for example information on a missing command.

Parameters:
<InfoString> string

Example: `SYST:INF:SCPI "missing command"`
enters the information into a recorded SCPI command list.

:SYSTem:SECurity:NETWork:AVAHi[:STATe] <SecPassWord>, <AvahiState>

Disables the Avahi service for automatic configuration of the instrument in a network.

Parameters:
<AvahiState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

Manual operation: See "LAN Services" on page 614

:SYSTem:SECurity:NETWork:FTP[:STATe] <SecPassWord>, <FtpState>

Disables FTP protocol for file transfer between the instrument and host.

Parameters:
<FtpState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

Manual operation: See "LAN Services" on page 614

:SYSTem:SECurity:NETWork:HTTP[:STATe] <SecPassWord>, <HttpState>

Disables control of the instrument over HTTP, the protocol for hypermedia information systems.

Parameters:
<HttpState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

Manual operation: See "LAN Services" on page 614

:SYSTem:SECurity:NETWork:RAW[:STATe] <SecPassWord>, <RawState>

Disables the LAN interface for remote control of the instrument over raw socket port.

Parameters:
<RawState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

:SYSTem:SECurity:NETWork:REMSupport[:STATe] <NetRemSupport>

Disables communication over SSH (SCP) for service purposes.

Parameters:
<NetRemSupport> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 1)

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

Manual operation: See "LAN Services" on page 614

:SYSTem:SECurity:NETWork:RPC[:STATe] <SecPassWord>, <RpcState>

Enables the LAN interface for remote control of the instrument via remote procedure calls (RPC).

Parameters:
<RpcState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

:SYSTem:SECurity:NETWork:SMB[:STATe] <SecPassWord>, <SmbState>

Disables access to the file system, printers and serial ports in a network over SMB.

Parameters:
<SmbState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

Manual operation: See "LAN Services" on page 614

:SYSTem:SECurity:NETWork:SOE[:STATe] <SecPassWord>, <SoeState>

Disables control of the instrument over LAN using SCPI commands.

Parameters:
<SoeState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

Manual operation: See "LAN Services" on page 614

:SYSTem:SECurity:NETWork:SSH[:STATe] <SecPassWord>, <SshState>

Disables control of the instrument over LAN using the SSH network protocol.

Parameters:
<SshState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

Manual operation: See "LAN Services" on page 614

:SYSTem:SECurity:NETWork:SWUPdate[:STATe] <SecPassWord>, <SwUpdateState>

Disables software update over LAN.

Parameters:
<SwUpdateState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

Manual operation: See "LAN Services" on page 614

:SYSTem:SECurity:NETWork:VNC[:STATe] <SecPassWord>, <VncState>

Disables the VNC interface for remote control of the instrument.

Parameters:
<VncState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.

Example: See Example "To disable the LAN interface and LAN services" on page 1056.

Manual operation: See "LAN Services" on page 614

:SYSTem:SECurity:NETWork[:STATe] <SecPassWord>, <LanStorState>

Disables the LAN interface in general, including all services.

Parameters:
<LanStorState> 1 | ON | 0 | OFF

Setting parameters:
<SecPassWord> string
Current security password.
The default password is 123456.

Example: See Example "To disable the LAN interface and LAN services" on page 1056

Manual operation: See "LAN" on page 614

:SYSTem:SECurity:SANitize[:STATe] <SecPassWord>, <MmemProtState>

Sanitizes the internal memory.

Parameters:
<MmemProtState> 0 | 1 | OFF | ON
*RST: 0

Setting parameters:
<SecPassWord> string

Example: `SYSTem:SECurity:SANitize[:STATe] 1`

Manual operation: See "Sanitize" on page 608

:SYSTem:SECurity:VOLMode[:STATe] <SecPassWord>, <MmemProtState>

Activates volatile mode, so that no user data can be written to the internal memory permanently.

To enable volatile mode, reboot the instrument. Otherwise the change has no effect.

Parameters:
<MmemProtState> 0 | 1 | OFF | ON
*RST: 0

Setting parameters:
<SecPassWord> string
Current security password
The default password is 123456.

Example:
```
SYSTem:SECurity:VOLMode:STATe "123456", 1
SYSTem:REBoot
```

Manual operation: See "Volatile Mode" on page 608

:SYSTem:SPECification? <Id>

Retrieves data sheet information for a specific parameter.

Setting parameters:
<Id> string
Identifies the name of the entry in the data sheet, as queried with the command `:SYSTem:SPECification:IDENtification:CATalog?` on page 1078

Return values:
<ValList> float
Comma-separated list with the specified and, if available, the typical value of the parameter, as specified in the data sheet. See also Section 12.7.4, "Datasheet", on page 668.

Example: See Example "To check the instrument specifications" on page 1054.

Usage: Query only

:SYSTem:SPECification:VERSion <Version>

Selects a data sheet version from the data sheets saved on the instrument.

Further queries regarding the data sheet parameters (<Id>) and their values refer to the selected data sheet.

To query the list of data sheet versions, use the command :SYSTem:SPECification:VERSion:CATalog? on page 1078.

Parameters:
<Version> string

Example: See :SYSTem:SPECification? on page 1077.

:SYSTem:SPECification:IDENtification:CATalog?

Queries the parameter identifiers (<Id>) available in the data sheet.

Return values:
<IdList> string
Comma-separated string of the parameter identifiers (<Id>)

Example: See Example "To check the instrument specifications" on page 1054.

Usage: Query only

:SYSTem:SPECification:PARameter? <Id>[, <Parameter>]

Retrieves data sheet information for a specific parameter.

Setting parameters:
<Id> string
Identifies the name of the entry in the data sheet.
Query the data sheet parameters with the command :SYSTem:SPECification:IDENtification:CATalog?.

<Parameter> float
An additional value the result (ValList) depends on.

Return values:
<ValList> float
Comma-separated list with the specified and, if available, the typical value of the parameter, as specified in the data sheet.

Example: See Example "To check the instrument specifications" on page 1054.

Usage: Query only

:SYSTem:SPECification:VERSion:CATalog?

Queries all data sheet versions stored in the instrument.

Return values:
<VersCatalog> string

Example: See Example "To check the instrument specifications" on page 1054.

Usage: Query only

:SYSTem:SPECification:VERSion:FACTory?

Queries the data sheet version of the factory setting.

Return values:
<Version> string

Example: See Example "To check the instrument specifications" on page 1054.

Usage: Query only

Manual operation: See "Versions" on page 1111

:SYSTem:SRData?

Queris the SCPI recording data from the internal file.

This feature enables you to transfer an instrument configuration to other test environments, as e.g. laboratory virtual instruments.

Return values:
<FileData> block data

Example:
```
SYSTem:SRData?
// #3118:SOURce1:ROSCillator:SOURce EXT
// :SOURce1:FREQuency:CW 4000000000
// :SOURce1:FREQuency:OFFSet 1000000
// :SOURce1:AM1:STATe 1
// :OUTPut1:STATe 1
```

Usage: Query only

:SYSTem:STARtup:COMPlete?

Queries if the startup of the instrument is completed.

Return values:
<Complete> 1 | ON | 0 | OFF
*RST: 0

Example:
```
SYSTem:STARtup:COMPlete?
Response: 1
// the instrument has started and is ready for operation.
```

Usage: Query only

:SYSTem:DATE <Year>, <Month>, <Day>

Queries or sets the date for the instrument-internal calendar.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:

<Year> integer

<Month> integer
Range: 1 to 12

<Day> integer
Range: 1 to 31

Example: See Example "To configure date and time" on page 1057.

Manual operation: See "Date" on page 1117

:SYSTem:NTP:HOSTname <NTPName>

Sets the address of the NTP server. You can enter the IP address, or the hostname of the time server, or even set up an own vendor zone. See the Internet for more information on NTP.

Parameters:

<NTPName> string

Manual operation: See "NTP Address" on page 1117

:SYSTem:NTP:STATe <UseNtpState>

Activates clock synchronization via NTP.

Parameters:

<UseNtpState> 1 | ON | 0 | OFF
*RST: n.a. (factory preset: 0)

Example: See Example "To configure date and time" on page 1057.

Manual operation: See "NTP Address" on page 1117

:SYSTem:TIME <Hour>, <Minute>, <Second>

Queries or sets the time for the instrument-internal clock.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:

<Hour> integer
Range: 0 to 23

<Minute> integer
Range: 0 to 59

<Second> integer
Range: 0 to 59

Example: See Example "To configure date and time" on page 1057.

Manual operation: See "Time" on page 1117

:SYSTem:TIME:ZONE <TimeZone>

Sets the timezone. You can query the list of the available timezones with `:SYSTem:TIME:ZONE:CATalog?`.

Parameters:
<TimeZone> string

Example: See Example "To configure date and time" on page 1057.

Manual operation: See "Timezone" on page 1117

:SYSTem:TIME:ZONE:CATalog?

Querys the list of available timezones.

Return values:
<Catalog>

Example: See Example "To configure date and time" on page 1057.

Usage: Query only

Manual operation: See "Timezone" on page 1117

:SYSTem:TIME:PROTocol <TimeProtocol>

Sets the date and time of the operating system.

Parameters:
<TimeProtocol> OFF | NONE | 0 | NTP | ON | 1

NONE
Sets the date and time according to the selected timezone, see `:SYSTem:TIME:ZONE:CATalog?` on page 1081 and `:SYSTem:TIME:ZONE` on page 1081.

NTP
Sets the date and time derived from the network time protocol. To select the NTP time server, use the commands `:SYSTem:NTP:HOSTname` on page 1080 and `:SYSTem:NTP:STATe` on page 1080.

*RST: n.a. (factory preset: NONE)

Example: See Example "To configure date and time" on page 1057.

Manual operation: See "Time Protocol" on page 1117

:SYSTem:UPTime?

Queries the up time of the operating system.

Return values:
<UpTime> "<ddd.hh:mm:ss>"

Example: `SYSTem:UPTime?`
Response: `"0.08:11:00"`

Usage: Query only

:SYSTem:BIOS:VERSion?

Queries the BIOS version of the instrument.

Return values:
<Version> string

Example: `SYST:BIOS:VERS?`
queries the BIOS version.
`Response: 123456`

Usage: Query only

:SYSTem:VERSion?

Queries the SCPI version the instrument's command set complies with.

Return values:
<Version> string

Example:
```
SYSTem:VERSion
// queries the SCPI version.
Response: "1996"
// the instrument complies with the SCPI version from 1996.
```

Usage: Query only

:SYSTem:OSYStem?

Queries the operating system of the instrument.

Return values:
<OperSystem> string

Example:
```
SYSTem:OSYStem?
Response: "Linux"
```

Usage: Query only

:SYSTem:MMEMory:PATH:USER?

Queries the user directory, that means the directory the R&S SMM100A stores user files on.

Return values:
<PathUser> string

Example:
```
SYSTem:MMEMory:PATH:USER?
Response: "'/var/user/"
```

Usage: Query only

:SYSTem:DFPRint <Directory>

Creates a file with the device footprint of the product.

The content is formatted in machine-readable form, suitable for automatic further processing.

The generic file name is composed of `DeviceFootprint_<SerialNumber>_<Date>_<Time>.xml`. R&S SMM100A saves the file in the definable directory. If the directory is not specified, it saves the footprint file in the internal default directory (`/var/lib/Rohde-Schwarz/DeviceFootprint`).

You can download the file by using the SCPI commands of the `MMEMory` subsystem.

Setting parameters:
<Directory> string

Path to the directory for saving the device footprint file.
Ensure that you have the permission to write into the directory.

Return values:
<DeviceFootprint> string

Information on the product type, identification and the installed hardware, software and further service-related information on the product's configuration.

Example:
```
SYSTem:DFPRint "/var/user/devicefootprint"

SYSTem:DFPRint?
// MMEM:DATA?
// returns the device footprint information saved with SYST:DFPRint
```

:SYSTem:REBoot

Reboots the instrument including the operating system.

Usage: Event

:SYSTem:RESTart

Restarts the instrument without restarting the operating system.

Usage: Event

:SYSTem:SHUTdown

Shuts down the instrument.

Usage: Event

:SYSTem:WAIT <TimeMs>

Delays the execution of the subsequent remote command by the specified time.

This function is useful, for example to execute an SCPI sequence automatically but with a defined time delay between some commands.

See Section 11.4.2, "How to assign actions to the [★ (User)] key", on page 583.

Setting parameters:

<TimeMs> integer

Wait time in ms

Range: 0 to 10000
*RST: 0

Example:

```
SYSTem:WAIT 10000
// Waits 10s before resetting the instrument.
*RST
```

Usage: Setting only

13.19 STATus subsystem

This system contains the commands for the status reporting system.

See also section Network operation and remote control > Status reporting system for detailed information.

*RST on page 713 has no effect on the status registers.

Value ranges

- Queries return the current value of the respective register, which permits a check of the device status.
  Return values: A decimal value in the range 0 to 32767 (=2^{15}-1)
- The configuration commands set the respective register thus determining which status changes of the R&S SMM100A cause the status registers to be changed.
  Setting values: A decimal value in the range 0 to 32767 (=2^{15}-1)

:STATus:OPERation:CONDition?....1085
:STATus:OPERation:ENABle....1085
:STATus:OPERation[:EVENt]....1085
:STATus:OPERation:NTRansition....1086
:STATus:OPERation:PTRansition....1086
:STATus:PRESet....1086
:STATus:QUEStionable:CONDition....1086
:STATus:QUEStionable:ENABle....1087
:STATus:QUEStionable[:EVENt]....1087
:STATus:QUEStionable:NTRansition....1087
:STATus:QUEStionable:PTRansition....1087
:STATus:QUEue[:NEXT]?....1088

:STATus:OPERation:CONDition?

Quieries the content of the CONDition part of the STATus:OPERation register.

This part contains information on the action currently being performed in the instrument. The content is not deleted after being read out because it indicates the current hardware status.

Return values:
<Condition> string

Example: `:STATus:OPERation:CONDition?`

Usage: Query only

:STATus:OPERation:ENABle <Enable>

Sets the bits of the ENABle part of the STATus:OPERation register. This setting determines which events of the Status-Event part are forwarded to the sum bit in the status byte. These events can be used for a service request.

Parameters:
<Enable> string

Example: `:STAT:OPER:ENAB 32767`
all events are forwarded to the sum bit of the status byte.

:STATus:OPERation[:EVENt] < >

Queries the content of the EVENt part of the STATus:OPERation register. This part contains information on the actions performed in the instrument since the last readout. The content of the EVENt part is deleted after being read out.

Parameters:
< > string

Example: `:STAT:OPER:EVEN?`
queries the STATus:OPERation:EVENt register.

:STATus:OPERation:NTRansition <Ntransition>

Sets the bits of the NTRansition part of the STATus:OPERation register. If a bit is set, a transition from 1 to 0 in the condition part causes an entry to be made in the EVENt part of the register. The disappearance of an event in the hardware is thus registered, for example the end of an adjustment.

Parameters:
<Ntransition> string

Example: `:STAT:OPER:NTR 0`
a transition from 1 to 0 in the condition part of the Status:Operation register does not cause an entry to be made in the EVENt part.

:STATus:OPERation:PTRansition <Ptransition>

Sets the bits of the PTRansition part of the STATus:OPERation register. If a bit is set, a transition from 0 to 1 in the condition part causes an entry to be made in the EVENt part of the register. A new event in the hardware is thus registered, for example the start of an adjustment.

Parameters:
<Ptransition> string

Example: `:STAT:OPER:PTR 32767`
all transitions from 0 to 1 in the condition part of the Status:Operation register cause an entry to be made in the EVENt part.

:STATus:PRESet <Preset>

Resets the status registers. All PTRansition parts are set to FFFFh (32767), i.e. all transitions from 0 to 1 are detected. All NTRansition parts are set to 0, i.e. a transition from 1 to 0 in a CONDition bit is not detected. The ENABle parts of STATus:OPERation and STATus:QUEStionable are set to 0, i.e. all events in these registers are not passed on.

Parameters:
<Preset> string

Example: `STAT:PRES`
resets the status registers.

:STATus:QUEStionable:CONDition <Condition>

Queries the content of the CONDition part of the STATus:QUEStionable register. This part contains information on the action currently being performed in the instrument. The content is not deleted after being read out since it indicates the current hardware status.

Parameters:
<Condition> string

Example: `:STATus:QUEStionable:CONDition?`
queries the Status:Questionable:Condition register.

:STATus:QUEStionable:ENABle <Enable>

Sets the bits of the ENABle part of the STATus:QUEStionable register. The enable part determines which events of the STATus:EVENt part are enabled for the summary bit in the status byte. These events can be used for a service request.

If a bit in the ENABle part is 1, and the correesponding EVENt bit is true, a positive transition occurs in the summary bit. This transition is reportet to the next higher level.

Parameters:
<Enable> string

Example: `STAT:QUES:ENAB 1`
Problems when performing an adjustment cause an entry to be made in the sum bit.

:STATus:QUEStionable[:EVENt] < >

Queries the content of the EVENt part of the `STATus:QUEStionable` register. This part contains information on the actions performed in the instrument since the last readout. The content of the EVENt part is deleted after being read out.

Parameters:
< > string

Example: `STAT:QUES:EVEN?`
queries the Status:Questionable:Event register.

:STATus:QUEStionable:NTRansition <Ntransition>

Sets the bits of the NTRansition part of the STATus:QUEStionable register. If a bit is set, a transition from 1 to 0 in the condition part causes an entry to be made in the EVENt part of the register.

Parameters:
<Ntransition> string

Example: `STAT:QUES:NTR 0`
a transition from 1 to 0 in the condition part of the STATus:QUEStionable register does not cause an entry to be made in the EVENt part

---

:STATus:QUEStionable:PTRansition <PTransition>

Sets the bits of the NTRansition part of the STATus:QUEStionable register. If a bit is set, a transition from 1 to 0 in the condition part causes an entry to be made in the EVENt part of the register.

Parameters:
<PTransition> string

Example: `STAT:QUES:PTR 32767`
all transitions from 0 to 1 in the condition part of the STATus:QUEStionable register cause an entry to be made in the EVENt part

---

:STATus:QUEue[:NEXT]?

Queries the oldest entry in the error queue and then deletes it. Positive error numbers denote device-specific errors, and negative error numbers denote error messages defined by SCPI. If the error queue is empty, 0 ("No error") is returned.

The command is identical to `SYSTem:ERRor`.

Return values:
<Next> string

Example: `:STATus:QUEue?`
queries the oldest entry in the error queue.
`Response: 0, 'no error'`
no errors have occurred since the error queue was last read out

Usage: Query only

13.20 TEST subsystem

The `TEST` subsystem contains the commands for performing test routines directly at the hardware assemblies.

The selftetst responses with a `0` if the test is performed successfully, otherwise a value other than `0` is returned. None of the commands of this system has a `*RST` value.

Example: Testing the screen display

```
// show the check screen
:TEST:PIXel:WINdow 1
// selct the color for the display, e.g. blue
TEST:PIXel:COLor BLUE
// select the sequence for changing the color automatically
TEST:PIXel:COLor AUTO //(~3s per color)
// select a specific RGB color, e.g. black
TEST:PIXel:RGBA 0,0,0,255
// turn on the gradient
TEST:PIXel:GRADient 1
// switch to text mode
 :TEST:PIXel:TEXT 1
// set the point size of the text
:TEST:PIXel:POINtsize 600
// exit the check screen
:TEST:PIXel:WINdow 0
```

:TEST:BASeband? 1089
:TEST:BASeband:LOG? 1090
:TEST:BB:BNC:CONNection? 1090
:TEST:BB:BNC:DESTination 1090
:TEST:BB:BNC:LOG? 1091
:TEST:BB:BNC:SOURce 1091
:TEST:BB:GENerator:ARBitrary 1091
:TEST:BB:GENerator:FREQuency<ch> 1092
:TEST:BB:GENerator:GAIN 1092
:TEST:BB:GENerator:SOURce 1092
:TEST:BB:GENerator:STATe 1093
:TEST<hw>:DIRect:BLOCk:READ? 1093
:TEST<hw>:DIRect:BLOCk:WRITe 1093
:TEST<hw>:ALL:STARt 1094
:TEST<hw>:ALL:RESult? 1094
:TEST:PIXel:COLor 1094
:TEST:PIXel:GRADient 1094
:TEST<hw>:PIXel:POINtsize 1094
:TEST:PIXel:RGBA 1095
:TEST:PIXel:TEXT 1095
:TEST:PIXel:WINDow 1095

:TEST:BASeband?

Queries the result of the baseband selftest.

Return values:

<TestBbError> 0 | 1 | RUNning | STOPped

Example:

```
:TEST:BASeband?
// 0
// the test succeeded
```

Usage: Query only

Manual operation: See "Execute Baseband Selftest" on page 1132

:TEST:BASeband:LOG?

Queries the log message reported during the baseband test.

This is a password-protected function. Unlock the protection level 1 to access it.

Return values:
<TestBasebandLog> string

Example:
```
SYSTem:PROTect1 0,123456
TEST:BB:BASeband:LOG?
// queries the reported message
```

Usage: Query only

Manual operation: See "Log Message" on page 1132

:TEST:BB:BNC:CONNection?

Queries the BNC connection test result.

This is a password-protected function. Unlock the protection level 1 to access it.

Return values:
<TestStatus> 0 | 1 | RUNning | STOPped

Example:
```
SYSTem:PROTect1 0,123456
TEST:BB:BNC:CONNection?
// RUN
// test is running
```

Usage: Query only

Manual operation: See "Execute BNC Connection Test" on page 1131

:TEST:BB:BNC:DESTination <BncDestination>

Selects the BNC connection test destination.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:
<BncDestination> AUTO | USER1 | USER2 | USER3 | USER4 | USER5 | USER6 | TRGA | TRGB | C1TMC1 | C1TM2 | C1TM3 | C2TMC4 | C2TM5 | C2TM6 | F1TMC1 | F1TM2 | F1TM3 | F2TMC4 | F2TM5 | F2TM6 | F3TMC1 | F3TM2 | F3TM3 | F4TMC4 | F4TM5 | F4TM6

*RST: USER2

Example:
```
SYSTem:PROTect1 0,123456
TEST:BB:BNC:DESTination TRGA
// tests the instrument trigger connector of path A
```

Manual operation: See "Destination" on page 1131

:TEST:BB:BNC:LOG?

Queries the log message reported during the BNC connector test.

This is a password-protected function. Unlock the protection level 1 to access it.

Return values:
<Log> string

Example:
```
SYSTem:PROTect1 0,123456
TEST:BB:BNC:LOG?
// queries the reported message
```

Usage: Query only

Manual operation: See "Log Message" on page 1131

:TEST:BB:BNC:SOURce <BncSource>

Selects the BNC connection test source.

This is a password-protected function. Unlock the protection level 1 to access it.

Parameters:
<BncSource> AUTO | USER1 | USER2 | USER3 | USER4 | USER5 | USER6 | TRGA | TRGB | C1TMC1 | C1TM2 | C1TM3 | C2TMC4 | C2TM5 | C2TM6 | F1TMC1 | F1TM2 | F1TM3 | F2TMC4 | F2TM5 | F2TM6 | F3TMC1 | F3TM2 | F3TM3 | F4TMC4 | F4TM5 | F4TM6

*RST: USER1

Example:
```
SYSTem:PROTect1 0,123456
TEST:BB:BNC:SOURce AUTO
// detects the connectors at that signal is assigned
// and performs the connecton test
```

Manual operation: See "Source" on page 1131

:TEST:BB:GENerator:ARBitrary <Filename>

Selects the ARB waveform to be tested.

Parameters:
<Filename> string

Example:
```
TEST:BB:GENerator:ARBitrary "3gpp.wv"
// Tests the loaded waveform, generating a 3GPP signal
```

Manual operation: See "Select ARB File" on page 1133

:TEST:BB:GENerator:FREQuency<ch> <Frequency>

Sets the frequency of the test sine or constant I/Q test signal.

Parameters:

<Frequency> float

Range: -250E6 to 250E6
Increment: 1E-3
*RST: 1E6

Example:
```
TEST:BB:GENerator:FREQuency 50 MHz
```

Manual operation: See "Frequency" on page 1133

:TEST:BB:GENerator:GAIN <Gain>

Sets the gain for a sine or constant I/Q test signal.

Parameters:

<Gain> float

Range: -1 to 1
Increment: 1E-6
*RST: 1

Example:
```
TEST:BB:GENerator:GAIN 0.5
// amplifies the test signal by a factor of 0.5
```

Manual operation: See "Gain" on page 1133

:TEST:BB:GENerator:SOURce <IqSource>

Selects the test signal source.

Parameters:

<IqSource> SINE | CONStant | ARB | TTONe

SINE
Generates a sine waveform. To determine the frequency, use command :TEST:BB:GENerator:FREQuency<ch> on page 1092.

CONStant
Uses a constant I/Q test signal.

ARB
Selects a signal generated generated by the ARB.

*RST: SINE

Example:
```
:TEST:BB:GENerator:SOURce SINE
```

Manual operation: See "IQ Source" on page 1133

:TEST:BB:GENerator:STATe <State>

Starts the test generator.

Parameters:

<State> 1 | ON | 0 | OFF
*RST: 0

Example:
```
TEST:BB:GENerator:STATe ON
// activates the test generator
```

Manual operation: See "State" on page 1132

:TEST<hw>:DIRect:BLOCk:READ? <Board>, <SubAddr>, <Addr>[, <Len>]

Direct mode for querying the blocks of the hardware assemblies directly.

The respective hardware assembly responds directly to the command; any safety mechanisms are bypassed. This function is only available via remote control.

Query parameters:

<Board> string

<SubAddr> integer

<Addr> integer

<Len> integer

Return values:

<DataBlock> string

Example:
```
TEST:DIR:BLOC:READ? 'TEST_SCPI',0,0,8
```

Usage: Query only

:TEST<hw>:DIRect:BLOCk:WRITe <BoardName>, <SubAddress>, <StartAddress>, <DataBlock>

Direct mode for programming the blocks of the hardware assemblies directly.

The respective hardware assembly responds directly to the command; any safety mechanisms are bypassed. This function is only available via remote control.

Setting parameters:

<BoardName> string
<Board>, <SubAddr>, <Addr>, <Data>

<SubAddress> integer

<StartAddress> integer

<DataBlock> string

Example:
```
TEST:DIR:BLOC:WRIT 'TEST_SCPI',0,0,#1812345678
```

Usage: Setting only

:TEST<hw>:ALL:STARt

Starts the selftest. Use the command `:TEST<hw>:ALL:RESult?` to query the progress of the test.

Usage: Event

:TEST<hw>:ALL:RESult?

Queries the progress of the performed selftest. Start the selftest with `:TEST<hw>:ALL:STARt`.

Return values:

<Result> 0 | 1 | RUNning | STOPped
*RST: STOPped

Usage: Query only

:TEST:PIXel:COLor <PixTestColor>

Selects the color of the screen.

"AUTO" switches from one color to the next in tme intervals of approximately 3 s per color.

Setting parameters:

<PixTestColor> RED | BLUE | WHITe | GREen | AUTO | GR25 | GR50 | GR75 | BLACk
*RST: RED

Example: See Example "Testing the screen display" on page 1089.

Usage: Setting only

Manual operation: See "Check Display Screen" on page 1125

:TEST:PIXel:GRADient <PixTestGradStat>

Activates the gradient for display screen test.

Parameters:

<PixTestGradStat> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Testing the screen display" on page 1089.

Manual operation: See "Check Display Screen" on page 1125

:TEST<hw>:PIXel:POINtsize <PixTestGradStat>

Sets the point size of the test text.

Parameters:
<PixTestGradStat> integer
Range: 0 to 999
*RST: n.a. (no preset. default: 0)

Example: See Example "Testing the screen display" on page 1089.

Manual operation: See "Check Display Screen" on page 1125

:TEST:PIXel:RGBA

Sets a specific RGBA color for the screen.

Example: See Example "Testing the screen display" on page 1089.

Manual operation: See "Check Display Screen" on page 1125

:TEST:PIXel:TEXT <PixTestGradStat>

Activats the test text mode.

Parameters:
<PixTestGradStat> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Testing the screen display" on page 1089.

Manual operation: See "Check Display Screen" on page 1125

:TEST:PIXel:WINDow <PixTestWindow>

Activates the check display screen.

Setting parameters:
<PixTestWindow> 1 | ON | 0 | OFF
*RST: 0

Example: See Example "Testing the screen display" on page 1089.

Usage: Setting only

Manual operation: See "Check Display Screen" on page 1125

13.21 TRIGger subsystem

The `TRIGger` system contains the commands for selecting the trigger source for the RF and LF sweep.

You can work with an internal or with an externally applied trigger signal. In this case, use the commands in the `SOURce:INPut` subsystem to configure the signal.

The trigger system of the R&S SMM100A is a simplified implementation of the SCPI trigger system. The TRIGger system differs from the SCPI system as follows:

- No INITiate command; the instrument behaves as if INITiate:CONTinuous ON were set.
- Under TRIGger several sweep subsystems exist.
- The trigger source names correspond directly to the various settings of manual control. SCPI uses different names which are also accepted by the instrument. The SCPI names should be used if compatibility is an important consideration.

In addition to these commands, see more trigger-related commands in the modulation and RF signal subsystems.

Table 13-5: Cross-reference between the manual and remote control

R&S proprietary value name	SCPI conform value name	Parameter in manual control
AUTO	IMMediate	"Auto" mode
SINGle	BUS	"Single" mode.
EXTernal	EXTernal	"Ext Single" and "Ext Step" mode. Use command LFO:SWEep:MODE to select between the two sweep modes.
EAUTo	-	"Ext Start/Stop" mode.

:TRIGger<hw>:FSWeep:SOURce....1096
:TRIGger<hw>:LFFSweep:SOURce....1096
:TRIGger<hw>:PSWeep:SOURce....1096
:TRIGger<hw>[:SWEep]:SOURce....1096
:TRIGger<hw>:FSWeep[:IMMediate]....1097
:TRIGger<hw>:LFFSweep:IMMediate....1097
:TRIGger<hw>:PSWeep[:IMMediate]....1097
:TRIGger<hw>[:SWEep][:IMMediate]....1097
:TRIGger<hw>:LFFSweep....1098

:TRIGger<hw>:FSWeep:SOURce <Source>
:TRIGger<hw>:LFFSweep:SOURce <Source>
:TRIGger<hw>:PSWeep:SOURce <Source>
:TRIGger<hw>[:SWEep]:SOURce <Source>

Selects the trigger source for the corresponding sweeps:

- FSWeep - RF frequency
- LFFSweep - LF frequency
- PSWeep - RF level
- SWEep - all sweeps

The source names of the parameters correspond to the values provided in manual control of the instrument. They differ from the SCPI-compliant names, but the instrument accepts both variants.

Use the SCPI name, if compatibility is an important issue. Find the corresponding SCPI-compliant commands in Cross-reference between the manual and remote control.

Setting parameters:

<Source> AUTO | IMMediate | SINGle | BUS | EXTernal | EAUTo

AUTO [IMMediate]
Executes a sweep automatically.
In this free-running mode, the trigger condition is met continuously. I.e. when a sweep is completed, the next one starts immediately.

SINGle [BUS]
Executes one complete sweep cycle.
The following commands initiate a trigger event:
`*TRG` on page 714
`[:SOURce<hw>]:SWEep:POWer:EXECute`
`[:SOURce<hw>]:SWEep[:FREQuency]:EXECute`
`:TRIGger<hw>[:SWEep][:IMMediate]`, `:TRIGger<hw>:PSWeep[:IMMediate]` and `:TRIGger<hw>:FSWeep[:IMMediate]`.
Set the sweep mode with the commands:
`[:SOURce<hw>]:SWEep:POWer:MODE`AUTO|STEP
`[:SOURce<hw>]:SWEep[:FREQuency]:MODE`AUTO|STEP
`[:SOURce<hw>]:LFOutput:SWEep[:FREQuency]:MODE` AUTO|STEP
In step mode (`STEP`), the instrument executes only one step.

EXTernal
An external signal triggers the sweep.

EAUTo
An external signal triggers the sweep. When one sweep is finished, the next sweep starts.
A second trigger event stops the sweep at the current frequency, a third trigger event starts the trigger at the start frequency, and so on.

*RST: AUTO

Example: See Example "Setting up an RF frequency or power sweep" on page 1047

Usage: Setting only

:TRIGger<hw>:FSWeep[:IMMediate]
:TRIGger<hw>:LFFSweep:IMMediate
:TRIGger<hw>:PSWeep[:IMMediate]
:TRIGger<hw>[:SWEep][:IMMediate]

Performs a single sweep and immediately starts the activated, corresponding sweep:

- `FSWeep` - RF frequency
- `PSWeep` - RF level

- LFFSweep - LF frequency
- SWEep - all sweeps

Effective in the following configuration:

- TRIG:FSW|LFFS|PSW|[:SWE]:SOUR **SING**
- SOUR:SWE:FREQ|POW:MODE **AUTO** or SOUR:LFO:SWE:[FREQ:]MODE **AUTO**

Alternatively, you can use the IMMediate command instead of the respective SWEep:[FREQ:]|POW:EXECute command.

Example: TRIG
Starts all active sweeps.

Usage: Event

Manual operation: See "Execute Single Sweep" on page 355

:TRIGger<hw>:LFFSweep

Executes an LF frequency sweep in the following configuration:

- TRIG:LFFS:SOUR SING
- LFO:SWE:MODE AUTO

Example:
```
LFO:SWE:MODE AUTO
TRIG:LFFS:SOUR SING
TRIG:LFFSweep
```

Usage: Event

13.22 UNIT subsystem

The UNIT subsystem is used to set default units for parameters if no unit is indicated in a command. These settings are valid for the entire instrument.

Example: Setting default units for remote control

```
UNIT:POW V
UNIT:ANGL DEG
```

Sets V (volts) as unit of all power parameters, DEG (degrees) for the phase modulation angle and KMH for the speed.

:UNIT:ANGLe.....1098
:UNIT:POWer.....1099

:UNIT:ANGLe <Angle>

Sets the default unit for phase modulation angle. The command affects no other parameters, such as RF phase, or the manual control or display.

Parameters:

<Angle> DEGree | DEGRee | RADian

*RST: RADian

:UNIT:POWer <Power>

Sets the default unit for all power parameters. This setting affects the GUI, as well as all remote control commands that determine power values.

Parameters:

<Power> V | DBUV | DBM

*RST: DBM

14 Troubleshooting and notifications

Handling R&S SMM100A start-up issues

If the product does not start, a blown fuse in the power supply can be the cause. Contact the Rohde & Schwarz customer service to confirm the fault symptoms. If the power supply has a blown fuse, you must return the product to the Rohde & Schwarz customer service to have the power supply replaced. Follow the instructions from the Rohde & Schwarz customer service.

If you need to transport or ship the instrument, see Section 15, "Transporting", on page 1114.

Understanding R&S SMM100A notifications

The R&S SMM100A distinguishes between various notifications caused by events or functions. It displays a notification in the "Info" line on the screen temporarily, and saves all notifications in a history list. In addition, an event initiates an entry in the event/error queue of the status reporting system.

See:

- Section 12.4, "Status reporting system", on page 635
- Section 14.4, "Querying notifications", on page 1103

14.1 Notifications

Notifications inform about operation states of the instrument, and point out deviations, deficiencies or imperfection of functions that initiate an event in the instrument. The instrument distinguishes the notifications according to the significance of the events by different icons.

Some events require that you eliminate the deviation to make sure that the instrument operates correctly.

To access the notifications and history list dialog, see Section 14.4, "Querying notifications", on page 1103. In remote control mode, you can query the notifications using the command `:SYSTem:ERRor:ALL?` on page 1059.

14.1.1 Volatile notifications

Volatile notifications report automatic settings in the instrument (e.g. switching off incompatible types of modulation) or on entries that are not accepted by the instrument (e.g. range violations).

Volatile notifications do not normally demand user actions and disappear automatically after a short period of time. They are saved in the history list, however.

Remote command:

`:SYSTem:ERRor:ALL?` or

`:SYSTem:ERRor:CODE[:NEXT]?`

14.1.2 Permanent notifications

Permanent notifications are displayed if an error occurs that impairs further instrument operation, e.g. a hardware fault. The error signaled by a permanent notification must be eliminated before correct instrument operation can be continued.

The message is displayed until the error is eliminated. It covers the status display in the info line. After error elimination, the message automatically disappears and is also recorded in the history.

Remote command:

`:SYSTem:ERRor:STATic?`

14.2 SCPI notifications

The SCPI notifications are similar for all SCPI instruments. Detailed information and an overview of all notifications as defined in the SCPI standard can be found in the corresponding documentation.

SCPI notifications have negative codes (numbers). The error text being entered into the error/event queue or being displayed is printed in bold face on the left together with the error code. Below the error text, there is an explanation to the respective error.

14.3 Device-specific notifications

The following table contains all error messages specific for the instrument, marked by positive error codes in numerical order and an explanation of the error situation.

The device-specific error messages set bit 3 in the ESR register.

The index provides a list of the error messages sorted according to their error codes.

Error code	Error	Description	Remedy
50	External reference out of range or disconnected	The configured reference frequency source is external but there is no physical external signal or this signal is out of range.	In the "RF Frequency" > "Reference Frequency" dialog, set the correct reference signal source.
140	This modulation forces other modulations off	The instrument disables a modulation because you enabled another modulation. For example, if you enable GSM/EDGE modulation, the state of a previously enabled digital modulation is off.	
180	Adjustment failed	The instrument cannot execute an adjustment.	Generate the adjustment data and load it into the device.
182	Adjustment data missing	Adjustment data is missing.	Generate the adjustment data and load it into the device.
183	Adjustment data invalid	Adjustment data is invalid.	Generate the adjustment data and load it into the device.
200	Cannot access hardware	The data transmission to a module was unsuccessful.	The module is not installed, not properly installed or missing.
201	Hardware revision out of date	You cannot execute a specific function because of a too old hardware version. The driver does not support the installed version of a hardware module.	Consider installing a newer hardware module or downgrading the driver version
202	Cannot access the EEPROM	An error occurs when writing or reading a EEPROM.	The EEPROM is possibly defective. Replace it.
203	Invalid EEPROM data	Reading a EEPROM is possible, however the data are inconsistent.	
204	Driver initialization failed	Initialization of a driver fails when booting the instrument firmware.	The driver is not compatible with the hardware or software configuration of the instrument.
241	No current list	There is no list file selected to execute the required operation.	Select a list file with the correct file extension. If no list files is available, create a list file.
242	Unknown list type specified	The list type selected is not valid for the required operation. For example, the file extension for waveform list files is `*.wv`. It is not possible to enter another file extension when selecting a list.	Check the selected list type.
261	Waveform protected	You cannot transfer a waveform file to an Rohde & Schwarz instrument because the file is encrypted. For example, the simulation software R&S WinIQSIM2 creates protected waveform files.	Install the related waveform file software option or select an unprotected waveform file.
460	Cannot open file	You or the application cannot open the selected file.	Check the file path and filename.
461	Cannot write file	You or the application cannot edit or write the selected file.	Check if the file is read-only.
462	Cannot read file	You or the application cannot read the selected file.	Check if the file contents are compatible with the file type.

Error code	Error	Description	Remedy
463	Filename missing	You cannot execute a task because the filename is missing.	Enter the filename.
464	Invalid filename extension	The file extension is not valid for the required operation.	Check the file extension. For example, the file extension for waveform list files is `*.wv`. It is not possible to enter another file extension when saving a list.
465	File contains invalid data	The file with its file extension contains invalid data. The file extension is wrong for the expected data. For example, if you change the standard file extension of a waveform file from `*.wv` to `*.txt`, the instrument cannot read the waveform file anymore.	Check the file extension.

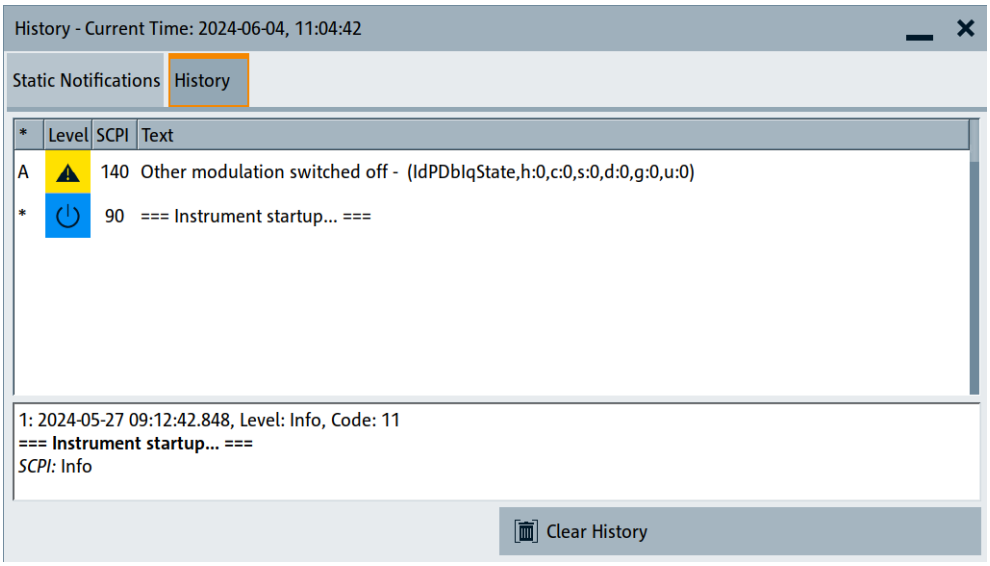
14.4 Querying notifications

The R&S SMM100A monitors the functions performed and automatically detects irregularities. The instrument displays corresponding notifications in the "Info" line and collects all notifications in a history with a detailed description.

Find details to the system notifications in Section 14, "Troubleshooting and notifications", on page 1100.

To monitor static notifications and history

► On the front panel, press the [Info] key.



- The "Static Notifications" dialog lists the recently monitored notifications chronologically and displays additional information on the highlighted message.

- The "History" dialog lists the accumulated messages with a short description. The software reports volatile notifications once. The "Info" line displays identical errors repeatedly only if the original error disappeared. Selecting this info line also opens the "Static Notifications" dialog.

Handling permanent notifications

If any critical error occurs, the R&S SMM100A automatically shows the warning icon in the taskbar. Select the icon to obtain information on the error and the number of occurrences.

The icon is assigned to permanent notifications. The notification and icon are displayed until the error is eliminated.

Static Notifications/History

Toggles between "Static Notifications" and the "History" tab in the info dialog.

Remote command:
`:SYSTem:ERRor[:NEXT]?` on page 1061
Each time a `SYST:ERR:NEXT?` query is sent, the eldest entry in the error queue is returned and at the same time cleared in the list.
`:SYSTem:ERRor:STATic?` on page 1062
Queries the list of all errors.

Clear History

Clears all messages in the "History" tab.

Remote command:
`:SYSTem:ERRor:ALL?` on page 1059
Each time a `SYST:ERR:ALL?` query is sent, the error queue is returned and at the same time cleared.
`:SYSTem:ERRor:HISTory:CLEar` on page 1062
Clears the messages in the "History" view.

14.5 Resolving network connection failures

Several issues may cause failures in the network connection to the instrument. This section lists the most likely reasons and the recommended solutions.

Common reasons for network connection failures

- Network connecting cables and cable connectors of poor quality
- Incompatibility between the network interface of the R&S SMM100A and certain switches or routers available on the market
- An invalid IP address assigned to the instrument

Possible solutions to network connection failures

1. **NOTICE!** Risk of network failure. Connecting to the network can cause network failure. 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

2. Try out the following to resolve network connection failures:

   - Exchange connecting cables, if obvious damage is visible.
     See also "Cable selection to minimize electromagnetic interference" on page 28.
   - Observe the link status LED on the R&S SMM100A or the connected network device. The link status LED is located next to the LAN connector.
     If a link failure is detected, connect the instrument to a different device port or to a different network device.
   - Check whether the LAN interface and the required LAN services are enabled.
     See Section 11.6.4, "Configuring LAN services", on page 612.
   - If the IP address is set manually (no DHCP) or obtained with the Zeroconf (Avahi) protocol:
     – Check whether the IP address of the instrument is within the network's address range.
     – Check whether the IP address is valid.

     See also "IP Address" on page 640.

14.6 Resolving errors during internal adjustments

Internal adjustments can fail for various reasons, e.g. if the adjustment data is invalid or missing, or if any error causes process to abort.

To resolve a failed adjustment process, you have the following options:

- Abort on error (default setting), see "To resolve aborted internal adjustments" on page 1105
- Continue on error, see "To continue internal adjustments on error" on page 1106
- Record the adjustment process in a log file and request technical support, see "To record failed adjustments and request technical support" on page 1106

To resolve aborted internal adjustments

If an error occurs, the R&S SMM100A displays a notification in the "Information" field and saves the notification in the history list.

1. Select "System Config > Info / Notifications".
2. Look up the error code of the notification in the overview of device-specific notifications.
   See Section 14.3, "Device-specific notifications", on page 1101.

   The overview provides a brief explanation of all notifications and information on how to fix an error.

3. To resolve an adjustment failure, generate adjustment data and load it into the instrument.
4. Restart internal adjustments as described in "Running internal adjustments" on page 1129

   If the error persists:
   Contact the Rohde & Schwarz customer support, see Section 14.9, "Collecting information for technical support", on page 1111.

To continue internal adjustments on error

If the failed internal adjustments has no significant effect on your application, you can skip it and continue the calibration despite the error message. This function is password-protected.

1. Select "System Config > Setup > Security > Protection".
2. Unlock protection level 1, see"Protection Level/Password" on page 612.
3. Select "System Config > Setup > Internal Adjustment > Configuration > Continue Adjustment on Error > On".
4. Proceed as described in "Running internal adjustments" on page 1129.

To record failed adjustments and request technical support

Logging the internal adjustment process is password-protected.

1. Select "System Config > Setup > Security > Protection".
2. Unlock protection level 1, see"Protection Level/Password" on page 612.
3. To enable recording, select "System Config > Setup > Internal Adjustment > Adjustment Configuration" > Log Debug Info > "On".
4. Send the report to the Rohde & Schwarz customer support for an initial check. See Section 14.9, "Collecting information for technical support", on page 1111.

14.7 Measuring USB cable quality

To check the quality of the USB cable, see the service manual of the R&S SMM100A.

14.8 Checking the instrument configuration

The R&S SMM100A uses various hardware and software components. To get an overview, you can check the instrument assemblies, hardware options, software options and the firmware version. The "Hardware Config" and "Versions/Options" dialogs list all components according to their hardware configuration, software options and connected Rohde & Schwarz equipment, like R&S NRP power sensors.

Installing software and hardware options

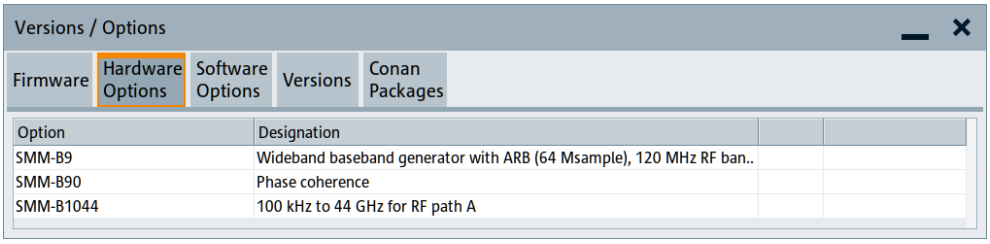
Activate newly purchased software options with a keycode. After purchase, the keycode is part of the delivery of the software option. See also Section 11.5, "Managing licenses and license keys", on page 586.

For installing newly purchased hardware options, contact Rohde & Schwarz customer support.

Checking the installed hardware options

To find out the installed options:

1. Select "System Config" > "Setup" > "Instrument Assembly" > "Versions / Options".
2. Select "Hardware Options".



The dialog lists installed hardware options on the R&S SMM100A.

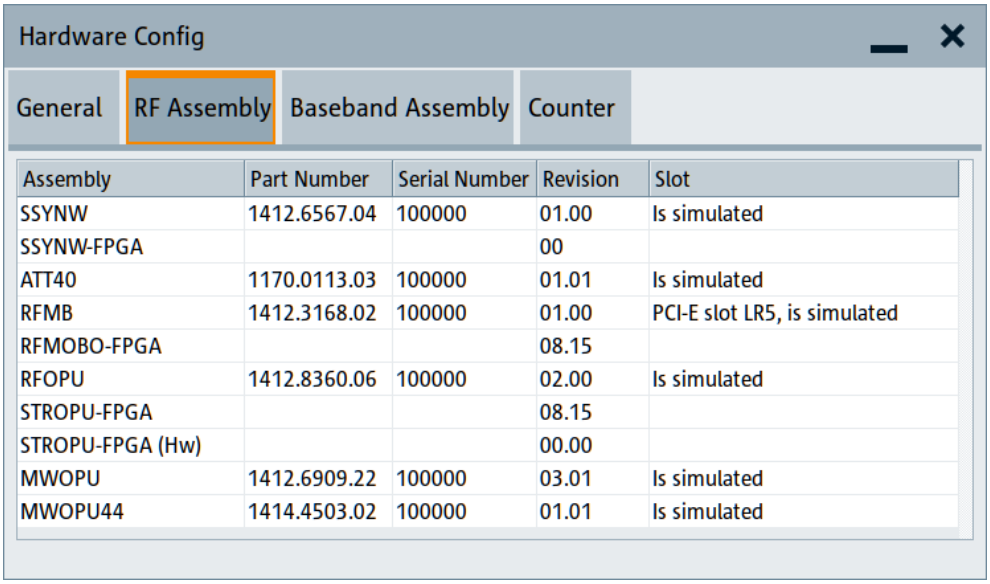
Proceed the same way to get information on the firmware or the installed software options in the corresponding tab.

Checking the RF hardware assembly

To find out the installed RF hardware:

1. Select "System Config" > "Setup" > "Instrument Assembly" > "Hardware Config".

2. Select "RF Assembly".



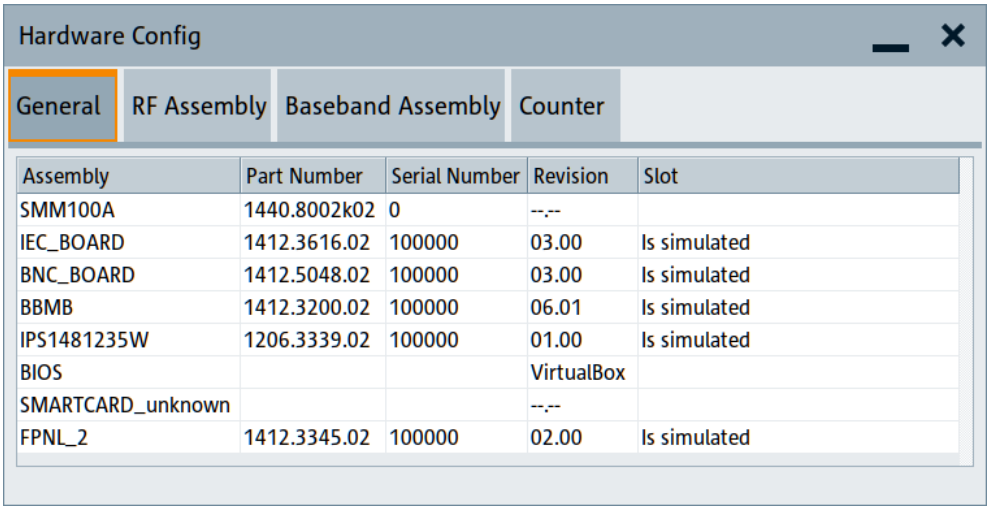
The dialog lists the installed RF hardware components installed on the R&S SMM100A.

Proceed the same way to get information on general or baseband hardware modules or on the operating times of the R&S SMM100A in the corresponding tab.

14.8.1 Hardware configuration settings

Access:

► Select "System Config" > "Setup" > "Instrument Assembly" > "Hardware Config".



The "Hardware Config" dialog lists all installed assemblies and connected external instruments with information on their part and serial numbers, and revision states. Also, it lists the BIOS version. A firmware update does not update the BIOS version. The "Counter" tab provides information on the operation time, the number of times that the instrument was powered on and the last factory calibration of the instrument.

The remote commands required to query the hardware configuration are described in Section 13.8, "DIAGnostic subsystem", on page 738.

Assembly
The tables in the tabs show characteristics of the installed assemblies.

"Assembly" Assembly designation.

"Part Number" Part number of the assembly.

"Serial Number" Serial number of the assembly.

"Revision" Revision state of the assembly.

"Slot" Indicates whether the assembly is connected to the serial bus or PCI bus.

Remote command:
`:DIAGnostic<hw>:BGINfo?` on page 740

Counter
Displays information on the operation times of the R&S SMM100A.

Operation Time / h ← Counter
Displays the operation time in hours so far.

Remote command:
`:DIAGnostic:INFO:OTIMe?` on page 740

Power On Count ← Counter
Displays the number the instrument has been turned on.

Remote command:
`:DIAGnostic:INFO:POCount?` on page 740

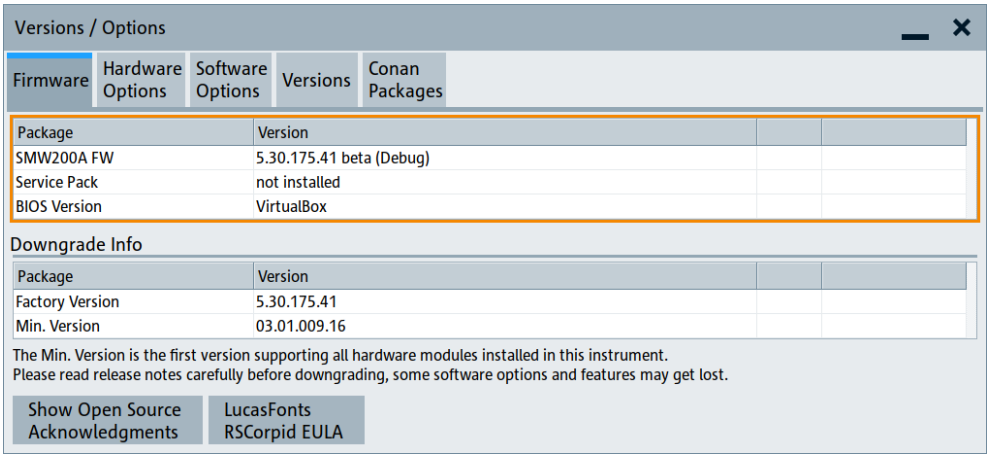
Last Full Factory Adjustment ← Counter
Displays the date of the last factory calibration.

Remote command:
`:CALibration:DATA:FACTory:DATE?` on page 735

14.8.2 Versions and options settings

Access:

► Select "System Config" > "Setup" > "Instrument Assembly" > "Versions / Options".



The "Versions / Options" dialog shows the version of the installed instrument firmware, the hardware and software options, the data sheet and the software components of the firmware. The BIOS version is also listed; firmware updates do not update the BIOS version.

The remote commands required to query the hardware configuration are described in Section 13.8, "DIAGnostic subsystem", on page 738.

Firmware
Shows the firmware version and the version of the software platform.

Note: Your instrument is delivered with the latest firmware version available.
You can download firmware updates and the "Release Notes" that describe the modifications and the firmware update procedure.

See www.rohde-schwarz.com/firmware/smm100a

Remote command:
n.a.

Downgrade Info
Shows downgrade information, like factory firmware version and minimum firmware version to that the instrument can be downgraded.

Remote command:
n.a.

Show Open Source Acknowledgments
Accesses the list of the used open-source software packages and the corresponding verbatim license texts.

LucasFonts RSCorpid EULA
Accesses copyright information on LucasFonts font type RSCorpid EULA.

Hardware Options/Software Options
The tables in the "Hardware" and "Software" tabs list the installed hardware and software options.

"Option" Short name of option

"Designation" Name of option

"Licenses" (optional)
Number of licenses.

"Expiration Date"
For regular options, "Permanent" is indicated in this column.
For options with floating licenses, the expiration date indicates, how long the option is enabled on the instrument. When the time has elapsed, the R&S SMM100A blocks further use of the option.

Remote command:
`*OPT?` on page 712
`*IDN?` on page 712

Versions
The "Versions" tab shows the versions of the technical specification of the R&S SMM100A and of the software components that comprise the firmware.

"Package" Name of the component.

"Version" Current issue of the component.
E.g. the data sheet covers the technical data of the hardware components of the factory settings.
See also Section 12.7.4, "Datasheet", on page 668.

Remote command:
`:SYSTem:SPECification:VERSion:FACTory?` on page 1079

14.9 Collecting information for technical support

If you encounter problems that you cannot solve yourself, contact your Rohde & Schwarz support center at www.rohde-schwarz.com/support. Our support center staff is optimally trained to assist you in solving problems.

The support center finds solutions more quickly and efficiently if you provide them with information on the instrument and an error description.

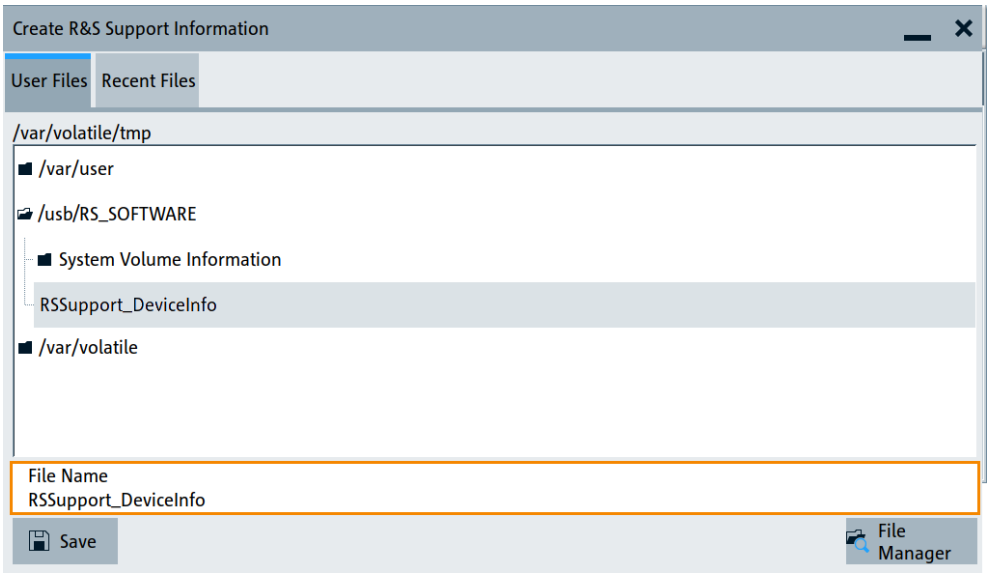
- The following dialog boxes in the "Setup > Instrument Assembly" menu provide useful information:
  - **Hardware Configuration:** hardware assemblies
  - **Software and Options:** the status of all software and hardware options installed on your instrument
- **System Messages:** displayed in the "Info" line and provide information on any errors that have occurred
- **Support file:** a special file (`*.tar.gz` file) with important support information that can be created automatically.
  The support `*.tar.gz` file has a user-definable name and contains the following files and information:
  - `SgErrors.txt`: chronological record of errors

- `SystemRestaurationSMM100A.savrcltxt`: instrument settings at the last correct shutdown of the instrument
- `UndoHistSuppInfo.xml`: list of the last user interactions
- `DeviceFootprint_<SerialNumber>_<Date>_<Time>.xml`: service-related information on the instrument's configuration.
- `crashlog.txt`, `coredump`: Postmortem debug info
- Several files with information on the last performed adjustment and self-test.

See also the description of error messages Section 14.1, "Notifications", on page 1100.

To collect error information in a support file

1. Connect a USB device to the R&S SMM100A.
2. Select "System Config > Setup > Maintenance > Create R&S Support Information".
3. In the "Create R&S Support Information" dialog, navigate to the `/usb` directory. Enter the support filename, for example `RSSupport_DeviceInfo`.



The error information and further required data are collected automatically.
The support file `RSSupport_DeviceInfo.tar.gz` is created and stored in the `/usb` directory.
Collect the error information and attach it to an email in which you describe the problem. Send the email to the customer support address as listed on the Internet (www.rohde-schwarz.com/support).

To remove sensitive data

► For information on how to handle or remove the sensitive data from your instrument, refer to the description "R&S SMM100A Instrument Security Procedures".

To pack and transport the instrument

► If you need to transport or ship the instrument, see Section 15, "Transporting", on page 1114.

14.10 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 14-1: QR code to the Rohde & Schwarz support page

15 Transporting

Lifting and carrying

For safety information, see:

- "Lifting and carrying the product" on page 21
- Section 3.1.1, "Lifting and carrying", on page 25

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 R&S SMM100A in a vehicle or using transporting equipment, make sure that the R&S SMM100A is properly secured. Only use items intended for securing objects.

Transport altitude

The maximum transport altitude without pressure compensation is specified in the specifications document.

16 Maintenance, storage and disposal

We advise to check the nominal data from time to time.

16.1 Cleaning

How to clean the product is described in "Cleaning the product" on page 22.

Do not use any liquids for cleaning. Cleaning agents, solvents, acids and bases can damage the front panel labeling, plastic parts and display.

16.2 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.

16.3 Performing maintenance tasks

The R&S SMM100A is accurate due to integrated adjustment procedures and the following additional capabilities that assure correct functioning:

- Internal adjustments
  Internal adjustments are integrated self-calibration routines, which you can execute directly on the instrument.
  How to: See Section 16.3.4.3, "How to use the internal adjustments", on page 1129.
  Self-calibration routines that require additional equipment are performed at an authorized Rohde & Schwarz service center. For description, see the R&S SMM100A service manual.
- Self-test
  A self-test is provided for service purposes.
  We recommend that you perform a selftest, if the instrument does not respond as expected.
  How to: See Section 16.3.5.4, "How to set up the R&S SMM100A for BNC connections tests", on page 1133.
- Test points
  If necessary for service purposes, internal test points can be queried. For description, see the R&S SMM100A service manual.

- Date and time 1116
- Check front panel 1118
- Check display screen 1124

- Internal adjustments 1125
- Selftest 1130
- FPGA/uC update settings 1134

16.3.1 Date and time

The R&S SMM100A uses an internal real-time clock to determine the date and time. It adjusts the time and date to the timezone of your location automatically, by providing a selection list of continents and cities.

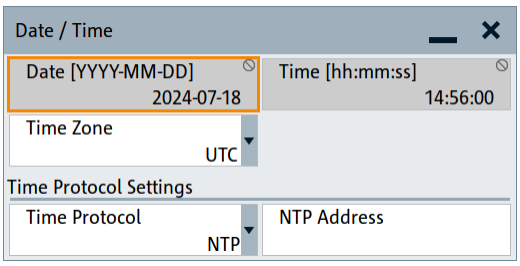
The instrument records the time whenever you create or modify files on your instrument or you use timed licenses. By default, the instrument is set to the UTC timezone, but you can select the timezone according to your location.

Moreover, the instrument supports NTP protocol for synchronizing all connected instruments and computer systems to minimize time delays in the network.

16.3.1.1 Date and time settings

Access:

► Select "System Config" > "Setup" > "Maintenance" > "Date / Time".



The "Date / Time" dialog contains the time and data settings of the operating system.
This function is password-protected. Unlock the protection level 1 to access it.
You can also set the time zone for your location, and select a time protocol controlled by a time server for synchronization.

The required remote commands are described in Section 13.18, "SYSTem subsystem", on page 1054.

Settings:

Date 1117
Time 1117
Timezone 1117
Time Protocol 1117
NTP Address 1117

Date
Displays the date set in the operating system in the format [yyyy.mm.dd].

Remote command:
:SYSTem:DATE on page 1080

Time
Displays the time set in the operating system in the format [hh.mm.ss].

The time setting corresponds to the selected Timezone.

Remote command:
:SYSTem:TIME on page 1080

Timezone
Selects the timezone in the date and time settings of the operating system.

You can select the timezone according to the major cities on the respective continents.

Tip: By typing the first letter, you can quickly navigate through the lists to find the desired destination.

Remote command:
:SYSTem:TIME:ZONE on page 1081
:SYSTem:TIME:ZONE:CATalog? on page 1081

Time Protocol
Enables the instrument to refer to a network time protocol.

A network time protocol synchronizes the system clocks of all participating devices in a computer network (Ethernet). A time server in the network provides the time base for the connected devices that refer to this time to synchronize events.

You can select a high-precision time protocol to achieve high clock accuracy and thus reduce the impact of varying network delays.

"None" Refers to the selected timezone, see "Timezone" on page 1117.

"NTP" Uses the network time protocol (NTP).

Remote command:
:SYSTem:TIME:PROTocol on page 1081

NTP Address
Sets the IP address or host name of the NTP server.

When the server is detected and verified, the instrument enables the connection automatically.

Remote command:
:SYSTem:NTP:HOSTname on page 1080
:SYSTem:NTP:STATe on page 1080

16.3.1.2 How to set date and time

To select the timezone

1. Press the [Setup] key.
2. Select "Maintenance > Date /Time > Timezone".
3. Select continent and city of your location.
   Tip: By typing the first letter, you can quickly navigate through the lists to find the desired destination.
4. Close the dialogs.

   The instrument adjusts the time according to the selected location.

To set the date and time

1. **NOTICE!**
   This function is password-protected. Unlock the protection level 1 to access it.

   Since the date and time settings affect time-based options, changing the date and time can therefore lead to loss of access to the function of the options. We recommend that you only change the system time in urgent cases.

   If the time is not displayed correctly, the internal CMOS battery can be discharged. To change the battery, contact your Rohde & Schwarz support center at www.rohde-schwarz.com/support.

   Press the [Setup] key.
2. Select "Security > Protection".
3. Enable the "Protection Level 1".
   The default password is *123456*.
4. Select "Setup > Maintenance > Date / Time".
5. Adjust the settings.
6. Close the dialogs.

   The instrument sets the new date and time.

16.3.2 Check front panel

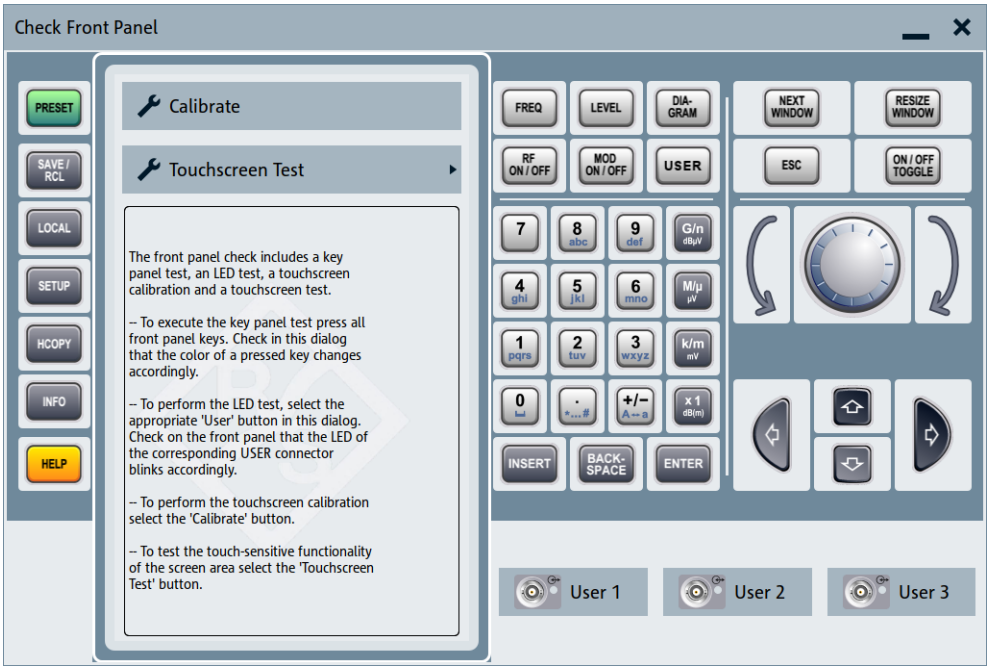
Within this dialog, you can verify the functionality of the control keys.

How To: See Section 16.3.2.2, "How to test the front panel", on page 1119

16.3.2.1 Check front panel settings

Access:

► Select "System Config > Setup > Maintenance > Check Front Panel".



Reflecting the front panel, the "Check Front Panel" dialog contains all functions to test the operating elements of the instrument.
In addition, you can check the touch-sensitive functionality by dragging one or more lines across the screen with your finger.

Calibrate
Executes the touchscreen calibration.

See "Calibrating the touchscreen" on page 1120.

Touchscreen Test
Enables you to perform a touchscreen test. This test checks whether the touchscreen area has gaps in the response.

See "Testing the touchscreen" on page 1122

16.3.2.2 How to test the front panel

See:

- "Calibrating the touchscreen" on page 1120
- "Testing the key panel" on page 1120
- "Testing the LEDs" on page 1121
- "Testing the touchscreen" on page 1122

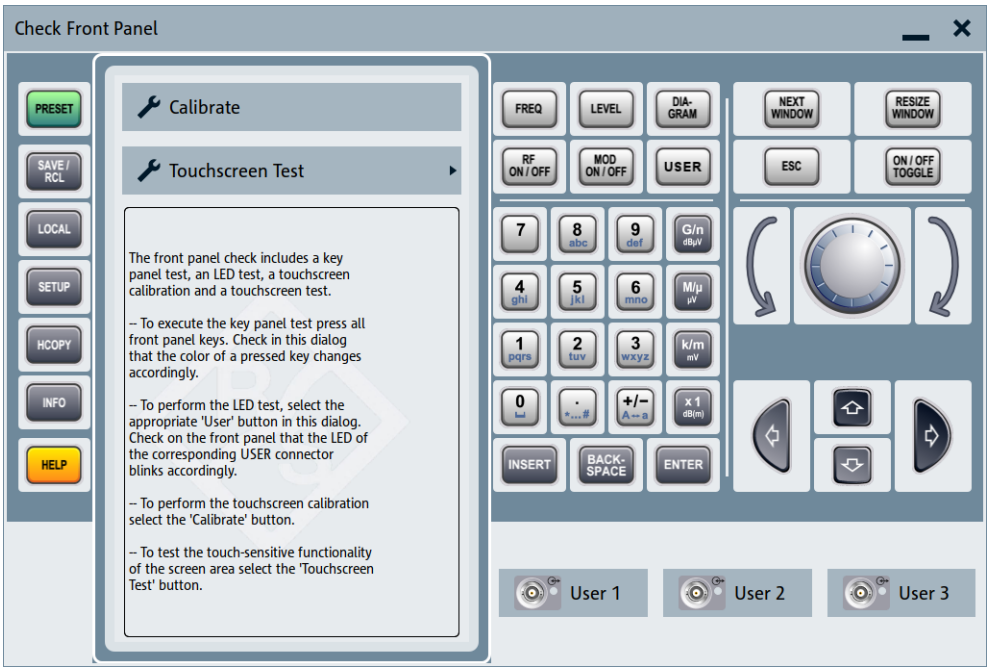
- "Terminating the test" on page 1123
- "Debugging" on page 1124

Calibrating the touchscreen

The screen responds to the touch of your finger, that means you can select or activate an item by tapping it. Due to the design of the touchscreen, the capture area is firmly set to a certain size and you do not need to define a range. If the instrument does not respond correctly to the touch, we recommend that you calibrate the touchscreen.

1. Press the [Setup] key.
2. Select the "Maintenance > Check Front Panel"

   The "Check Front Panel" opens.



3. Select "Calibrate".
4. Tap the calibration points.

   The instrument completes the calibration process automatically and returns to the "Check Front Panel" dialog.

Testing the key panel

To perform the key panel test, you operate the keys at the front panel, and check the response of the instrument in the "Check Front Panel" dialog. To perform this test properly, check each key of the front panel. The test is only completed, when you have verified all keys.

During the test, the actual functions of the keys are disabled.

1. Press the [Setup] key.

2. Select "Maintenance > Check Front Panel"
   The "Check Front Panel" dialog opens.
3. Press a key on the front panel.
   Check if the corresponding key in the "Check Front Panel" dialog turns green.
4. Press the same key a second time.
   Check that the key in the dialog turns red.
   Note: Pressing the same key again has no further effect, except for the [Esc] key. Pressing this key a third time, terminates the test procedure.
5. Continue with the next key on the front panel and repeat step 3 to step 5 until all keys are tested.

   The test is completed, when each key is verified successfully, confirmed by a "Test passed" message.

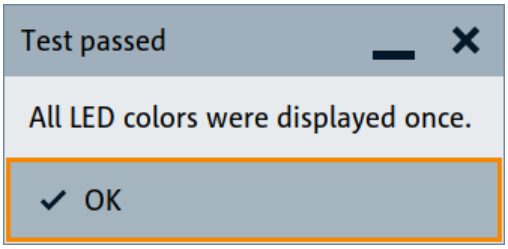
Testing the LEDs

To perform the LED test, you operate the corresponding "★ (User)" buttons in the "Check Front Panel" dialog, and check the response of the connector LEDs on the front panel. To perform this test properly, check each User connector. The test is only completed, when you have verified [Setup] the functionality of all connector LEDs.

Proceed as follows:

1. Press the key.
2. Select "Maintenance > Check Front Panel"
   The "Check Front Panel" dialog opens.
3. Select a "★ (User)" button in the dialog.
   The associated LED in the dialog changes its color.
   Check that the LED of the corresponding User connector on the front blinks in the same color.
4. Repeat step 3 until all possible colors were displayed once. With the last step, the associated LED in the dialog changes to gray and the "★ (User)" button turns green.
   Check that the LED of the corresponding User connector on the front panel stops blinking.
   Note: Selecting the same user connector again has no further effect.
5. Repeat step 3 and step 3 for the remaining "★ (User)" buttons, until all connector LEDs are tested.

   The test is completed, when each LED functionality is verified successfully.



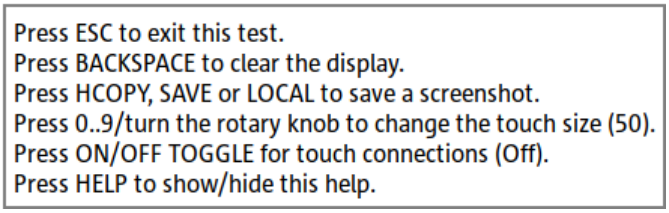
When you have completed the test and close the dialog, the LEDs switch back to the state they had before the test, according to the current settings of the User connector.

Expected responses:

- Selecting the "★ (User)" button three times (the LED at the front panel is blinking green, yellow, red)
- Selecting the "★ (User)" key once more, the LED turns off.
- After testing all LEDs, a "Test passed" message confirms the success.

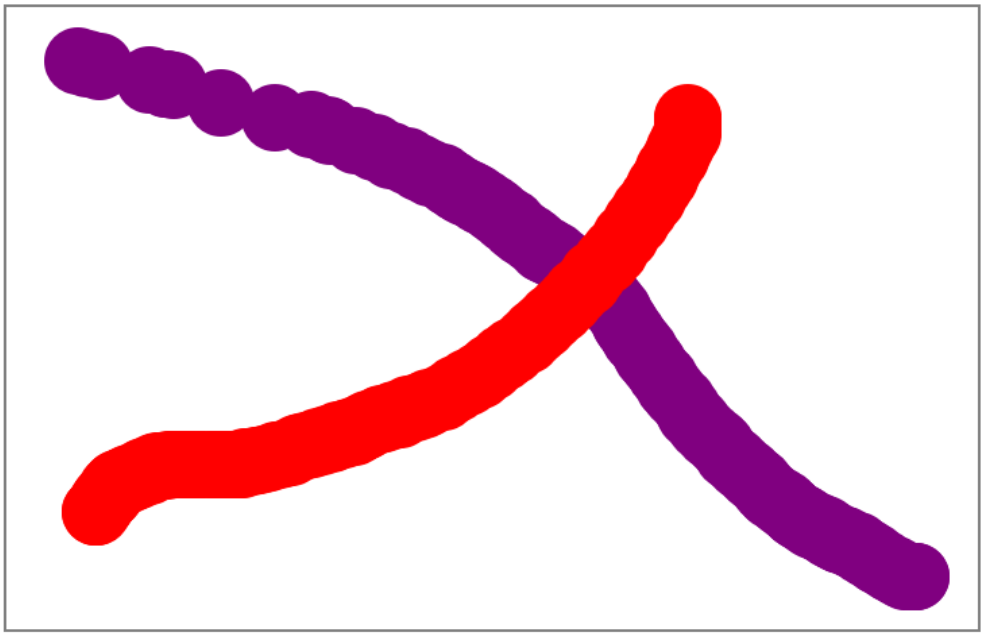
Testing the touchscreen

1. Press the [Setup] key.
2. Select "Maintenance > Check Front Panel"
   The "Check Front Panel" dialog opens.
3. Select "Touchscreen Test" to access the "Finger Paint" test window.

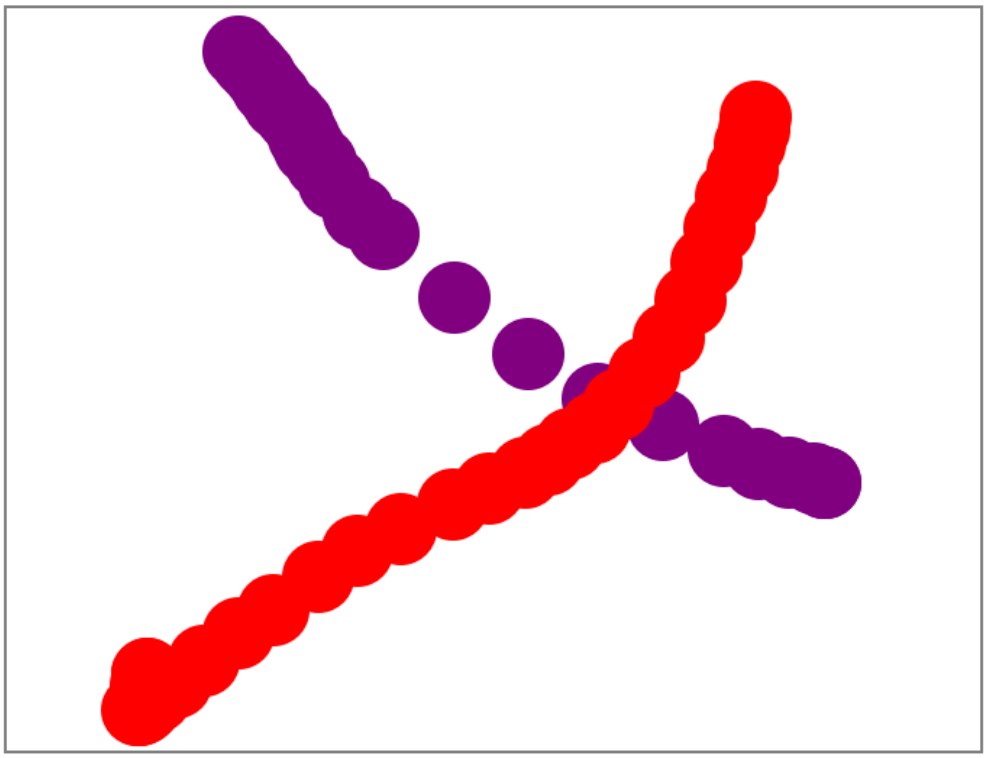


4. Drag with your finger one or more lines, for example diagonally across the screen.
   The test traces the movements of your finger on the screen.

   The following results are expected:
   - If the lines are uninterrupted, the touchscreen works properly.



- If there are any gaps, the touch-sensitive functionality is damaged.



- To return to the "Check Front Panel" dialog, press [Esc].

Terminating the test

► Press the [Esc] key.

Exits the "Check Front Panel" dialog.

Debugging

1. If you detect a malfunction, for example, when you press the front panel key for the first time, and the color of the button in the dialog turns red (instead of green), the front panel key has probably stuck.
2. Contact the Rohde & Schwarz customer support, see Section 14.9, "Collecting information for technical support", on page 1111.

16.3.3 Check display screen

Using this function, you can verify the color depth and gradient, pixels and the text display of the screen.

Access:

► Select "System Config > Setup > Maintenance > Check Display Screen".

The R&S SMM100A fades out the current display and indicates the screen in red. Short instructions on the screen explain how to execute the test.

The remote commands required to define these settings are described in Section 13.20, "TEST subsystem", on page 1088.

Testing the display screen

1. Press the [Setup] key.
2. Select "Maintenance > Check Display Screen"
   The "Check Display Screen" window opens.
3. Test the color and gradient of the display screen:

   a) Use the [Help] key to hide the indicated text.

b) To toggle between the provided colors manually, use the navigation controls [Left/Right] or the rotary knob.
The R&S SMM100A provides the colors red, green, blue, white, three levels of gray shades and black.
c) To switch between the screen colors automatically, use the [Up] key.
d) To toggle the gradient, use the [Down] key.

4. Check if the R&S SMM100A indicates the text correctly:
   a) Press [1] on the numeric keypad.
   The R&S SMM100A displays a test text over the entire screen.
   b) To inspect the text in detail, you can use the rotary knob to zoom it out.
5. To exit the test, press the [Esc] key.

Check Display Screen..... 1125

Check Display Screen
Opens the test window with instructions on how to perform the test.

Remote command:
`:TEST:PIXel:WINDow` on page 1095
`:TEST:PIXel:COLor` on page 1094
`:TEST:PIXel:RGBA` on page 1095
`:TEST:PIXel:GRADient` on page 1094
`:TEST:PIXel:TEXT` on page 1095
`:TEST<hw>:PIXel:POINtsize` on page 1094

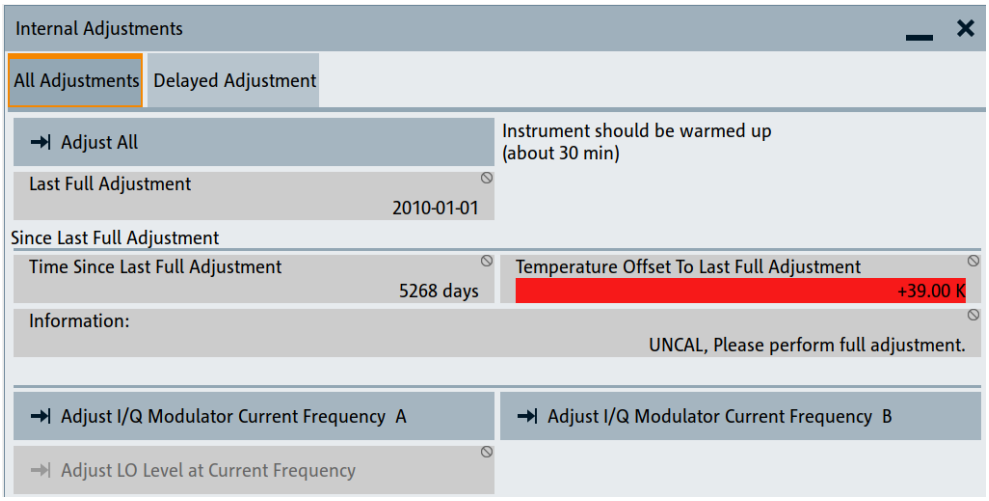
16.3.4 Internal adjustments

Using the integrated adjustment procedures, you can start the calibration directly on the instrument.

16.3.4.1 Internal adjustment settings

Access:

► Select "System Config > Setup > General > Internal Adjustments".



In this dialog, you can perform internal calibration routines, and get information on the last performed calibration.
The "Temperature Offset" indicates the deviation of the current temperature of the instrument, compared to the temperature of the last adjustment.

The remote commands required to define these settings are described in Section 13.7, "CALibration subsystem", on page 732.

How to: See Section 16.3.4.3, "How to use the internal adjustments", on page 1129.

Settings

Adjust All
Executes all available internal calibration routines of the instrument.

Note: Before you start the internal adjustment, make sure that you have connected a termination resistor, if necessary.

Remote command:
`:CALibration:ALL[:MEASure]?` on page 733

Last Full Adjustment
Displays the date of the last fully performed adjustment.

Remote command:
`:CALibration<hw>:ALL:DATE?` on page 734

Time
Displays the elapsed time since the last full adjustment.

If the last adjustment has been performed more than 100 days ago, the background color of the parameter turns red.

Remote command:
:CALibration<hw>:ALL:TIME? on page 734

Temperature Offset
Displays the temperature difference, comparing the temperature of the last adjustment to the current instrument temperature.

A green checkmark indícates that the offset is within the permitted range. If the temperature deviates more than ±5 K, the instrument indicates a warning icon.

Remote command:
:CALibration<hw>:ALL:TEMP? on page 734

Information
Displays information to the current adjustment state.

Remote command:
:CALibration<hw>:ALL:INFormation? on page 734

Adjust I/Q Modulator Current Frequency
Starts the adjustment for the I/Q modulator for the currently set frequency and baseband gain. The I/Q modulator is adjusted regarding carrier leakage, I/Q imbalance and quadrature.

How to: "To correct systematic I/Q modulation errors" on page 291

Remote command:
:CALibration<hw>:IQModulator:LOCal? on page 737

Adjust External Frequency Converter
Calibrates the parameters of an externally connected R&S SZU IQ Upconverter.

The function is available when an R&S SZU is connected and activated.

Remote command:
:CALibration<hw>:FREQuency:CONVerter:EXTernal? on page 737

Continue Adjustment on Error
Continues the calibration even though an error was detected. By default adjustments are aborted on error.

This function is password-protected. Unlock the protection level 1 to access it.

Remote command:
:CALibration<hw>:CONTinueonerror on page 735

Log Debug Info
Activates logging of the internal adjustments.

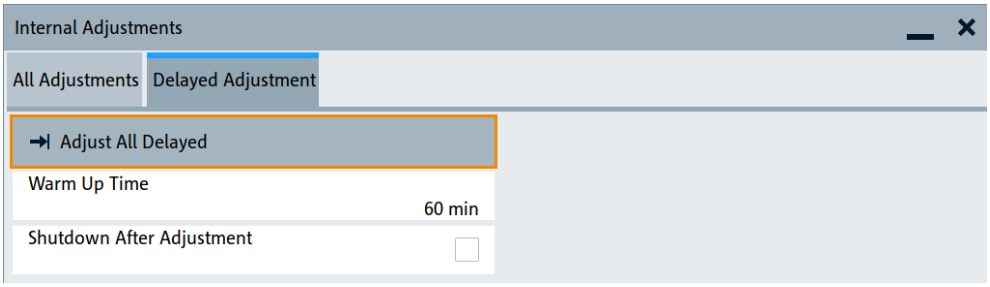
This function is password-protected. Unlock the protection level 1 to access it.

Remote command:
:CALibration<hw>:DEBug on page 736

16.3.4.2 Delayed adjustment settings

Access:

► Select "System Config > Setup > General > Delayed Adjustment".



In this dialog, you can set the internal adjustments to start automatically after the selected warm up time and to switch off the instrument after calibration.

The remote commands required to define these settings are described in Section 13.7, "CALibration subsystem", on page 732.

Settings

Adjust All Delayed 1128
Warm Up Time 1128
Shutdown After Adjustment 1128

Adjust All Delayed
Performs all available internal calibration routines of the instrument.

How to: See Starting internal adjustments automatically.

Remote command:
`:CALibration:DELay[:MEASure]?` on page 736

Warm Up Time
Sets the time for warming up the instrument before the calibration starts automatically.

How to: See Starting internal adjustments automatically.

Remote command:
`:CALibration:DELay:MINutes` on page 735

Shutdown After Adjustment
Enables the automatic shutdown after internal adjustments.

How to: See Starting internal adjustments automatically.

Remote command:
`:CALibration:DELay:SHUTdown[:STATe]` on page 736

16.3.4.3 How to use the internal adjustments

Deciding whether to run internal adjustments

1. Select "System Config > Setup > Internal Adjustment".
2. Check the status and color indication in the section "Since Last Full Adjustment".

   Green: internal adjustments are not required.
   Red: internal adjustments are required. Observe also the indication in the "Information" field.
3. We recommend that you run internal adjustments in the following cases:
   - Before starting any application that requires a maximum of level accuracy.
   - When a long period of time has passed since the last adjustments.
   - If the ambient temperature of the instrument significantly differs from the one of the last adjustments.
4. Proceed as described in "Running internal adjustments" on page 1129.

Running internal adjustments

1. After switching on, the R&S SMM100A requires up to 30 minutes to warm up. Wait until the instrument has reached operating temperature to achieve accurate adjustments.
2. Select "System Config > Setup > Internal Adjustment > Adjust All".
3. Confirm with "Ok".

   The adjustment process starts.

   The adjustment process takes some time depending on the equipment of the instrument.
   A status dialog shows progress of the current adjustment step. If necessary, you can stop the adjustments after a completed step.
   If any error occurs, the process aborts. To resolve adjustment issues, see Section 14.6, "Resolving errors during internal adjustments", on page 1105.

Starting internal adjustments automatically

The delayed adjustment function executes the adjustments automatically. You can set the warm-up time and shut down after the adjustment process finishes. Using this function, you can execute adjustments without being on-site and start measurements directly when back.

1. If necessary, terminate the RF output. See "Running internal adjustments" on page 1129.
2. Select "System Config > Setup > General > Internal Adjustment".
3. Select "Delayed Adjustment".
4. Set the "Warm Up Time", e.g. *40 min*.

   The R&S SMM100A requires a warm-up time of at least 30 min.

5. Enable "Shut Down After Adjustment"
6. Select "Adjust All Delayed".

   The process starts with warming up the instrument, indicating the progress in a status dialog. In this dialog, you can abort the process again, if necessary.
   After warming up, the R&S SMM100A executes the internal adjustments and shuts down when finished.

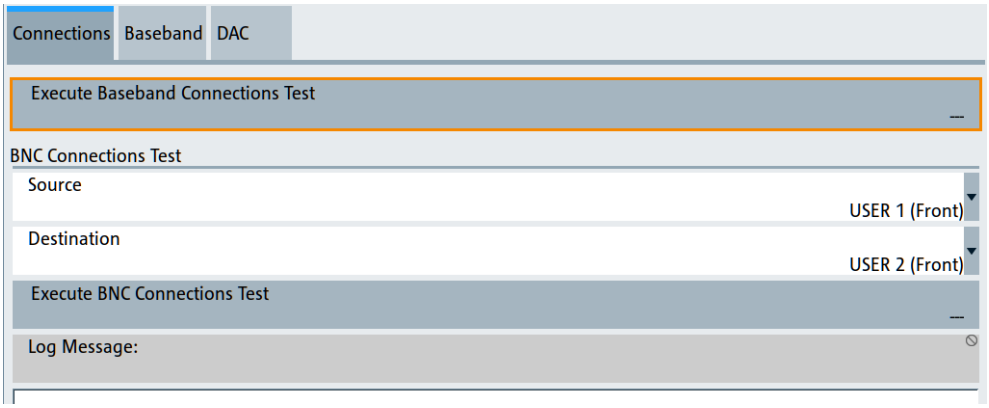
16.3.5 Selftest

Self-test is provided for service purposes.

16.3.5.1 Selftest connections settings

Access:

► Select "System Config > Setup > Maintenance > Selftest > Connections".



The "Connections" dialog contains the parameters for testing the signal flow at the connectors.

The remote commands required to define these settings are described in Section 13.20, "TEST subsystem", on page 1088.

Execute Baseband Connections Test....1130
BNC Connections Test....1131
└ Source....1131
└ Destination....1131
└ Execute BNC Connection Test....1131
└ Log Message....1131

Execute Baseband Connections Test
Performs a connection test on each of the internal digital baseband links.

The test implies to all installed options as baseband inputs, motherboard, universal coding generators, fading simulators, and baseband outputs.

The result (succeeded or failed) is displayed in the status field on the right.

Remote command:
n.a.

BNC Connections Test
This function is password-protected. Unlock the protection level 1 to access it.

Source ← BNC Connections Test
Selects the BNC connector source to be tested.

Remote command:
`:TEST:BB:BNC:SOURce` on page 1091

Destination ← BNC Connections Test
Selects the BNC connector destination to be tested.

Remote command:
`s:TEST:BB:BNC:DESTination` on page 1090

Execute BNC Connection Test ← BNC Connections Test
Performs the BNC connection test at the selected connectors.

Remote command:
`:TEST:BB:BNC:CONNection?` on page 1090

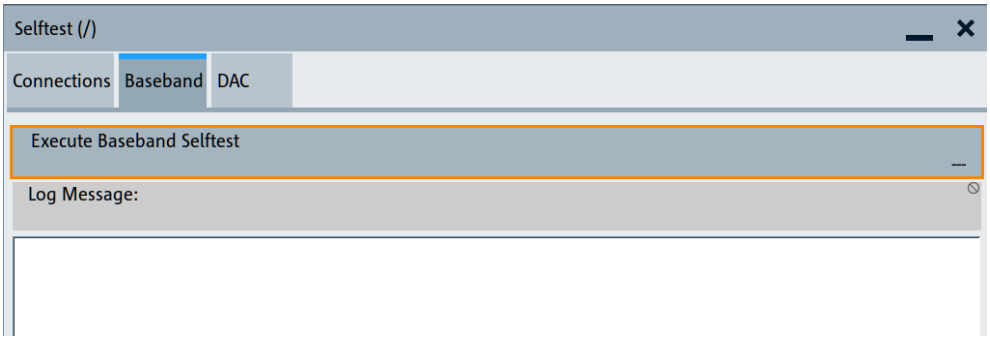
Log Message ← BNC Connections Test
Displays the log message reported during the BNC connections test.

Remote command:
`:TEST:BB:BNC:LOG?` on page 1091

16.3.5.2 Selftest baseband settings

Access:

► Select "System Config > Setup > Maintenance > Selftest > Baseband".



In the "Baseband" dialog you can execute the baseband selftest.

The remote command required to start the test is described in Section 13.20, "TEST subsystem", on page 1088.

Execute Baseband Selftest
Performs a baseband selftest.

The result (succeeded or failed) is displayed in the status field on the right.

Remote command:
`:TEST:BASeband?` on page 1089

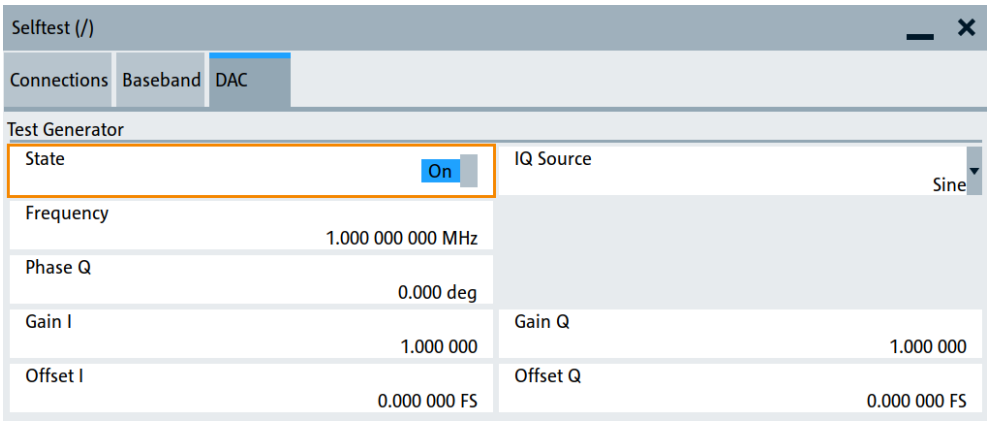
Log Message
Displays the log message reported during the baseband test.

Remote command:
`:TEST:BASeband:LOG?` on page 1090

16.3.5.3 Self-test DAC settings

Access:

1. This function is password-protected. Unlock the protection level 1 to access it.
2. Select "System Config" > "Setup" > "Maintenance" > "Selftest".
3. Select "DAC".



The "DAC" tab provides test generator settings of the digital-analog converter to test the I/Q signal source.

The remote commands required to define these settings are described in Section 13.20, "TEST subsystem", on page 1088.

State 1132
IQ Source 1133
Gain 1133
Frequency 1133
Select ARB File 1133

State
Starts the test generator.

Remote command:
:TEST:BB:GENerator:STATe on page 1093

IQ Source
Selects the test signal source.

"Sine" Generates a sine waveform with frequency as set with the parameter Frequency.

"Constant I/Q" Uses a constant I/Q test signal.
See Section 4.6.3.4, "Constant IQ test signal settings", on page 162.

"ARB" Selects a signal generated by the ARB. Select the waveform file with the parameter Select ARB File.

Remote command:
:TEST:BB:GENerator:SOURce on page 1092

Gain
Sets the gain for a sine or a constant I/Q test signal.

Remote command:
:TEST:BB:GENerator:GAIN on page 1092

Frequency
Requires "IQ Source" > "Sine".

Sets the frequency of the test signal.

Remote command:
:TEST:BB:GENerator:FREQuency<ch> on page 1092

Select ARB File
Provides access to the standard "File Select" function of the instrument. The provided navigation possibilities in the dialog are self-explanatory.

See also, section "File and Data Management" in the R&S SMM100A User Manual.

Remote command:
:TEST:BB:GENerator:ARBitrary on page 1091

16.3.5.4 How to set up the R&S SMM100A for BNC connections tests

1. This function is password-protected. Unlock the protection level 1 to access it.
2. Select "System Config > Setup > Maintenance > Selftest > Connections".
3. Select the BNC Source (signal output).
4. Select the BNC Destination (signal input).
5. On the instrument, connect the selected "Source" connector with the "Destination" connector.
   The selection list in the dialog shows you where to find the associated connector on the instrument.

6. Select "Execute BNC Connections Test".

16.3.6 FPGA/uC update settings

Access:

► Select "System Config > Setup > Maintenance > FPGA/µC Update".

This dialog enables you to check for internal assembly updates and perform updates.

Settings:

FPGA/µC 1134

FPGA/µC
Performs an update of the FPGA/µC.

Remote command:
n.a.

16.4 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 16-1: 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.

Annex

A Available user files and file extensions

The table Table A-1 lists available file extensions for user files on the instrument. Some files depend on the installed options.

For more information, refer to the specifications document.

Table A-1: User files and file extensions on the instrument

Context or function	Content type	File contents	File extension
Instrument state	Settings	Instrument settings	`*.savrcltxt`
User menu	Settings	User-defined favorite settings	`*.user_menu`
License key	License	License key	`*.xml`
User correction	List	User-defined level correction values	`*.uco`
List Mode	List	User-defined frequency/level value pairs	`*.lsw`
Power sensing	Settings	R&S NRP settings	`*.nrp`, `*.rsu`
SCPI command list	List	Export file containing list of SCPIs	`*.iec`
SCPI command script	Command script	SCPI script file formats: Plain SCPI, MATLAB, NICVI, Python3	`*.txt`, `*.m`, `*.c`, `*.py`
R&S support information	Support file	Automatically collected support information	`*.tar.gz`
Tutorials	Tutorial files	Lists containing SCPIs and explanations	`*.tut`
ARB	Waveform	ARB waveforms ARB multi-segment waveforms	`*.wv`
ARB	I/Q data files	I/Q data	`*.iq.tar`, `*.csv`, `*.mat`
ARB	Waveform	ARB multicarrier settings	`*.arb_multcarr`
ARB	Configuration data	Configuration file for creation of multisegment ARB waveforms	`*.inf_mswv`
ARB	Play List	ARB Sequencing List	`*.wvs`
Baseband filtering	Settings	User Filter	`*.dat`
I/Q data file	Settings	User-defined I/Q-File	`*.iqw`
Custom digital modulation	Data List	Digital modulation data	`*.dm_iqd` `*.tdm`
Custom digital modulation	Control List	Data to control digital modulation	`*.dm_iqc`
Custom digital modulation	Settings	Digital modulation settings	`*.dm`
Custom digital modulation	User standard	Digital modulation user standard	`*.dm_stu`

Context or function	Content type	File contents	File extension
Custom digital modulation	User mapping	Digital modulation user mapping	*.vam
Custom digital modulation	User Filter	Digital modulation user filter	*.vaf
Frequency response correction	Settings	User-defined baseband frequency response correction file	*.frc
Envelope tracking	Setting	Envelope shaping function (shaping table)	*.iq_lut *.iq_lutpv
Envelope tracking	Settings	Envelope shaping function (polynomial coefficients)	*.iq_poly
Digital predistortion	Settings	DPD settings	*.dpd
Digital predistortion	Settings	Predistortion function (AM/AM and AM/PM shaping table)	*.dpd_magn *.dpd_phase
Digital predistortion	Settings	Predistortion function (polynomial coefficients)	*.dpd_poly
GSM/EDGE	Settings	Complete settings of the GSM/EDGE dialog	*.gsm
GSM/EDGE	Slot	User-defined slot data	*.gsm_slu
GSM/EDGE	Frame	User-defined frame data	*.gsm_fu
GSM/EDGE	Slot	Higher symbol rate slot	*.gsm_hslu
GSM/EDGE	Frame	Higher symbol rate frame	*.gsm_hfu
Bluetooth	Bluetooth settings	Complete setting of the Bluetooth dialog	*.bto
TETRA	TETRA settings	Complete setting of the TETRA dialog	*.tetra
3GPP FDD	Settings	Complete setting of the 3GPP FDD dialog	*.3g
3GPP FDD	Settings	Channel coding enhanced DPCH channels (downlink)	*.3g_ccod_dl
3GPP FDD	Settings	Channel coding enhanced DPDCH channels (uplink)	*.3g_ccod_ul
3GPP FDD	Settings	User scheduling	*.3g_sch
CDMA2000	Settings	Complete setting of the CDMA2000 dialog	*.cdma2k
TD-SCDMA	Settings	Complete setting of the TD-SCDMA2000 dialog	*.tdscdma
TD-SCDMA	Settings	Test Model for TD-SCDMA2000	*.tdtmd
1xEV-DO	Settings	Complete setting of the 1xEV-DO dialog	*.1xevdo
IEEE 802.11	Settings	Complete setting of the IEEE 802.11 WLAN dialog	*.wlann
EUTRA/LTE	Settings	Complete setting of the EUTRA/LTE dialog	*.eutra *.lte
EUTRA/LTE	Settings	TDD settings	*.lte_tdd
5G NR	Settings	Complete setting of the 5G NR signal generation dialog	*.nr5g
OFDM signal generation	Settings	Complete setting of the OFDM signal generation dialog	*.c5g

Context or function	Content type	File contents	File extension
NFC	Settings	Complete setting of the NFC dialog	`*.nfc`
Baseband power ramping	Settings	Complete setting of the BB Power Ramp dialog	`*.pwr_ramp`

B ARB file formats CSV and MAT

This section provides information on the format and the structure of I/Q data in ARB files with file extension `*.csv` and `*.mat`.

CSV file format

The table Table B-1 provides mandatory tags for parameters and exemplary values of CSV files. You can load these files into the ARB application of the R&S SMM100A. Make sure that your CSV file follows the order and name of these tags or parameters. Separate parameters and values by a semicolon.

Table B-1: CSV file mandatory tags and values

Tag	Value	Description
`MandatoryData`	-	Header to define the start of mandatory tags in the file.
`Name`	TestImportInSiggen	Filename
`Comment`	test to import a CSV file.	The comment value can be empty.
`DateTime`	2024-2-2T18:47:33	Date and time values `<date>T<time>`, with format `<date>` = `YYYY-MM-DD` and `<time>` = `HH-MM-SS`.
`Format`	complex	I/Q format
`DataType`	float32	Data type format
`NumberOfChannels`	1	The number of channels is fixed to one channel or I/Q stream.
`Ch1_ChannelName`	Kanal0	Channel name of the first channel.
`Ch1_Samples` *)	2	Number of samples of the first channel.
`Ch1_Clock[Hz]`	2.20E+9	Clock frequency of the first channel in Hz.
`Ch1_CenterFrequency[Hz]`	1.33E+9	Center frequency of the first channel in Hz.
`DataImportExport_EndHeaderSection`	-	Header to define the start of data in the file.
`Kanal0_I;Kanal0_Q`	-	Header to define the samples for the I/Q values in the first channel `Kanal0`.
`I_1;Q_1`	0.9;0	Value of the I- and Q-component of the first sample.
`I_2;Q_2`	0;0.9	Value of the I- and Q-component of the second sample.

*) Make sure that the number of samples per channel `Ch<n>_Samples` equals the number of I/Q pairs `I_<n>` and `Q_<n>`. For example, if channel 1 has two samples (`Ch1_Samples` = 2), set also values for the two I/Q pairs (`I_1`,`Q_1` and `I_2`,`Q_2`).

Example: CSV file with 2 I/Q samples

```
MandatoryData
Name;TestImportInSMW
Comment;test to import csv in siggen.
DateTime;2024-2-2T18:47:33
Format;complex
DataType;float32
NumberOfChannels;1
Ch1_ChannelName;Kanal0
Ch1_Samples;2
Ch1_Clock[Hz];2.20E+9
Ch1_CenterFrequency[Hz];1.33E+9
DataImportExport_EndHeaderSection
Kanal0_I;Kanal0_Q
0.9;0
0;0.9
```

MAT file format

Creating and editing files with file extension `*.mat` requires installation of MATLAB:

https://mathworks.com/products/matlab.html

The table Table B-2 provides mandatory tags and exemplary values of MAT files. You can load these files into the ARB application of the R&S SMM100A. Make sure that your MAT file follows the order and name of these parameters.

Table B-2: *.mat file mandatory tags and values

Tags	Value	Description
`Ch1_CFrequency_Hz`	0.1000	Center frequency of the first channel in Hz.
`Ch1_ChannelName`	'IQValues'	Channel name of the first channel.
`Ch1_Clock_Hz`	2.0000e+09	Clock frequency of the first channel in Hz.
`Ch1_Data` *)	[1,0;0,1;-1,0;0,-1]	Values for I/Q data of the first channel.
`Ch1_Samples` *)	4	Number of samples of the first channel.
`Comment`	'MATLAB file for ARB.'	The comment value can be empty.
`DataType`	'float32'	Data type format
`DateTime`	'2024-01-01T09:00:00'	Date and time values `<date>`T`<time>`, with format `<date>` = `YYYY-MM-DD` and `<time>` = `HH-MM-SS`.
`Format`	'complex'	I/Q format
`Name`	'fileToTestMatlabImport'	Filename
`NumberOfChannels`	1	The number of channels is fixed to one channel or I/Q stream.

*) Make sure that the number of samples per channel `Ch<n>_Samples` equals the number of I/Q pairs `I_<n>` and `Q_<n>` of the `Ch<n>_Data` parameter. For example, if channel 1 has two samples (`Ch1_Samples` = 2), set also values for the two I/Q pairs (`Ch1_Data` = [`I_1,Q_1;I_2,Q_2`]).

C Unit shortcuts

When specifying units or quantities during data entry, the R&S SMM100A provides the following shortcuts for simplified input.

Shortcut	Designation	Context	Unit
a, A	ampere	Current	A
	atto-	Area, surface	am^2
c, C	centi-	Distance, length	cm
d, D	deci-	Distance, length	dm
		Level, power	dB, dBFS, dBm, dBU, dBW
	degree	Phase, polar/spherical coordinates	deg
e, E	exa-	Area, surface	em^2
f, F	femto-	Area, surface	fm^2
g, G	giga-	Area, surface	Gm^2
		Data rate, sample rate, symbol rate	Gbit/s, Gsample/s, Gsymbol/s, Gchip/s
		Frequency	GHz
		Impedance, resistance	GΩ
h, H	hertz	Frequency	Hz
k, K	kilo-	Area, surface	km^2
		Data rate, sample rate, symbol rate	kbit/s, ksample/s, ksymbol/s, kchip/s
		Distance, length	km
		Frequency	kHz
		Impedance, resistance	kΩ
		Velocity	km/h
m, M	milli-	Area, surface	mm^2
		Current	mA
		Distance, length	mm
		Electromagnetic force, level	mV
		Power	mW
		Time, period, etc.	ms
	mega-	Area, surface	Mm^2
		Data rate, sample rate, symbol rate	Mbit/s, Msample/s, Msym/s, Mchip/s
		Frequency	MHz
		Impedance, resistance	MΩ

Shortcut	Designation	Context	Unit
n, N	nano-	Area, surface	nm^2
		Current	nA
		Distance, length	nm
		Electromagnetic force, level	nV
		Power	nW
		Time, period, etc.	ns
o, O	ohm	Impedance, resistance	Ω
p, P	peta-	Area, surface	pm^2
	percent	Level, ratio	%
	pico-	Area, surface	pm^2
		Current	pA
		Electromagnetic force, level	pV
		Power	pW
		Time, period, etc.	ps
r, R	radiant	Phase, polar/spherical coordinates	rad
s, S	second	Time, period, etc.	s
t, T	terra-	Area, surface	Tm^2
		Data rate, sample rate, symbol rate	Tbit/s, Tsample/s, Tsym/s, Tchip/s
		Frequency	THz
		Impedance, resistance	TΩ
u, U	micro-	Current	µA
		Distance, length	µm
		Electromagnetic force, level	µV
		Power	µW
		Time, period, etc.	µs
v, V	volt	Level, voltage	V
w, W	watt	Level, power	W

D Reference information for remote control

D.1 Telnet program examples

The following program example shows a simple `TcpClient` class that is intended to explain on how to get started with programming of sockets.

The example sets up a socket communication to R&S SMM100A and opens a simple user interface, very similar to the telnet, which allows input of commands. To enable real automation, further development of the program is required.

TcpClient.h

```
#include <string>
//defines structs for socket handling
#include <netinet/in.h>
using namespace std;
typedef struct sockaddr_in SockAddrStruct;
typedef struct hostent     HostInfoStruct;
class TcpClient
{
  public:
    TcpClient();
    ~TcpClient();
    void connectToServer( string &hostname, int port );
    void disconnect( );
    void transmit( string &txString );
    void receive( string &rxString );
    string getCurrentHostName( ) const;
    int    getCurrentPort( ) const;
  private:
    string           currentHostName;
    int              currentPort;
    int              currentSocketDescr;
    SockAddrStruct   serverAddress;
    HostInfoStruct * currentHostInfo;
    bool             clientIsConnected;
    int              receiveBufferSize;
};
```

TcpClient.cpp

```
#include <string>
//defines structs for socket handling
#include <netinet/in.h>
using namespace std;
typedef struct sockaddr_in SockAddrStruct;
typedef struct hostent     HostInfoStruct;
```

```
class TcpClient
{
  public:
    TcpClient();
    ~TcpClient();
    void connectToServer( string &hostname, int port );
    void disconnect( );
    void transmit( string &txString );
    void receive( string &rxString );
    string getCurrentHostName( ) const;
    int    getCurrentPort( ) const;
  private:
    string           currentHostName;
    int              currentPort;
    int              currentSocketDescr;
    SockAddrStruct   serverAddress;
    HostInfoStruct * currentHostInfo;
    bool             clientIsConnected;
    int              receiveBufferSize;
};

#include <netdb.h>
#include <netinet/in.h>
#include <unistd.h>
#include "TcpClient.h"
TcpClient::TcpClient()
: currentHostName( "" )
, currentPort( 0 )
, currentSocketDescr( 0 )
, serverAddress ( )
, currentHostInfo( NULL )
, clientIsConnected( false )
, receiveBufferSize( 1024 )
{
}
TcpClient::~TcpClient()
{
  currentHostInfo = NULL;
}

void TcpClient::connectToServer( string &hostname, int port )
{
  currentHostInfo = gethostbyname( hostname.c_str( ) );
  if( currentHostInfo == NULL )
  {
    currentHostName   = "";
    currentPort       = 0;
    currentHostInfo   = NULL;
    clientIsConnected = false;
    printf("error connecting host\n" );
```

```
  }
  currentHostName = hostname;
  currentPort     = port;
  currentSocketDescr = socket(AF_INET, SOCK_STREAM, 0);
  if( currentSocketDescr == 0 )
  {
    currentHostName   = "";
    currentPort       = 0;
    currentHostInfo   = NULL;
    clientIsConnected = false;
    printf("can't create socket\n" );
  }
  serverAddress.sin_family = currentHostInfo->h_addrtype;
  serverAddress.sin_port   = htons( currentPort );
  memcpy( (char *) &serverAddress.sin_addr.s_addr,
  currentHostInfo->h_addr_list[0], currentHostInfo->h_length );
  if( connect( currentSocketDescr, ( struct sockaddr *) &serverAddress,
  sizeof( serverAddress ) ) < 0 )
  {
   throw string("can't connect server\n" );
  }
  clientIsConnected = true;
}
void TcpClient::disconnect( )
{
  if( clientIsConnected )
  {
    close( currentSocketDescr );
  }
  currentSocketDescr = 0;
  currentHostName    = "";
  currentPort        = 0;
  currentHostInfo    = NULL;
  clientIsConnected  = false;
}
void TcpClient::transmit( string &txString )
{
  if( !clientIsConnected )
  {
  throw string("connection must be established before any data can be sent\n");
  }
  char * transmitBuffer = new char[txString.length() +1];
  memcpy( transmitBuffer, txString.c_str(), txString.length() );
  transmitBuffer[txString.length()] = '\n'; //newline is needed!
  if( send( currentSocketDescr, transmitBuffer, txString.length() + 1, 0 ) < 0 )
  {
    throw string("can't transmit data\n");
  }
  delete [] transmitBuffer;
}
```

```
void TcpClient::receive( string &rxString )
{
  if( !clientIsConnected )
  {
  throw string("connection must be established before any data can be received\n");
  }
  char * receiveBuffer = new char[receiveBufferSize];
  memset( receiveBuffer, 0, receiveBufferSize );
  bool receiving = true;
  while( receiving )
  {
    int receivedByteCount = recv( currentSocketDescr,
    receiveBuffer, receiveBufferSize, 0 );
    if( receivedByteCount < 0 )
    {
      throw string("error while receiving data\n");
    }
    rxString += string( receiveBuffer );
    receiving = ( receivedByteCount == receiveBufferSize );
  }
  delete [] receiveBuffer;
}
string TcpClient::getCurrentHostName( ) const
{
  return currentHostName;
}
int TcpClient::getCurrentPort( ) const
{
  return currentPort;
}
```

TelnetClient.cpp

```
#include <iostream>
#include "TcpClient.h"
void printUsage()
{
  cout<<"usage: EthernetRawCommand <server-ip> [scpi-command]"<<endl;
}
int main( int argc, char *argv[] )
{
  int errorCode         = 0; //no error
  bool useSingleCommand = false;
  string singleCommand  = "";
  string hostname       = "";
  int    port           = 5025;
  string input          = "";
  TcpClient client;
  switch( argc )
  {
```

```
  case 3:
    useSingleCommand = true;
    singleCommand    = argv[2];
  case 2:
    hostname         = argv[1];
    break;
  default:
      printUsage();
      return(-1);
}
try
{
  client.connectToServer( hostname, port );
  bool terminate = false;
  while( !terminate )
  {
    char buffer[1024];
    if( useSingleCommand )
    {
      input =  singleCommand; //send string
    }
    else
    {
      cin.getline( buffer, 1024 );
      input = buffer;
      if( input == "end" )
      {
        terminate = true;
      }
    }
    if( !terminate)
    {
      client.transmit( input ); //send string
      int qPos = input.find( "?", 0 );
      //receive string only when needed
      if( qPos > 0 )
      {
        string rcStr = "";
        client.receive( rcStr );
        cout << rcStr << endl;
      }
    }
    if( useSingleCommand )
    {
      terminate = true;
    }
  }
}catch( const string errorString )
{
  cout<<errorString<<endl;
```

```
  }
  client.disconnect( );
  return errorCode;
}
```

D.2 GPIB interface

This section provides detailed information on the general-purpose interface bus (GPIB) interface "IEC 625/IEEE 488" for remote control of the instrument. It covers the following topics:

- "Pin assignment" on page 1147
- "Bus lines" on page 1147
- "Interface functions" on page 1148

For other remote control interfaces, see Section 12, "Network operation and remote control", on page 625.

Pin assignment

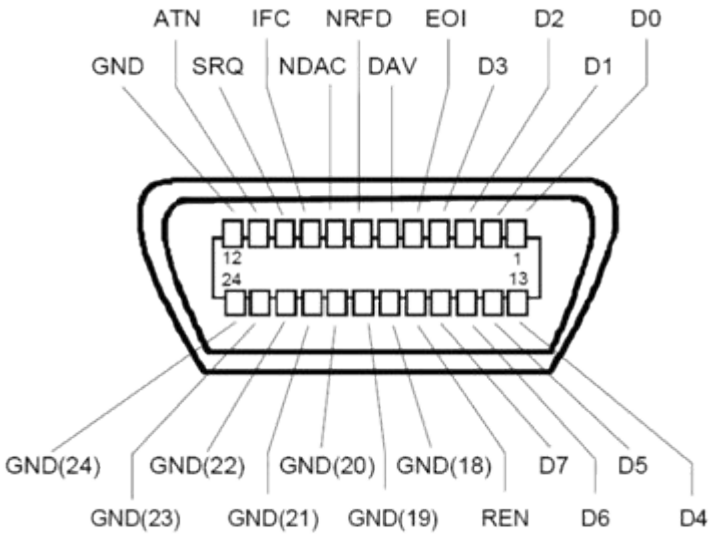


Figure D-1: Pin assignment of the GPIB interface

Bus lines

- Data bus with eight lines D0 to D7:
  The transmission is bit-parallel and byte-serial in the ASCII/ISO code. D0 is the least significant bit, D7 the most significant bit.
- Control bus with five lines:
  IFC (Interface Clear): active LOW resets the interfaces of the instruments connected to the default setting.

ATN (Attention): active LOW signals the transmission of interface messages, inactive HIGH signals the transmission of device messages.
SRQ (Service Request): active LOW enables the connected device to send a service request to the controller.
REN (Remote Enable): active LOW permits switchover to remote control.
EOI (End or Identify): two functions in connection with ATN:

– ATN=HIGH active LOW marks the end of data transmission.
– ATN=LOW active LOW triggers a parallel poll.

- Handshake bus with three lines:
  DAV (Data Valid): active LOW signals a valid data byte on the data bus.
  NRFD (Not Ready For Data): active LOW signals that one of the connected devices is not ready for data transfer.
  NDAC (Not Data Accepted): active LOW signals that the instrument connected is accepting the data on the data bus.

Interface functions

You can use different interface functions to control the instrument via the GPIB interface. Table D-1 lists the interface functions for the R&S SMM100A.

Table D-1: GPIB interface functions

Control character	Interface function
SH1	Handshake source function (source handshake), full capability
AH1	Handshake sink function (acceptor handshake), full capability
L4	Listener function, full capability, de-addressed by MTA.
T6	Talker function, full capability, ability to respond to serial poll, deaddressed by MLA
SR1	Service request function (Service Request), full capability
PP1	Parallel poll function, full capability
RL1	Remote/Local switch-over function, full capability
DC1	Reset function (Device Clear), full capability
DT1	Trigger function (Device Trigger), full capability

For more information, refer to the specifications document.

Glossary: Terms and abbreviations

A

Avahi: A licensed Zeroconf networking feature, including DNS service. The feature enables a device to self-configure an IP address and subnet mask automatically, when a DHCP server in the LAN is not available.

B

Base unit: This term describes a R&S SMM100A equipped with baseband generator and R&S SMM-B1006.

Baseband: The baseband signal, i.e. the I/Q stream at the output of the "Baseband" block.
In rear cases, the term Baseband is used as abbreviation of a "Baseband" block itself.

Baseband domain: A common term for signal processing up to the I/Q modulation. The signal in the baseband domain of the R&S SMM100A is digital.

Baseband(s) Signal: Baseband

BS: Basestation

C

Channel (Digital Input, Digital Output): The signal provided at a digital interface connector or the output stream at the digital output interface may consist of several multiplexed channels. Do not mistake the term *channel* used here with the term signal path. A digital channel is a part of an I/Q stream.

Clock: A mandatory internal or an external reference clock signal for generating the timing pulse in the instrument.

Complete file path: The complete file path specifies the root directory and all subdirectories that contain a file or folder.
Synonyms to this expression are "full file path" and "absolute file path".
See also Section 13.6.2, "Handling files in the default or in a specified directory", on page 721.

Computer name: Hostname

Continuous Wave Mode: CW/Mod

CW/Mod: An internally generated control signal that turns off/on digital modulation, i.e. the signal is generated in unmodulated form.

D

daisy chain: A connection scheme in which instruments are connected together in sequence, i.e. an output of the first one is connected to an input of the second one, etc.

DHCP: Dynamic Host Configuration Protocol

DNS: Domain Name System server

E

e.g.: For example

F

File transfer: The transmission of files from or to the instrument by a remote client. The instrument supports the standard methods File Transfer Protocol (FTP) and file sharing according to Server Message Protocol (SAMBA/SMB).

G

Glossary: List of the often used terms and abbreviations

GUI: Graphical User Interface

H

HDD: Hard disk drive, see System drive

Hostname: An unambiguous indication of the instrument in a LAN that uses a DNS server.
The default hostname follows the syntax `SMM100A-<serial number>`, e.g. *SMM100A-102030*.
See Serial number.
Synonym: Computer name

HUMS: Health and utilization monitoring system.

I

i.e.: That is

I/Q Stream: Stream

L

Level: In the Baseband domain, a term describing the signal level of the independent I and Q signals during signal processing (e.g. baseband signal leveling, modulation, etc.).

LSB: Least significant bit

M

Marker: User-defined digital signal for synchronizing external devices to the generated data stream.
Do not mistake the term *marker (signal)* used here with the term Marker (graphical signal display).

Marker (graphical signal display): Markers are tools for numerical readout of measured data in diagrams.

Marker signal: Marker

MIMO: Multiple Input Multiple Output

MSB: Most significant bit

MxN: Representation of a MIMO system, where M is the number of the transmitting Tx antennas and N the number of the receiving Rx antennas.

N

NTP: (Network Time Protocol)
A networking protocol for highly accurate clock synchronization between computer systems and instruments in local area networks, or over the public internet.

P

PC: Personal computer

PN sequence: PRBS generator

Power: A term describing the signal level in the RF domain or defining the length of the I/Q vector in the baseband domain.

PRBS generator: Delivers pseudo-random binary sequences of differing length and duration. They are known as maximum length sequences, and are generated with the aid of ring shift registers with feedback points determined by the polynomial.

primary-secondary instrument mode: Setup with two or more R&S SMM100A or one R&S SMM100A and several other signal generators such as R&S SGT or R&S SMBV that generates synchronous and time aligned signals.
The primary instrument generates and outputs a dedicated synchronization signal (Sync Out), that has to be fed into the secondary instruments.
See Section 9.2.1, "Connecting multiple instruments in primary-secondary instrument mode", on page 476.

product page: A designation of the R&S SMM100A product page www.rohde-schwarz.com/product/SMM100A.html

R

Remote access: Remote operation

Remote control: The operation of the R&S SMM100A by remote control commands or programs to perform automated tests. The instrument is connected to a system controller via LAN/VXI-11, GPIB or USB using Virtual Instrument Software Architecture (VISA). The instrument is controlled either directly, or supported by instrument drivers.

Remote device: External device controls the R&S SMM100A in remote operation mode, see Remote operation.
Synonyms: External controller, Client device

Remote operation: Allows you to operate the R&S SMM100A from a remote device via VNC.
Both the R&S SMM100A and the remote device are connected in a LAN.
Synonym: Remote access

RF: Radio Frequency

S

Serial number: Unique instrument identification, provided on the rear panel of the instrument and required to build the Computer name.
The serial number are the last 6 digits in the string `<stock no.>-<serial number>`, e.g. `SMM100A-102030`
See Section 3.2.2, "Rear panel tour", on page 41.

SISO: Single Input Single Output

Smart device: A mobile, cordless device, such as a smart phone or tablet, capable of internet browsing.
Synonyms: Smart phone, tablet

SSD: Solid-state drive, see System drive

Star configuration: A connection scheme for several instruments that consists of one central instrument and several other instruments, all connected to the central one.

Stream: An I/Q stream describes the signal at the input of the "I/Q Stream Mapper" up to the output connectors of the instrument.

Symbol Clock: Represents the frequency and exact timing of the transmission of the individual symbols.

Symbol Rate: Calculated as follows:
"Symbol Rate" = "Bit Rate" / Number of bits transmitted with each symbol

Sync signal: In master-slave mode, this term describes the signal generated by the master instrument and fed to the slaved.
The synchronization signal is precise signal that facilitates the time alignment between the instruments and acts as trigger signal.

System drive: The system drive holds the operating system, the firmware, and the stored data. It can be a hard disk drive (HDD) or a solid-state drive (SSD).
Throughout this description, the system drive is referred to as internal memory or hard disk.

T

Trigger: Internally generated or externally supplied signal which starts signal generation at a particular point in time.

Trigger event: A trigger event is caused by the received trigger signal or executed manual trigger.

U

UE: User Equipment

USBTMC: (USB Test & Measurement Class)
A protocol built on top of USB for communication with USB devices. Using VISA library, it supports service request, triggers, and other specific operations, similar to GPIB.

User directory: Describes the default file storage location for user data.
In the file system, user directory is always indicated as `/var/user`
It is physically located on the System drive.

W

Waveform: A file with settings provided for repeatable tests with the same test signal.

Z

Zeroconf: Zero-configuration, see Avahi.

Glossary: Publications and references

Symbols

1GP60: Rohde & Schwarz application note "MATLAB Toolkit for R&S® Signal Generators"
www.rohde-schwarz.com/appnote/1GP60

1GP72: Rohde & Schwarz application note "Connectivity of Rohde & Schwarz Signal Generators"
www.rohde-schwarz.com/appnote/1GP72

1GP88: Rohde & Schwarz application note "R&S®ARB Toolbox PC Software"
www.rohde-schwarz.com/appnote/1GP88

1GP141: Rohde & Schwarz application note "Using R&S® Power Sensors with R&S®Signal Generators"
www.rohde-schwarz.com/appnote/1GP141

1MA074: Rohde & Schwarz application note "RSCommander"
www.rohde-schwarz.com/appnote/1MA074

1MA99: Rohde & Schwarz application note "Guidance on Selecting and Handling Coaxial RF Connectors used with Rohde & Schwarz Test Equipment"
www.rohde-schwarz.com/appnote/1MA99

1MA100: Rohde & Schwarz application note "Test Port Adapter, R&S Interchangeable Port Connector"
www.rohde-schwarz.com/appnote/1MA100

G

GFM336: Rohde & Schwarz application note "Instrument Health & Utilization Monitoring"
www.rohde-schwarz.com/appnote/GFM336

R

R&S iq-tar: Rohde & Schwarz manual "Rohde & Schwarz iq-tar File Format Specification"
For example available at:
www.rohde-schwarz.com/manual/fsw/

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