R&S®SMCV100B
Vector Signal Generator
User Manual

1179059702

User Manual

Version 02

ROHDE&SCHWARZ

This document describes the R&S®SMCV100B, stock no. 1432.7000.02 and its options:

- R&S®SMCVB-B103/-KB106/-KB107
- R&S®SMCVB-K19
- R&S®SMCVB-K31
- R&S®SMCVB-K62
- R&S®SMCVB-K197
- R&S®SMCVB-K198
- R&S®SMCVB-K199
- R&S®SMCVB-K505
- R&S®SMCVB-K511
- R&S®SMCVB-K512
- R&S®SMCVB-K519
- R&S®SMCVB-K521
- R&S®SMCVB-K522
- R&S®SMCVB-K523
- R&S®SMCVB-K547
- R&S®SMCVB-K709
- R&S®SMCVB-KV10 to R&S®SMCVB-KV19
- R&S®SMCVB-KV50 to R&S®SMCVB-KV53

This manual describes firmware version FW 4.70.176.xx and later of the R&S®SMCV100B.

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1179.0597.02 | Version 02 | R&S®SMCV100B

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol , e.g. R&S®SMCV100B is indicated as R&S SMCVB, R&S®SFE is indicated as R&S SFE, R&S®SFE100 is indicated as R&S SFE100. Linux® is abbreviated as Linux.

Contents

1 Safety and Regulatory Information

The product documentation helps you use the product safely and efficiently. Follow the instructions provided here and in the Chapter 1.1, "Safety Instructions", on page 15.

Intended use

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

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 Chapter 1.1, "Safety Instructions", on page 15. The same information is provided in many languages as printed "Safety Instructions". The printed "Safety Instructions" are delivered with the product.
- Throughout the documentation, safety instructions are provided when you need to take care during setup or operation.

1.1 Safety Instructions

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

Use the product only for its intended use and within its performance limits. Intended use and limits are described in the product documentation such as the data sheet, manuals and the printed safety instructions. If you are unsure about the appropriate use, contact Rohde & Schwarz customer service.

Using the product requires specialists 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.

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

Lifting and carrying the product

The maximum weight of the product is provided in the data sheet. 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 a carrying bag designed for your product, you can use the product outdoors.

Unless otherwise specified, you can operate the product up to an altitude of 2000 m above sea level. 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 data sheet.

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 to power

The product is an overvoltage category II product and has to be connected to a fixed installation used to supply energy-consuming equipment such as household appliances and similar loads. Be aware that electrically powered products have risks, such as electric shock, fire, personal injury or even death.

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.
- If a product has an exchangeable fuse, its type and characteristics are indicated next to the fuse holder. Before changing the fuse, switch off the instrument and disconnect it from the power source. How to change the fuse is described in the product documentation.
- 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.

- If the product needs an external power supply, use the power supply that is delivered with the product or that is recommended in the product documentation or a power supply that conforms to the country-specific regulations.
- 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 warn against potential hazards.

	Potential hazard Read the product documentation to avoid personal injury or product damage.
	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 protects you against electric shock should an electric problem occur.

1.2 Labels on R&S SMCV100B

Labels on the casing inform about:

- Personal safety, see "Connecting to power" on page 16.
- Product and environment safety, see Table 1-1.
- Identification of the product, see the serial number on the rear panel.

Table 1-1: Labels regarding R&S SMCV100B 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 service life. For more information, see Chapter 16.4, "Disposal", on page 785.

1.3 Korea Certification Class B

이 기기는 가정용(B급) 전자파 적합기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다.

2 Preface

The R&S SMCV100B vector signal generator features a new Direct-RF DAC concept for RF signal generation. This concept enables I/Q modulation and up-conversion in the digital domain which eliminates I and Q imbalance errors and LO leakage as known from traditional analog I/Q modulators.

The R&S SMCV100B options concept is fully software defined. As a result no selection of hardware options is necessary to get full functionality of the instrument available. This includes also the upgrade of the RF frequency, memory, I/Q modulation bandwidth and all further R&S SMCV100B options for the whole variety of applications.

The intuitive, touchscreen-based operating concept makes the R&S SMCV100B ergonomic and practical to use. Thanks to its design for flexible customization, the instrument is prepared to meet future requirements. Options can be easily added via software key codes, allowing customers to easily upgrade additional functionalities like bandwidth, output power or even frequency range.

2.1 Key Features

Outstanding key features of the R&S SMCV100B are:

- First multi-standard platform for broadcast, navigation, cellular and wireless applications
- Fully software defined vector signal generator
- Modern RF signal generation concept from 8 kHz to 7.125 GHz
- High RF output power of up to 25 dBm
- Modulation bandwidth up to 240 MHz with internal baseband
- Powerful internal baseband generator with internal broadcast real-time coder, Custom Digital Modulation and internal baseband signal generation with ARB
- Support of terrestrial, satellite and audio broadcast standards such as ATSC 3.0, ATSC-M/H, DTMB, DVB-T2, DVB-T, ISDB-T, ISDB-T_{SB}, T-DMB/DAB, DVB-S2, DVB-S, DRM/DRM+, Audio AM/FM, RDS/RDBS/DARC
- Support of digital standard waveforms such as 5G NR, LTE including eMTC/NB-IoT, WLAN IEEE 802.11a/b/g/n/j/p/ac/ax
- Intuitive operation via 5" 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.)
- Easily extendable with software options
- Full remote compatibility with R&S SFE/R&S SFE100

For more information, see data sheet.

2.2 Documentation Overview

This section provides an overview of the R&S SMCV100B user documentation. Unless specified otherwise, you find the documents on the R&S SMCV100B product page at:

www.rohde-schwarz.com/manual/smcv100b

2.2.1 Getting Started Manual

Introduces the R&S SMCV100B and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc. A printed version is delivered with the instrument.

2.2.2 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 SMCV100B is not included.

The contents of the user manuals are available as help in the R&S SMCV100B. 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.

2.2.3 Service Manual

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

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

https://gloris.rohde-schwarz.com

2.2.4 Instrument Security Procedures

Deals with security issues when working with the R&S SMCV100B in secure areas. It is available for download on the Internet.

2.2.5 Printed Safety Instructions

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

2.2.6 Data Sheets and Brochures

The data sheet contains the technical specifications of the R&S SMCV100B. It also lists the options 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/smcv100b

2.2.7 Release Notes and Open Source Acknowledgment (OSA)

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

The open-source acknowledgment document provides verbatim license texts of the used open source software.

See www.rohde-schwarz.com/firmware/smcv100b

2.2.8 Application Notes, Application Cards, White Papers, etc.

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

See www.rohde-schwarz.com/application/smcv100b

3 Getting Started

This chapter contains the same information as the getting started manual.

3.1 Preparing for Use

This chapter describes the basic steps to be taken when setting up the product for the first time.

3.1.1 Lifting and Carrying

See also "Lifting and carrying the product" on page 15.

For mounting the R&S SMCV100B in a rack, see Chapter 3.1.4.2, "Mounting the R&S SMCV100B in a Rack", on page 24.

3.1.2 Unpacking and Checking

1. Unpack the R&S SMCV100B carefully.
2. Retain the original packing material. Use it to protect the control elements and connectors when transporting or shipping the R&S SMCV100B later.
   See also Chapter 15, "Transporting", on page 774.
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 accurate measurements and avoid damage to the product and connected devices. For information on environmental conditions such as ambient temperature and humidity, see the data sheet.

See also "Choosing the operating site" on page 16.

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 data sheet under "General data".

- 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 SMCV100B

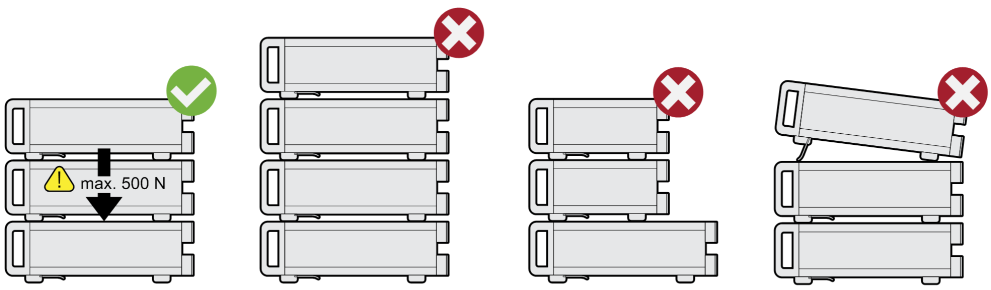
See also:

- "Setting up the product" on page 16.
- "Intended use" on page 15.

3.1.4.1 Placing the R&S SMCV100B 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 data sheet.
2. **CAUTION!** Foldable feet can collapse. See "Setting up the product" on page 16.
   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.
   - All products must have the same dimensions (width and length).
   - The overall load on the lowest product must not exceed 500 N.



Correct | Too many instruments | Different dimensions | Feet folded out

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.
- Do not place the product next to heat-generating equipment such as radiators or other products.

3.1.4.2 Mounting the R&S SMCV100B in a Rack

To prepare the rack

1. Observe the requirements and instructions in "Setting up the product" on page 16.
2. **NOTICE!** Insufficient airflow can cause overheating and damage the product.
   Design and implement an efficient ventilation concept for the rack.

To mount the R&S SMCV100B in a rack

1. Use an adapter kit that fits the dimensions of the R&S SMCV100B to prepare the instrument for rack mounting. For information on the dimensions, see data sheet.
   a) Order the rack adapter kit designed for the R&S SMCV100B. For the order number, see data sheet.
   b) Mount the adapter kit. Follow the assembly instructions provided with the adapter kit.
2. Lift the R&S SMCV100B to shelf height.
3. Push the R&S SMCV100B onto the shelf until the rack brackets fit closely to the rack.
4. Tighten all screws at the rack brackets with a tightening torque of 1.2 Nm to secure the R&S SMCV100B at the rack.

To unmount the R&S SMCV100B from a rack

1. Loosen the screws at the rack brackets.
2. Bring the lifting equipment to shelf height.
3. Remove the R&S SMCV100B from the rack.
4. If placing the R&S SMCV100B on a bench top again, unmount the adapter kit from the R&S SMCV100B. Follow the instructions provided with the adapter kit.

3.1.5 Important Aspects for Test Setup

Cable selection and electromagnetic interference (EMI)

Electromagnetic interference (EMI) can affect the measurement results.

To suppress electromagnetic radiation during operation:

- Use high-quality shielded cables, especially for the following connector types:
  - BNC
    Double-shielded BNC cables.
  - USB
    Double-shielded USB cables.
    How to: Chapter 3.1.9, "Connecting USB Devices", on page 26.
    See also Chapter 14.6, "Measuring USB cable quality", on page 767.
  - LAN
    At least CAT6 STP cables.
    How to: Chapter 3.1.7, "Connecting to LAN", on page 25
- Always terminate open cable ends.
- Ensure that connected external devices comply with EMC regulations.
- Use the cable R&S DIGIQ-HS for connection to the "Dig. IQ HS x" interfaces of the instrument. The cable is available under material number 3641.2948.03.
  How to: Chapter 3.1.12, "Connecting to Dig. IQ HS x", on page 28
- Use an SFP+ to RJ-45 adapter and an RJ-45 cable for connection to the "IP Data" interface of the instrument. We recommend that you use the adapter "FCLF850P2BTL" from Finisar available under material number 3627.0570.00.
  How to: Chapter 3.1.13, "Connecting to IP Data Interface", on page 29

Signal input and output levels

Information on signal levels is provided in the data sheet. Keep the signal levels within the specified ranges to avoid damage to the R&S SMCV100B and connected devices.

3.1.6 Connecting to Power

For safety information, see "Connecting to power" on page 16.

1. Plug the AC power cable into the AC power connector on the rear panel of the instrument. Only use the AC power cable delivered with the R&S SMCV100B.
2. Plug the AC power cable into a power outlet with ground contact.

   The required ratings are listed next to the AC power connector and in the data sheet.

3.1.7 Connecting to LAN

You can operate the R&S SMCV100B via LAN (local area network) or you can operate it locally. This section describes how to connect the instrument to a LAN to operate or control the instrument remotely via a PC in a LAN.

The connector is located on the rear panel.

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

By default, the R&S SMCV100B is configured to use DHCP (dynamic host configuration protocol) and no static IP address is configured.

If switched on and connected to the LAN, the R&S SMCV100B displays the address information on the screen.

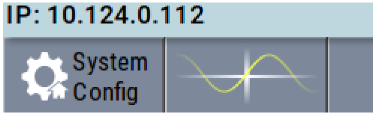


Figure 3-1: IP address indication on the screen (example)

See Chapter 12.6, "Connecting the Instrument to the Network (LAN)", on page 481

3.1.8 Connecting Monitor

This section describes how to connect a monitor for direct operation of the R&S SMCV100B. You can skip the following procedure, if you only operate the R&S SMCV100B remotely.

The connector is located on the rear panel.

► Connect the monitor to the ""DVI-D"" socket.

You can connect the following types of monitor sockets:
- DVI-D: Connect it to the ""DVI-D"" socket.
DVI-A: not supported
DVI-I: not supported
- HDMI: You need an adapter. Use a passive DVI to HDMI adapter.
- VGA: You need an active adapter, DVI to VGA or Display Port to VGA. Passive adapters do not work.

If the monitor provides touch functionality, an additional connection can be required, for example, a USB connection. Refer to the documentation of your monitor.

3.1.9 Connecting USB Devices

USB connectors are located on the front panel and rear panel. You can connect or disconnect all USB devices from the R&S SMCV100B during operation.

To connect USB storage devices

USB storage devices, such as memory sticks, allow easy data transfer from/to the R&S SMCV100B. You can also use them for firmware updates.

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

To connect USB devices with 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 SMCV100B.

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 storage 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 SMCV100B 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 SMCV100B detects the mouse automatically.

To connect power sensors

You can connect power sensors of the R&S NRP families to any of the USB connectors.

See Chapter 8.10.3, "Using Power Sensors", on page 353.

3.1.10 Connecting to RF 50 Ω

The connector is located on the front panel.

To prepare for connecting to "RF 50 Ω"

1. If the R&S SMCV100B is switched on, deactivate the RF output, before connecting an RF cable to the "RF 50 Ω" connector.
   In the block diagram, select the block "RF" > "RF Level" > "RF ON > Off".
2. Use a high-quality RF cable that matches the RF connector type.
   See "Cable selection and electromagnetic interference (EMI)" on page 24.

To connect to non-screwable connectors (BNC)

► To connect the RF cable with the ""RF 50 Ω"" connector, proceed as follows:
   a) Carefully align the connector of the cable and the ""RF 50 Ω"" connector along a common axis.
   b) Mate the connectors along the common axis until the male pin of the connector of the cable engages with the female socket of the ""RF 50 Ω"" connector.

Preventing RF output switch-off

► **NOTICE!** If you set a too high output level, the reverse power can exceed a limit forcing the R&S SMCV100B to switch off the RF output.

Set an RF output level that is not higher than the maximum permissible RF power as given in the data sheet.

3.1.11 Connecting to Ref In/Ref Out

The connector is located on the rear panel.

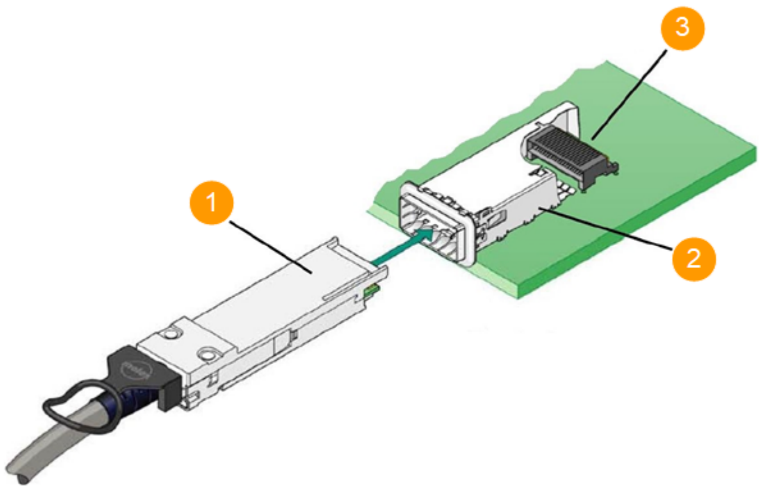
To connect to "Ref In"/"Ref Out" (reference < 1 GHz)

For connection, the R&S SMCV100B provides BNC connectors.

► Follow the instructions in "To connect to non-screwable connectors (BNC)" on page 27.

3.1.12 Connecting to Dig. IQ HS x

The "Dig. IQ HS x" connector comprises a QSFP+ (Quad Small Form-factor Pluggable) socket, that has two components: a QSFP+ cage and a QSFP+ connector. The QSFP+ cable is equipped with the QSFP+ plug.



1 = QSFP+ plug
2 = QSFP+ cage
3 = QSFP+ connector

The connector is located on the rear panel.

To connect to Dig. IQ HS x interface

1. For connection, use the QSFP+ cable R&S DIGIQ-HS.
   See "Cable selection and electromagnetic interference (EMI)" on page 24.
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.

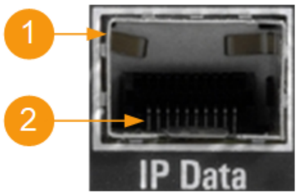
To disconnect from Dig. IQ HS x interface

1. **NOTICE!** If you pull the cable, you can damage the cable and the "Dig. IQ HS x" connector.
   Pull the release tab.
2. Pull the QSFP+ plug out of the QSFP+ cage.

See also:
- Chapter 5.3, "Digital Baseband Input Settings", on page 256.
- Chapter 5.4, "I/Q Digital Output Settings", on page 261.

3.1.13 Connecting to IP Data Interface

The "IP Data" connector comprises an SFP+ (Small Form-factor Pluggable) socket, that has two components an SFP+ cage and an SFP+ connector.



1 = SFP+ cage
2 = SFP+ connector

The connector is located on the rear panel.

To connect to IP Data interface

1. For connection, use an SFP+ to RJ-45 adapter and an RJ-45 cable.
   See "Cable selection and electromagnetic interference (EMI)" on page 24.

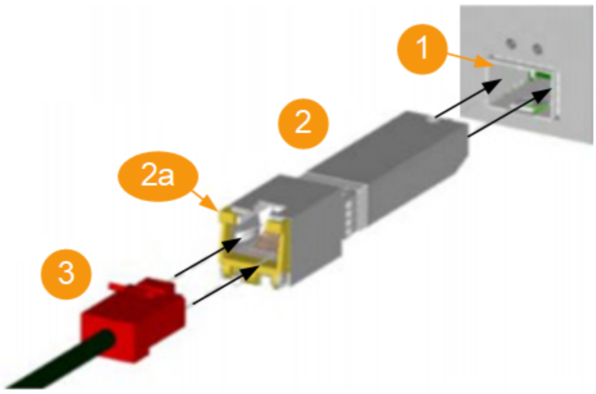


Figure 3-2: Connecting to the IP Data interface

1 = SFP+ socket of the "IP Data" connector
2 = SFP+ to RJ-45 adapter
2a = Bracket for mounting and releasing the adapter
3 = RJ-45 cable and plug

2. Connect the SFP+ to RJ-45 adapter to the SFP+ socket of the "IP Data" connector first (Figure 3-2).
   a) Turn the adapter, so that the release bracket joints show upwards.
   b) At the RJ-45 socket of the adapter, open the release bracket, so that the bracket shows upward.
   c) Insert and push the adapter into the cage of the SFP+ socket of the "IP Data" connector.
   d) To mount the adapter, push the release bracket down to close the bracket.
      The adapter is connected to the "IP Data" connector.
3. Plug the RJ-45 cable into the RJ-45 socket of the adapter.

To disconnect from IP Data interface

1. Unplug the RJ-45 cable.
2. Open the release bracket.
3. Carefully pull the SFP+ to RJ-45 adapter out of the SFP+ socket of the "IP Data" interface.

Use the "IP Data" interface as input of external coding IP data for broadcast baseband signals.

3.1.14 Switching On or Off

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

Table 3-1: 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 SMCV100B

The R&S SMCV100B is off but connected to power. See Chapter 3.1.6, "Connecting to Power", on page 25.

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

   The LED of the [On/Standby] key is orange.
2. Wait until the oven-controlled oscillator (OCXO) warms up. For the warm-up time, see data sheet.
3. Press the [On/Standby] key.
   Key and LED are located on the front panel.

The LED changes to green. The R&S SMCV100B boots.

When starting for the first time, the R&S SMCV100B starts with the default settings. When restarting the instrument, the settings depend on the instrument configuration before shut-down.
See Chapter 10.4, "Saving and Recalling Instrument Settings", on page 395.

When the instrument is switched on, it automatically monitors main functions. You can query erroneous functions. In addition to automatic monitoring, you can perform maintenance tasks.

See:
- Chapter 14.4, "Querying Error Messages", on page 764

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.

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 SMCV100B 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 SMCV100B from the power source.

3.2 Instrument Tour

The following topics help you get familiar with the instrument and perform the first steps:

- Front Panel Tour
- Rear Panel Tour

This section explains the control elements and the connectors of the R&S SMCV100B with the aid of the front and rear views. For specifications of the interfaces, refer to the data sheet.

The meanings of the labels on the R&S SMCV100B are described in Chapter 1.2, "Labels on R&S SMCV100B", on page 17.

3.2.1 Front Panel Tour

This section provides an overview of the control elements and connectors of the front panel of the R&S SMCV100B. On the rear panel, you find all further connectors of the unit.

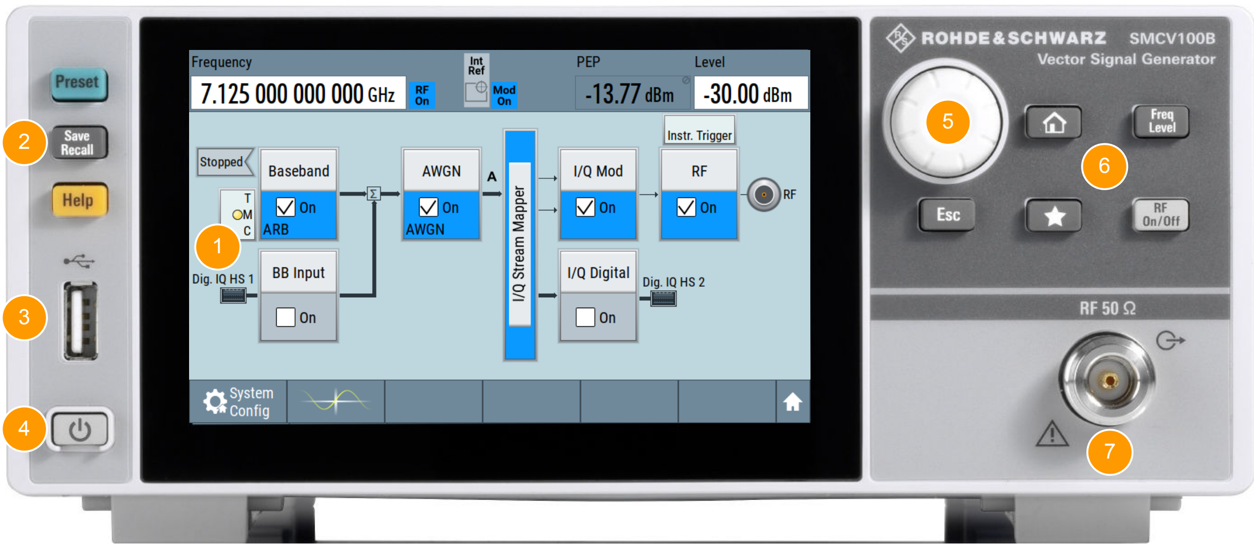


Figure 3-3: Front panel view

1 = Touchscreen, see Chapter 3.2.1.1, "Touchscreen", on page 32
2 = Utility keys, see "Utility Keys" on page 33
3 = "USB" connector, see "USB" on page 35
4 = [On/Standby], see "On/Standby" on page 34
5 = Navigation controls, see "Navigation Controls" on page 35
6 = Function keys, see "Function Keys" on page 34
7 = "RF 50 Ω" output connector, see Chapter 3.2.1.3, "Connectors", on page 35

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.

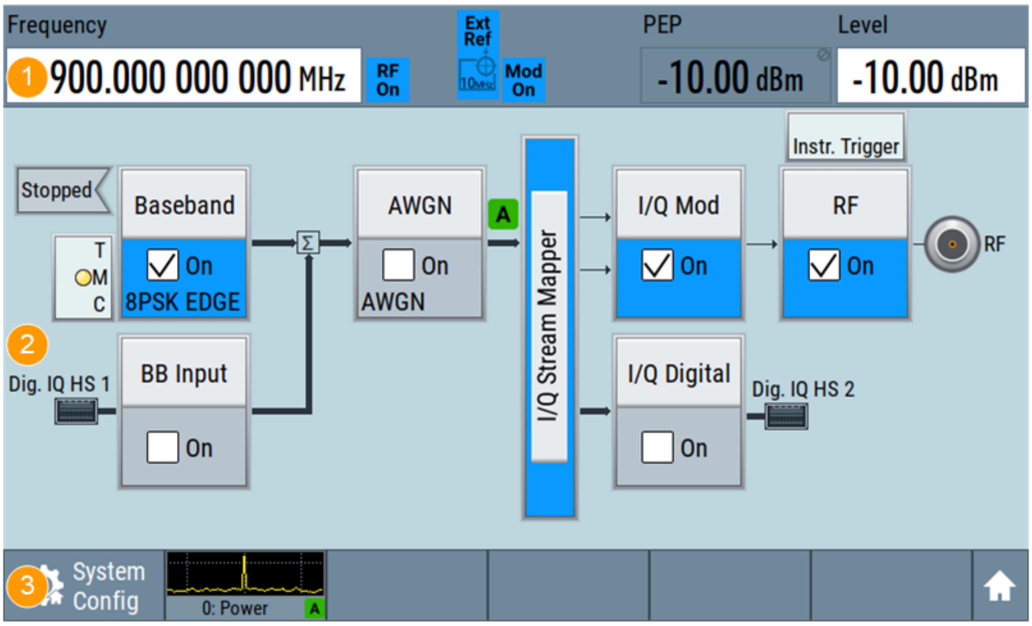


Figure 3-4: Touchscreen elements

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

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

- Changing a setting
- Selecting new settings
- Scrolling through a list or a table of parameters
- Saving or recalling settings
- Opening and closing dialogs

See also the following chapters:

- "Instrument Control" in the getting started manual, for operating the touchscreen.
- Chapter 16.1, "Cleaning", on page 775, for instructions on cleaning the screen.

3.2.1.2 Keys

Utility Keys

The utility keys cause the R&S SMCV100B to return to a defined instrument state and provide information on the instrument and assistance.

For more information, refer to Chapter 11, "General Instrument Functions", on page 416.

Table 3-2: 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
[Help]	Displays context-sensitive help text

On/Standby

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

The LED below the [On/Standby] key indicates the instrument state, see Chapter 3.1.14, "Switching On or Off", on page 30.

Function Keys

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

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

Table 3-3: Function keys

Function key	Assigned functions
[Freq/Level]	Pressing once: Activates frequency entry. Pressing twice: Activates level entry. Toggles between frequency and level entry.
[Home]	Brings the block diagram to the foreground. Active dialogs are minimized.
[RF on/off]	Switches the RF output on and off. Press the key again to restore the last active status. Status is displayed in the "Status bar".
[★ (User)]	Key with a customizable function.

Editing Keys

Editing keys enable you to confirm an entry, delete individual characters, or exit the current operation.

Table 3-4: Editing keys

Type of key	Description
[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. In dialog boxes that contain a "Cancel" button it activates that button. For "Edit" dialog boxes the following mechanism is used: ● If 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.

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 width.
- Moves the selection, e.g. to a function block in the block diagram.
- Shifts the selection bar within focused areas (e.g. lists).
- Activates editing of entries or confirms and terminates entries.
- Opens a context-sensitive menu, when it is pressed and held.

3.2.1.3 Connectors

The "RF 50 Ω" connector and "USB" connector are on the front panel.

USB
There is one female USB (universal serial bus) 2.0 connector of type A (host USB) on the front panel. You can connect, for example, a keyboard, a mouse or a USB memory stick.

Further "USB" connectors of type A are available on the rear panel.

How to: Chapter 3.1.9, "Connecting USB Devices", on page 26.

RF 50 Ω
N female connector for output of the RF signal.

How to: Chapter 3.1.10, "Connecting to RF 50 Ω", on page 27

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 data sheet.

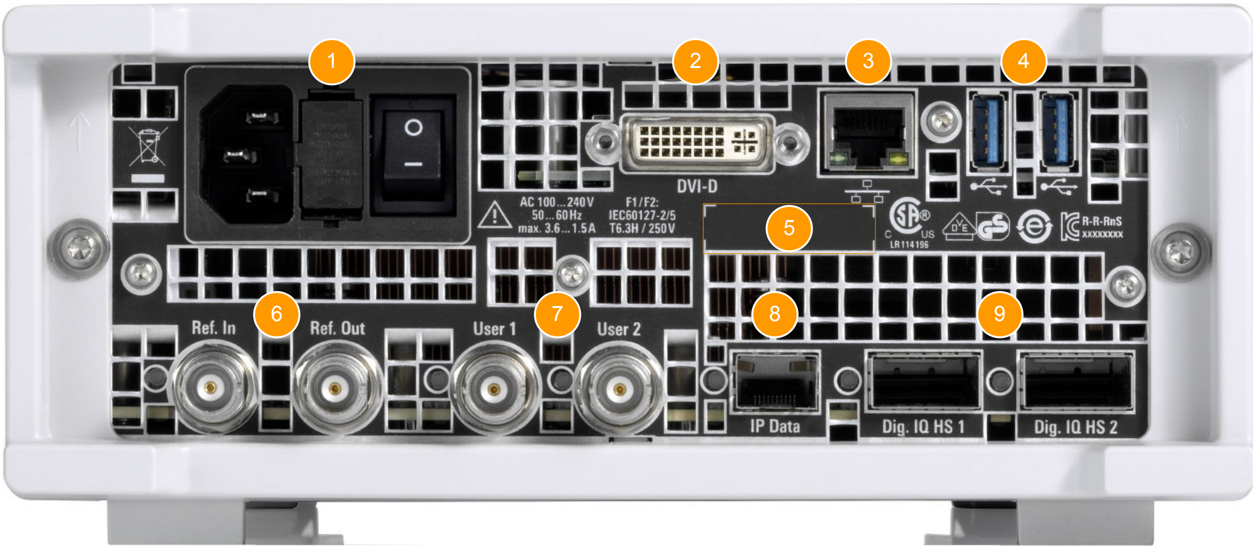


Figure 3-5: Rear panel

1 = AC power supply connection and main power switch, see "AC power supply connector and switch" on page 36
2 = "DVI-D" connector (output), see "DVI-D" on page 36
3 = "LAN" connector, see "LAN" on page 36
4 = "USB" connectors, see "USB" on page 37
5 = Serial number (six digits in the string 1432.7000.02-<serial number>-<checksum>)
6 = "Ref In"/"Ref Out" connectors, see "Ref In/Ref Out" on page 37
7 = "User x" connectors, "User x" on page 37
8 = "IP Data" connector, see "IP Data" on page 37
9 = "Dig. IQ HS x" connector, see "Dig. IQ HS x" on page 37

3.2.2.1 Connectors

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: Chapter 3.1.6, "Connecting to Power", on page 25.

DVI-D

DVI-D socket. Output for the monitor signal of the built-in computer. The connected computer monitor should provide a resolution of 1024x768 pixels or higher.

How to: Chapter 3.1.8, "Connecting Monitor", on page 26

LAN

RJ-45 connector to connect the R&S SMCV100B to a LAN for remote control, remote operation, and data transfer.

How to: Chapter 3.1.7, "Connecting to LAN", on page 25

USB

There are two female USB (universal serial bus) 3.0 connectors of type A (host USB) on the rear panel. They have the same functionality as the USB connectors on the front panel, but provide higher data rates. See "USB" on page 35.

How to: Chapter 3.1.9, "Connecting USB Devices", on page 26.

Ref In/Ref Out

Input/output for external reference signal.

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

How to: Chapter 3.1.11, "Connecting to Ref In/Ref Out", on page 28

User x

BNC multipurpose connectors for defining input signals and output signals.

Table 3-5 lists the signals assigned to the "User x" connectors in the default instrument state.

Table 3-5: Default configuration of the User x connectors

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

A dedicated LED indicates the connector status:
- green: an input connector
- yellow: an output connector
- red: error
- no light / gray: the connector is not active
- blinking LED: connection indication as result of the "Identify Connector" function

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

IP Data

Interface for input of IP data for real-time encoding in broadcast baseband signals.

The interface comprises a SFP+ (Small Form-factor Pluggable) socket.

How to: Chapter 3.1.13, "Connecting to IP Data Interface", on page 29

Dig. IQ HS x

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

Table 3-6 lists the interface designation (input/output) and the required option.

For more information, see data sheet.

Table 3-6: Overview of Dig. IQ HS x interfaces and required options

Interface	Designation	Required option
"Dig. IQ HS 1"	"BB Input"	R&S SMCVB-K19 digital baseband interface
"Dig. IQ HS 2"	"I/Q Digital Out"	

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

How to: Chapter 3.1.12, "Connecting to Dig. IQ HS x", on page 28

3.3 Trying Out the Instrument

This chapter introduces the most important functions and settings of the R&S SMCV100B step by step.

The complete description of the functionality and its usage is given in the R&S SMCV100B user manual. Basic instrument operation is described in Chapter 3.5, "Instrument Control", on page 60.

Prerequisites

- R&S SMCV100B equipped with its minimum configuration:
  - Base unit
  - Frequency option R&S SMCVB-B103
- The R&S SMCV100B is connected to the power supply, and started up as described in Chapter 3.1, "Preparing for Use", on page 22.

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, however, require an instrument equipped with additional options and/or external signals. Each task description lists its prerequisites.

The screenshots in this description show a fully equipped instrument. Consider that, the block diagram displayed on your particular instrument can differ from the one used in the example.

Touchscreen operation

For detailed information on touchscreen operation, see Chapter 3.5.2, "Means of Manual Interaction", on page 60.

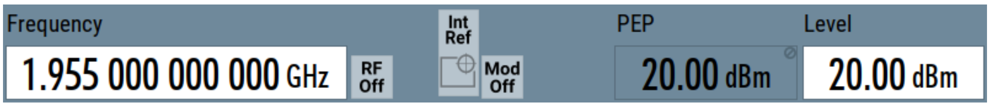
The following sections provide introductory operation examples using the touchscreen.

3.3.1 Generating an Unmodulated Carrier

We start out by generating a simple unmodulated signal. The R&S SMCV100B has a minimum configuration as in "Prerequisites" on page 38.

1. On the R&S SMCV100B front panel, press the Preset key to start out in a defined instrument configuration.
2. Set the frequency:
   a) On the "Status Bar", tap the "Frequency" field.
   b) On the on-screen keypad, enter *1.955* and press the "GHz" key.

   The on-screen keypad closes and the frequency value is displayed.
3. On the "Status Bar", tap the "Level" field and enter the level in the same way.



4. Select "Block Diagram > RF Block > On" to enable the output of the generated unmodulated signal.

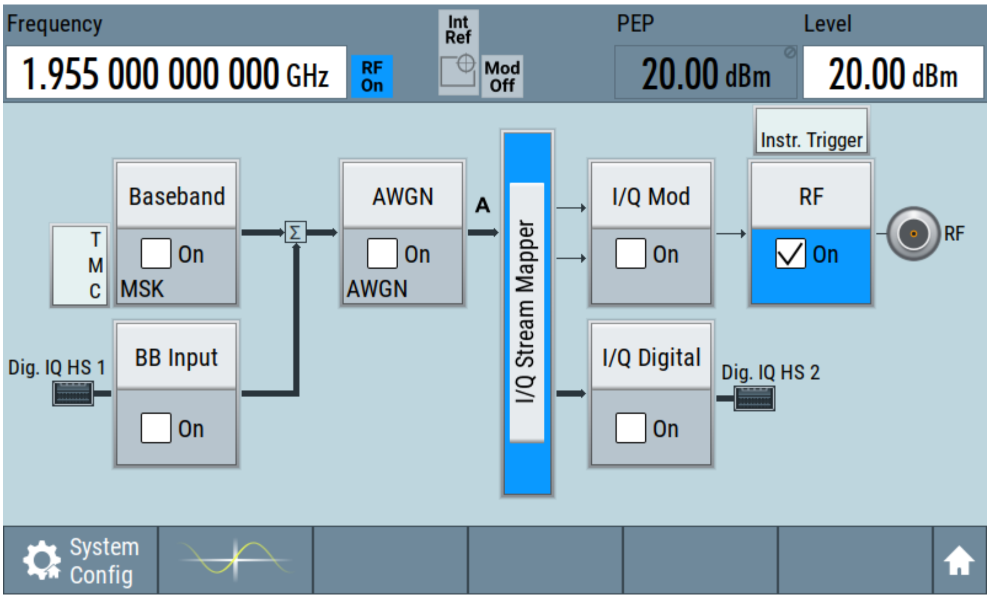


Figure 3-6: Block diagram: Generating an unmodulated signal

The 1.955 GHz signal is output at the "RF 50 Ω" connector at the front panel of the R&S SMCV100B.

Connect "RF 50 Ω" of the R&S SMCV100B to a signal analyzer, for example R&S®FSW, to display the generated signal.

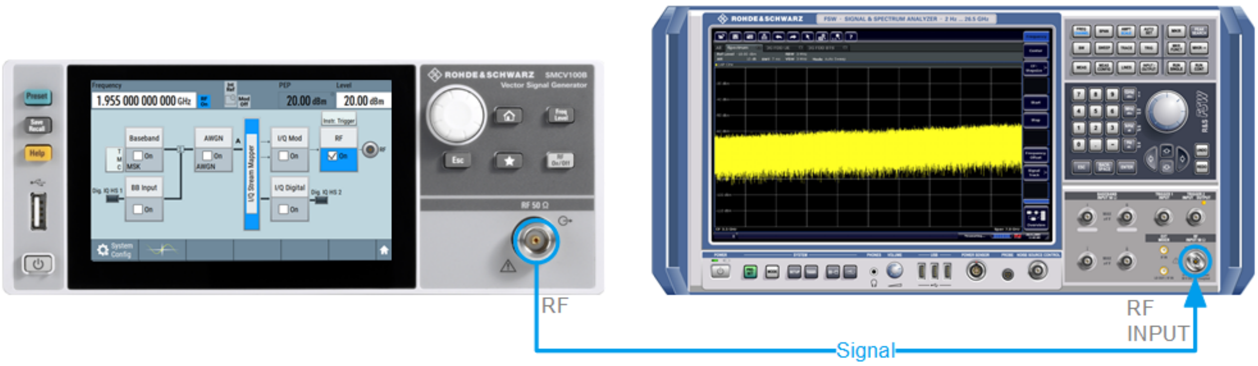


Figure 3-7: Simplified test setup

For the required settings of the signal analyzer, refer to its user manual or its online help.

3.3.2 Generating a Digitally Modulated Signal

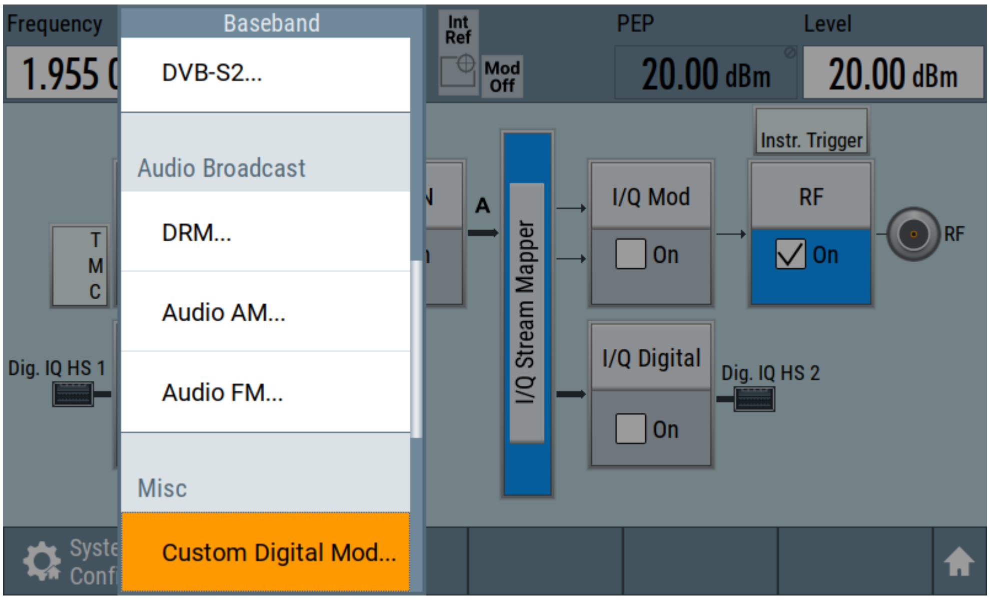
This example shows you how to generate a simple WCDMA-3GPP (QPSK 45° offset) signal with the help of the "Custom Digital Modulation" functionality.

Prerequisites

- Minimum configuration as in "Prerequisites" on page 38
- Option custom digital modulation R&S SMCVB-K199

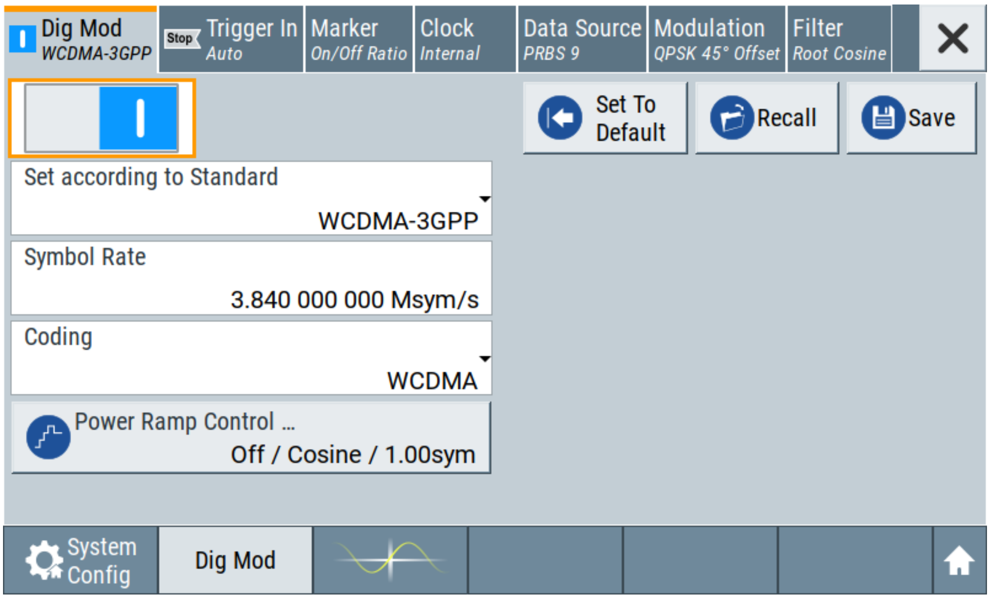
The initial situation is not the instrument's preset state but rather the configuration described in Chapter 3.3.1, "Generating an Unmodulated Carrier", on page 39.

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



The "Custom Digital Modulation" dialog opens.

2. In the "Custom Digital Modulation" dialog, select "General > Set according to Standard > WCDMA-3GPP".
3. Select "General > State > On" to enable signal generation.



The instrument activates automatically "I/Q Mod", uses the internal trigger and clock signals, and generates a WCDMA-3GPP signal, modulated with a QPSK 45° offset modulation.

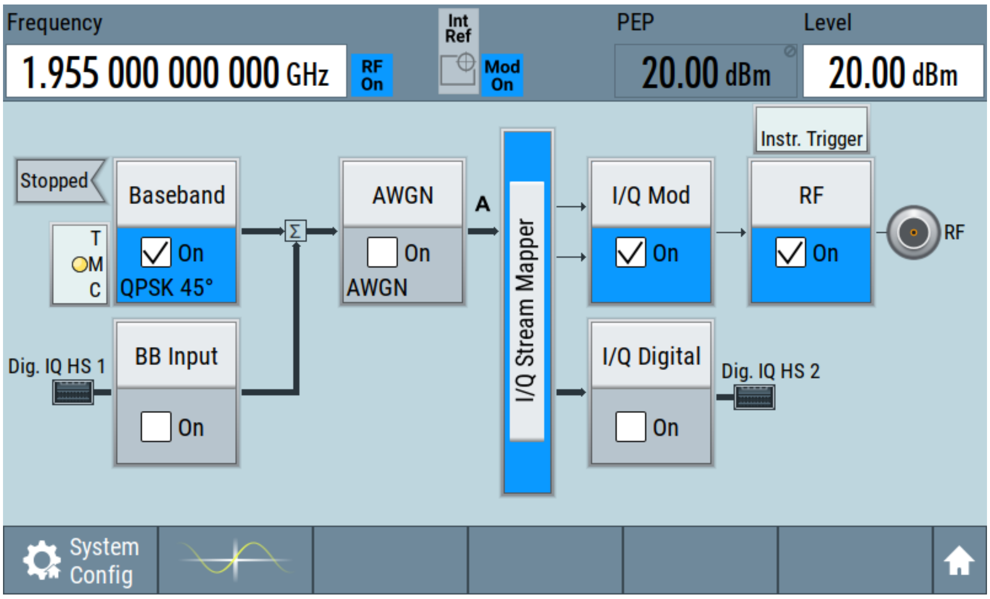


Figure 3-8: Block diagram: Generating a digitally modulated signal

4. Optionally, select the "Modulation" tab and observe the used "Modulation Type".

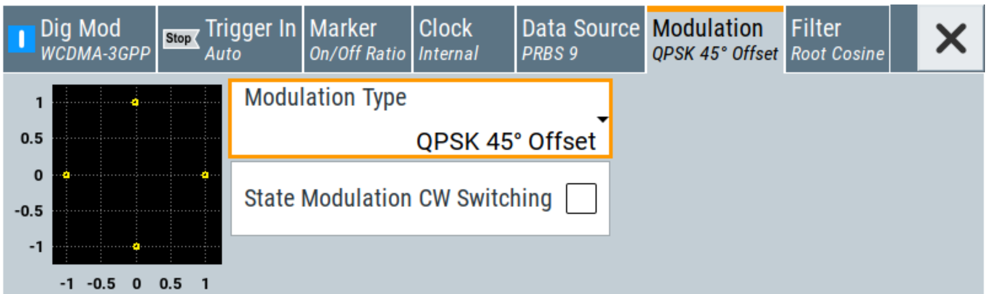


Figure 3-9: Display of the used modulation type

3.3.3 Triggering the Instrument with an External Signal

The following configurations are rather theoretical cases, because you rarely use the R&S SMCV100B as a standalone instrument. Usually, the instrument would be connected to a device under test (DUT) and/or other measurement equipment.

Prerequisites

- Minimum configuration as in "Prerequisites" on page 38
- Option custom digital modulation R&S SMCVB-K199

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, determined by a defined trigger event. For example, by triggering the instrument internally or externally from the DUT.

The example below illustrates the general principle of external triggering and extends the configuration performed in Chapter 3.3.2, "Generating a Digitally Modulated Signal", on page 40 by the configuration of the required trigger signal and connector settings.

This test setup requires one signal analyzer, like the R&S®FSW, as additional equipment.

To start signal generation synchronous to an external global trigger signal

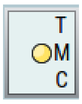
The configuration requires three main steps with the following goals:

1. Observe the current connector configuration. Define an input connector for the external global trigger signal.
   See "To verify the current connector configuration" on page 44
2. Configure the baseband to use the external global trigger signal as trigger source.
   See "To reconfigure the trigger settings" on page 45
3. Connect the instrument and the external trigger source.
   See "To connect the instrument and the external trigger source" on page 46

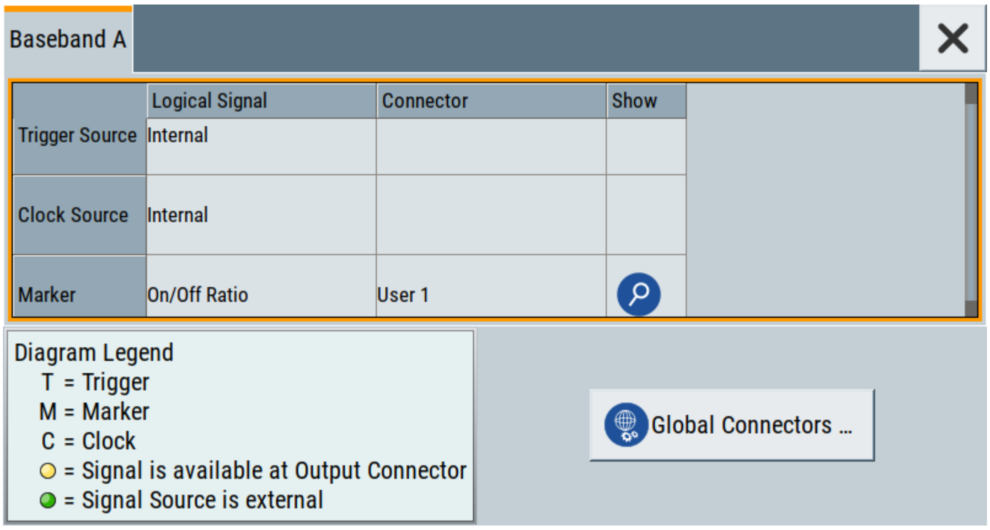
To verify the current connector configuration

The R&S SMCV100B 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 an overview of the current mapping of the logical signals to the connectors, perform one of the following:
   - In the block diagram, select the Trigger/Marker/Clock status LEDs on the left side of the "Baseband" block.

   - Select "Baseband > Trigger Marker Clock".

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

2. To access the related connector settings, perform one of the following:
   - Select "Global Connector Settings"
   - Tap the connector name, for example select the connector "User 1"

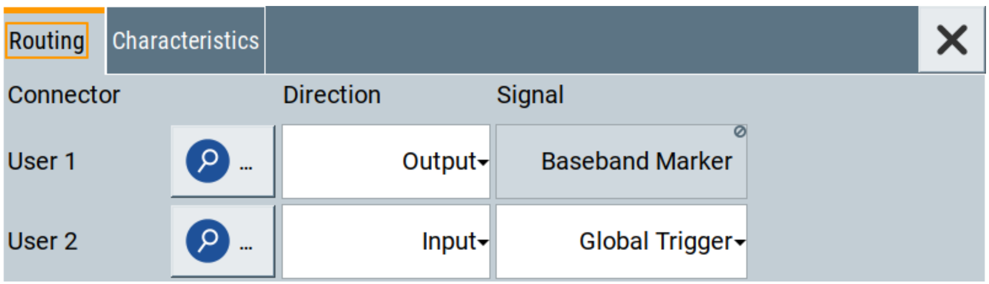
   

   Figure 3-10: Signal mapping to the global connectors

The "Global Connectors" dialog displays the current connectors configuration. The settings are configurable, but in this example we use the default mapping.

3. Alternatively, select "Block Diagram > Baseband > Misc > Custom Digital Mod", select the "Trigger In" tab and select "Global Connector Settings".

   In the current mapping, the two global connectors User x on the rear panel are configured as follows:
   - "Baseband Marker" signal is output at the "User 1" connector.
     The LED next to the connector is orange.
   - The "User 2" connector is an input for the "Global Trigger" signal.
     The LED next to the connector is green.

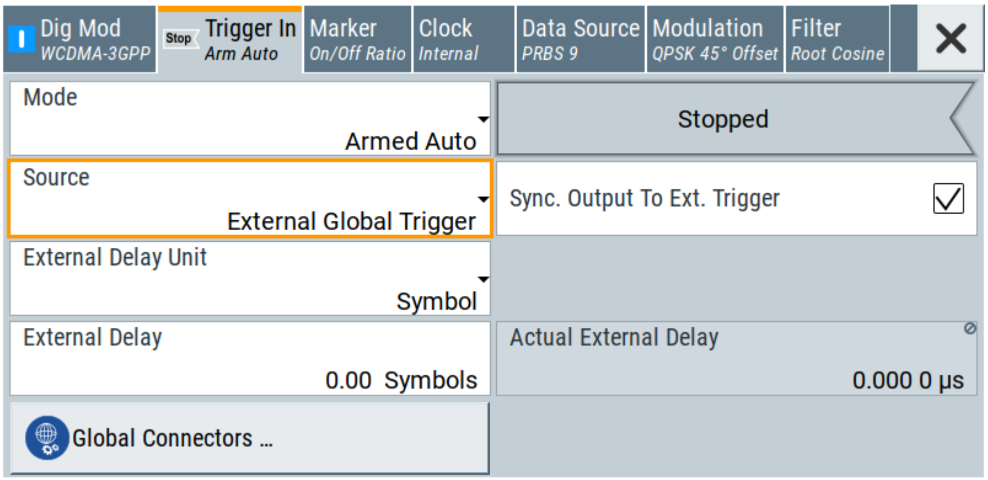
Find the physical location of each connector

Use the built-in "Trigger Marker Clock > Show" function to display the location of the selected connector. A blinking marker on the front/rear panel view also indicates the selected connector.

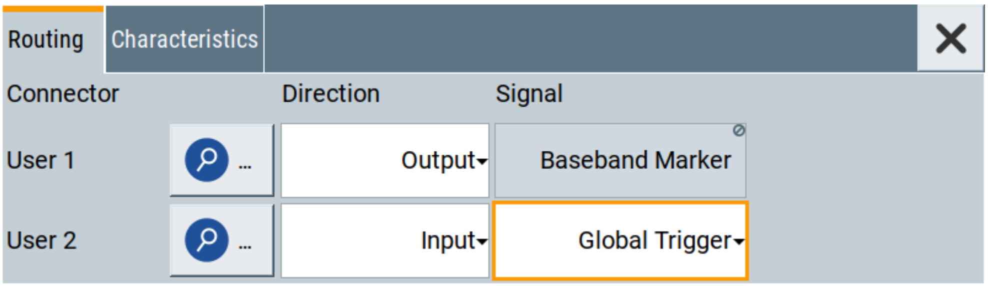
To reconfigure the trigger settings

We assume that the instrument is configured as described in Chapter 3.3.2, "Generating a Digitally Modulated Signal", on page 40 and the default connector mapping is maintained (see Figure 3-10).

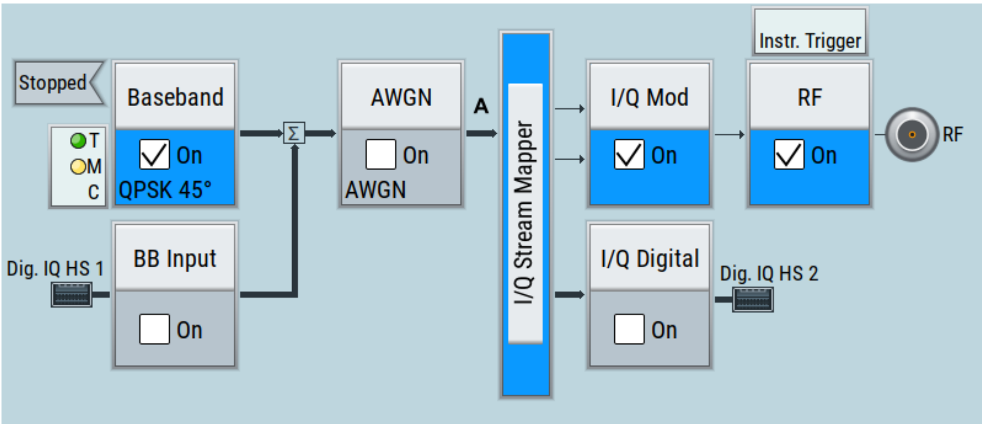
1. In the block diagram, select "Baseband > Misc > Custom Digital Mod > Trigger In".
2. Select the following settings:
   a) "Mode > Armed Auto"
   b) "Source > External Global Trigger".



3. Select "Global Connector Settings > Routing".
4. For "User 2", select "Direction > Input" and "Signal > Global Trigger".



The instrument expects an external global trigger event. In the current configuration, the "Global Trigger" signal has to be supplied at the input connector "User" 2. The Trigger/Marker/Clock status LEDs in the block diagram confirm that an external trigger signal is selected; the signal generation is however stopped.



To connect the instrument and the external trigger source

1. Use a suitable cable to connect the external trigger source to the "User" 2 connector of the R&S SMCV100B. See Figure 3-11.

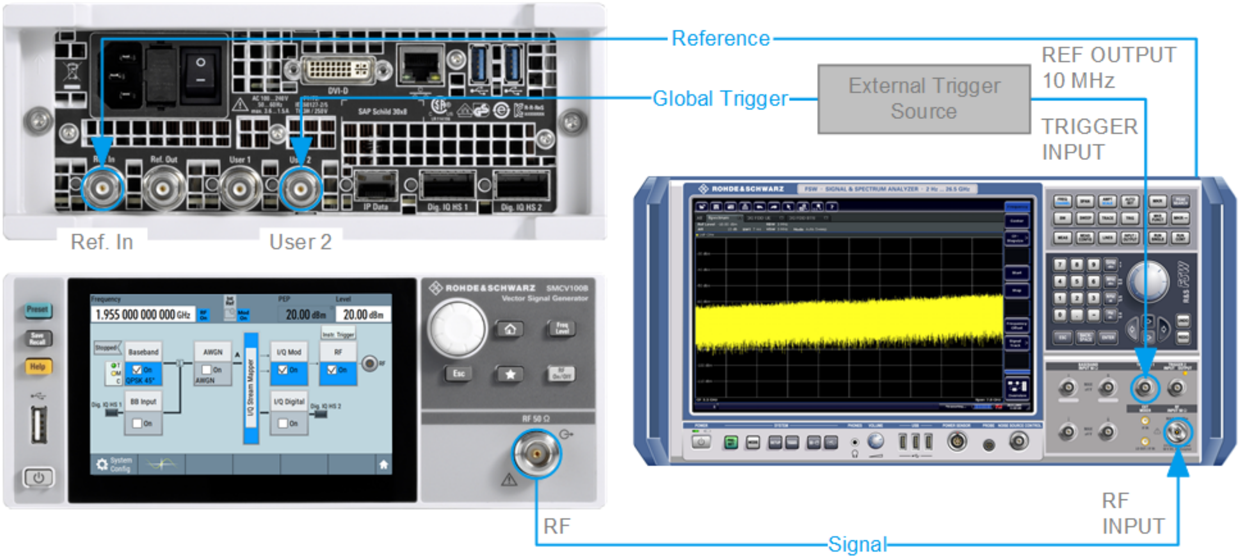


Figure 3-11: Simplified representation of a test setup**

** = The figure depicts the cabling as a general principle; particular test setups do not require all connections at the same time

The Figure 3-11 depicts the location of the connectors and explains the connection as principle. In practice, you would rather "substitute" the analyzer by a DUT, like a base station (BS).
Other than in the example, the DUT can be the source for the reference signal. Instead of using an external trigger source, the DUT can also send, for example, a frame trigger signal to the R&S SMCV100B. The R&S SMCV100B acts still as the signal source.

2. Use suitable cables to connect to RF 50 Ω and Ref. In connectors of the R&S SMCV100B to the signal analyzer or the DUT.
   The R&S®FSW supplies the 10 MHz external reference signal.

   Upon the receiving of an external trigger event, the R&S SMCV100B starts the signal generation and then generates a continuous signal. An "Arm" stops the signal generation. A subsequent trigger event causes a restart of the signal generation.

To learn more about this topic, refer to:
- Chapter 4.4.1.3, "Baseband Trigger Signals", on page 82

3.3.4 Enabling and Configuring a Marker Signal

Test setups often require synchronization of an external device with the generated data stream. For this purpose, the R&S SMCV100B can output maximum two marker signals (or markers) also to the generated signal.

The R&S SMCV100B provides four regular marker signals. You can output two of the marker signals, one to each of the "User"1/2 connectors.

With suitable marker settings for instance, you can mark slot or frame boundaries or mark the start of a particular modulation symbol.

Prerequisites

- Minimum configuration as in "Prerequisites" on page 38
- Option custom digital modulation R&S SMCVB-K199

This example extends further the configurations performed in Chapter 3.3.2, "Generating a Digitally Modulated Signal", on page 40. We assume a default connector mapping (see Figure 3-10).

This test setup requires one oscilloscope, like the R&S®RTO, as additional equipment.

1. In the block diagram, select "Block Diagram > Baseband > Misc > Custom Digital Mod > Marker" tab.
2. Select "Marker Mode > Marker 1 > Pulse" and "Divider = 32".

   Generated is a periodic marker with marker frequency of 120 KHz. The signal is output at the "User" 1 connector of the R&S SMCV100B (see Figure 3-10).
3. Use a suitable cable to connect the "User" 1 connector of the R&S SMCV100B to the monitoring instrument, for example an oscilloscope like R&S®RTO. See Figure 3-12.

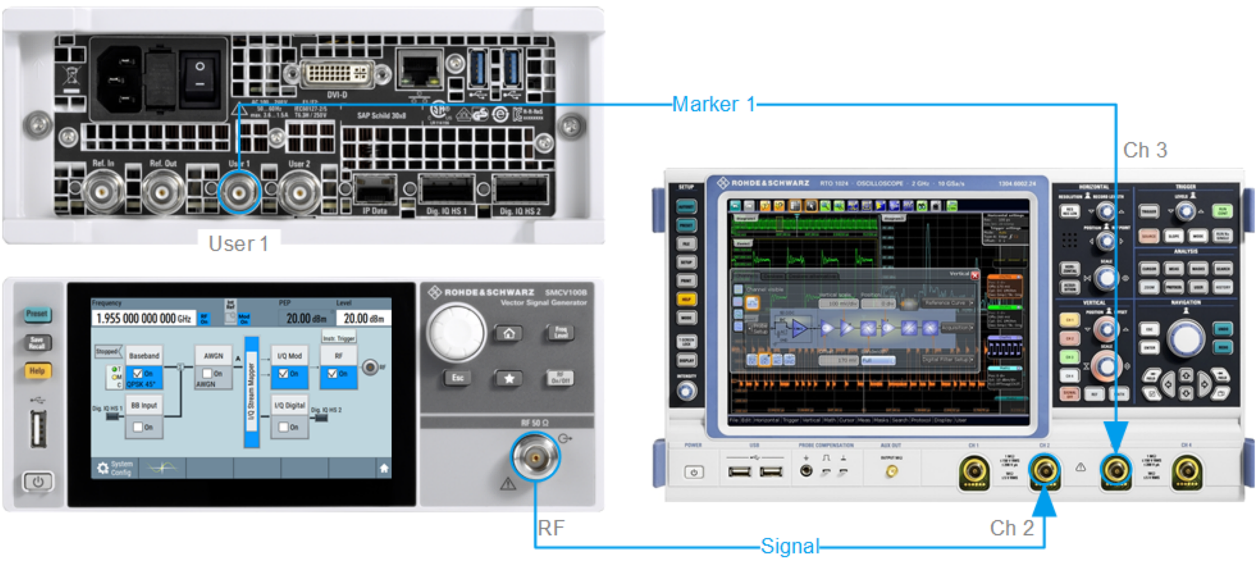


Figure 3-12: Simplified representation of a test setup for signal monitoring**

** = The figure depicts the cabling as a general principle

4. Use a suitable cable to connect the "RF 50 Ω" on page 35 connector of the R&S SMCV100B to the monitoring instrument.

To learn more about this topic, refer to Chapter 4.4.1.2, "Regular Marker Output Signals", on page 80.

3.3.5 Verifying the Generated Signal with the Graphics Display

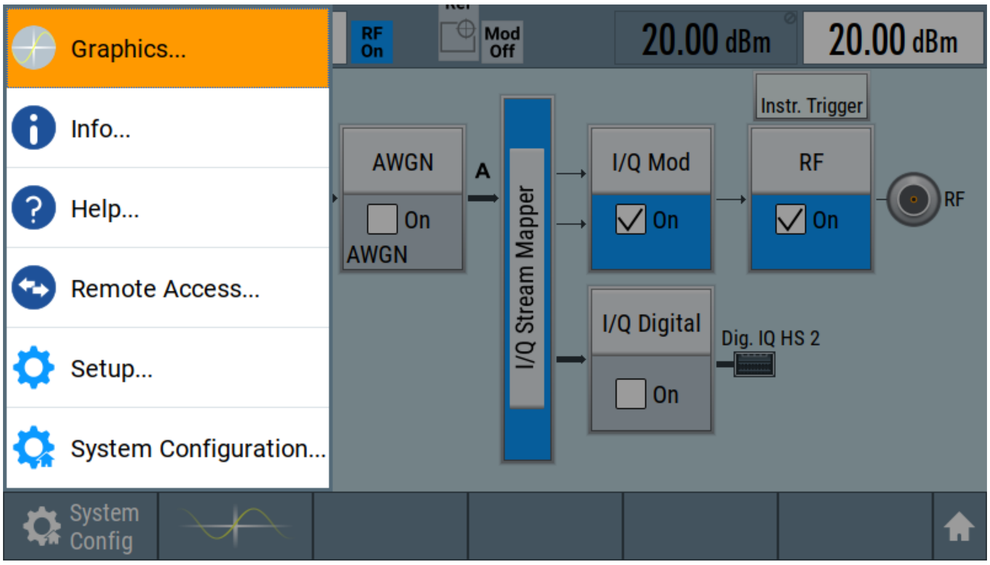
It is often useful to check the spectra of the configured signals, before you enable the RF output of the instrument. The R&S SMCV100B has a minimum configuration as in "Prerequisites" on page 38

The R&S SMCV100B 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.

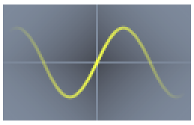
This example shows you how to use this graphical display to verify the generated signal. Use the signal generated in Chapter 3.3.4, "Enabling and Configuring a Marker Signal", on page 47.

To access the graphical signal display functionality

► Perform one of the following:
- Select "Taskbar > System Configuration > Graphics".



- On the "Taskbar", tap the wave icon.

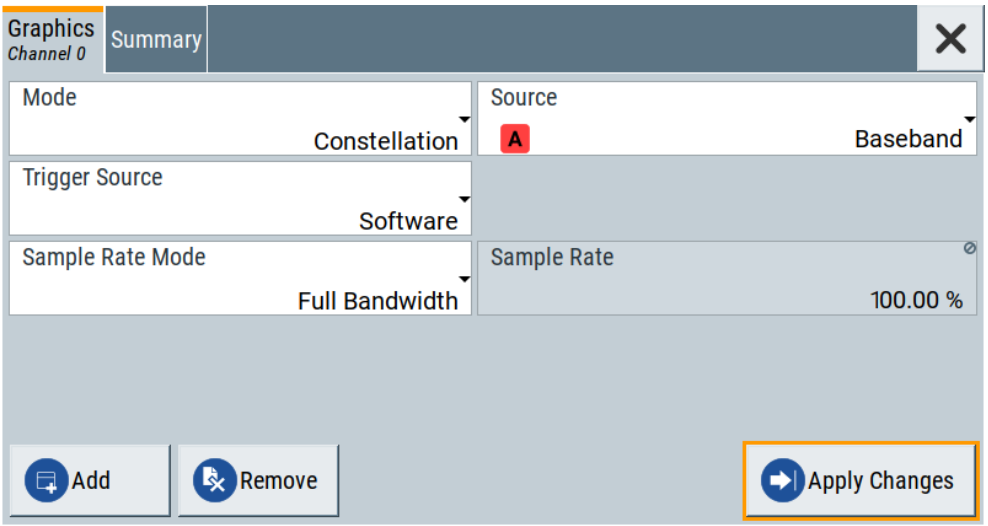


The "Graphics Configuration" dialog opens.

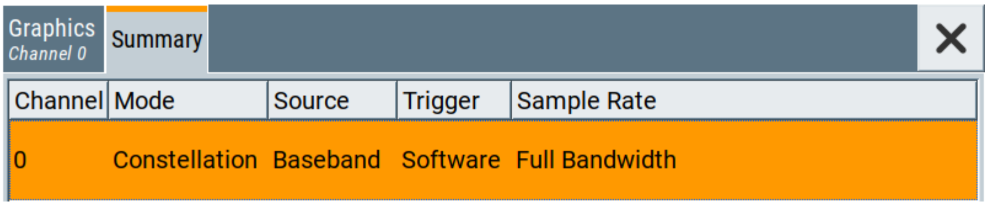
To visualize the signal

1. In the "Graphics Configuration" dialog, select "Mode > Constellation".

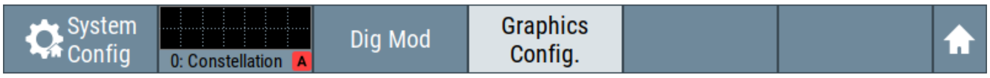
2. Select "Source > Baseband".
3. Select "Add" to enable signal display.



In the "Summary" tab, you can verify, that "Channel 0" graphic is visible in the table:

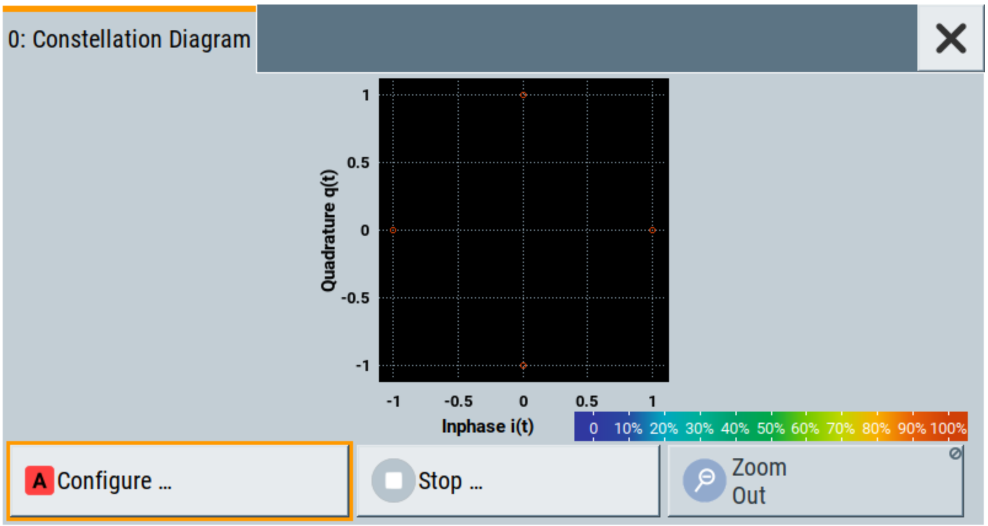


A new thumbnail (minimized view) indicating the active diagram appears in the "Taskbar".



4. Press the thumbnail graphic.

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



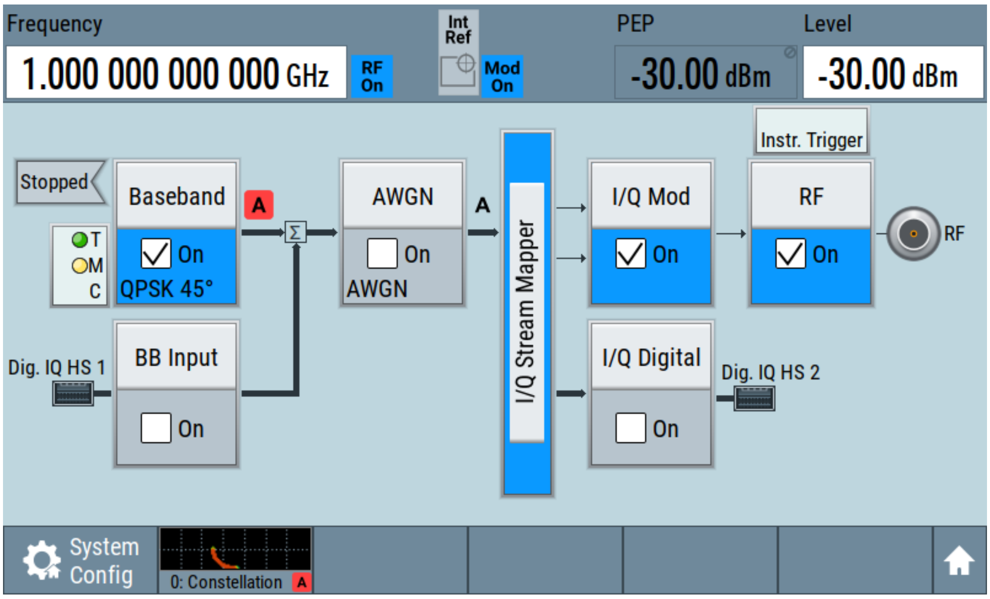
The "Constellation Diagram" displays the 3GPP FDD signal.

5. To retrieve more information, zoom in. In some diagrams you can select "Show Marker" to measure the distance, for example, between two signals.
   In principle, the zoom in function works like the two-finger pinching for magnifying images on your cellphone.

6. In the "Constellation Diagram" dialog, select "Configure" to return to the "Graphics Configuration" dialog.
   Close the "Graphics Configuration" dialog.

   This action 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".



See also Chapter 9, "Monitoring Signal Characteristics", on page 368.

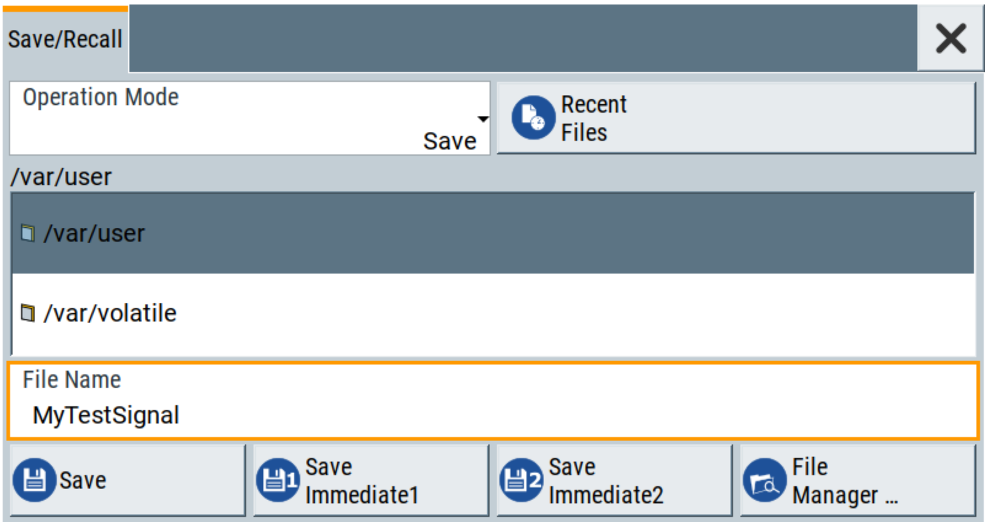
3.3.6 Saving and Recalling Settings

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 Chapter 3.3.4, "Enabling and Configuring a Marker Signal", on page 47.

1. Press the [Save/Rcl] key on the front panel.
2. In the "Save/Recall" dialog box, select "Operation Mode > Save".
   Tap the "Filename", use the on-screen keyboard, and enter *MyTestSignal*.

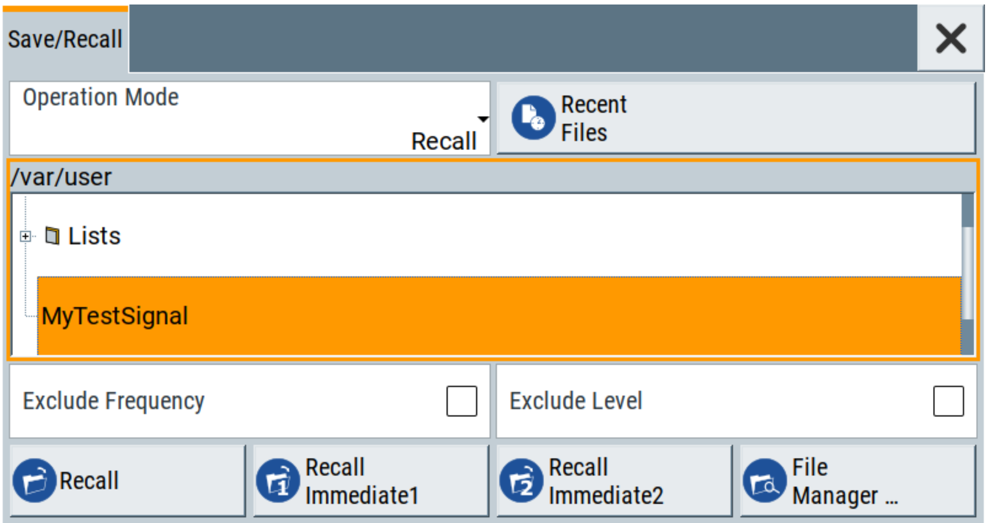
3. Tap the "Save" button.

   The file `MyTestSignal.savrcltxt` is saved in 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.
   Navigate to the directory of the saved file. Select the `MyTestSignal` file.



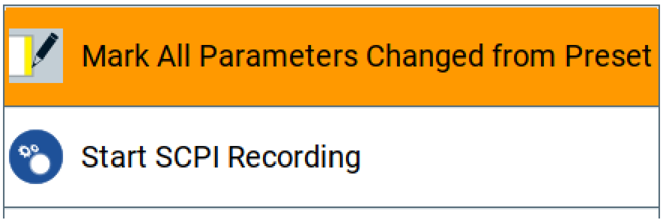
4. Tap the "Recall" button.

   All instrument settings are restored and the display resembles the instrument display right before the settings were saved.

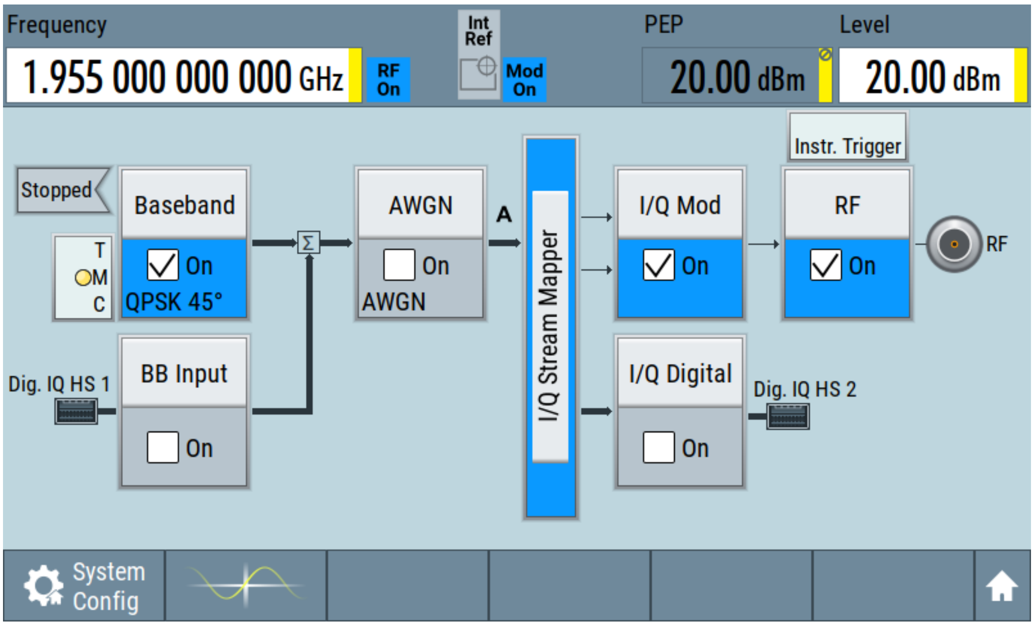
To display all parameters with values different to their preset values

After loading saved instrument setting, visualize all parameters that have been changed from their default state.

1. In the block diagram, open the context-sensitive menu:
   a) Imitate a right-click.
   b) Tap and hold on an empty space in the block diagram for about one second.
2. In the context-sensitive menu, select "Mark All Parameters Changed from Preset".



   All changed parameters are highlighted.



See also Chapter 10, "File and Data Management", on page 387.

3.3.7 Generating a DAB Signal

The main application field of the R&S SMCV100B is the generation of digital signals in accordance with broadcast standards, like DAB, DVB-T2 or ATSC3.0, to name a few. This example uses the digital broadcast standard DAB.

You can access and interact with the instrument and experience the advantages provided by the additional options.

Prerequisites

- Minimum configuration as in "Prerequisites" on page 38
- Option "Enable broadcast standard" R&S SMCVB-K519
- Option DAB/T-DMB R&S SMCVB-K156

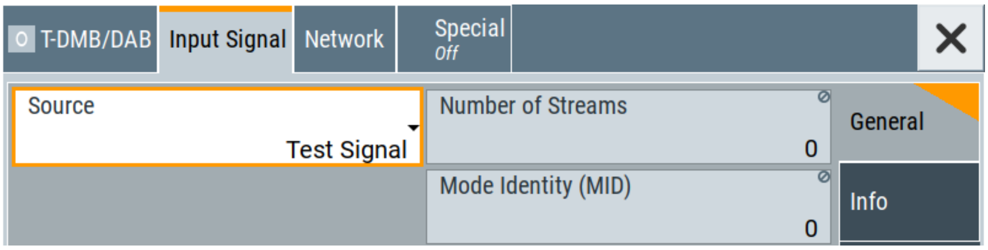
To generate a DAB test signal

1. On the R&S SMCV100B front panel, press the Preset key to start out in a defined instrument configuration.
2. In the block diagram, select "Baseband > T-DMB/DAB".

   The "T-DMB/DAB" dialog appears and displays the general settings provided for the digital standard.

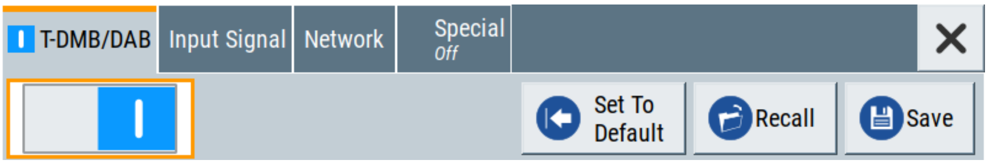
As in the user interfaces of all broadcast standards, the "T-DMB/DAB" dialog is divided into several tabs. The "T-DMB/DAB" tab comprises the primary settings of the standard.
Also, the functions for storing and recalling settings and provides access to further functions and dialogs. The more complex the digital standard itself is, the more comprehensive the further dialog and tab structure.

3. In the "Input Signal" tab, select "Source > Test Signal".
The test signal is a signal with audio content.



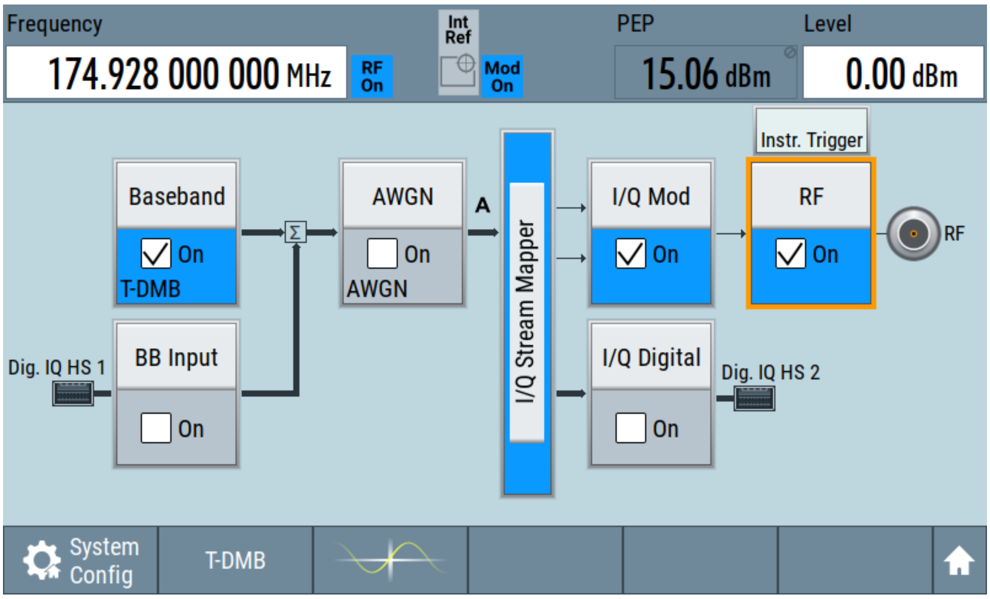
Tip: On the front panel, press the Help key to retrieve detailed information on the current settings and on the contents of the predefined files.

4. In the "T-DMB/DAB" tab, select "State > On".



5. On the "Status Bar", set "Frequency" and "Level" of the DAB test signal:
   a) Tap the "Frequency" field, to enter the center frequency, for example *174.928 MHz*.
   b) Tap the "Level" field, to enter the RMS level, for example *20.00 dBm*.

6. On the "Status Bar", activate the RF output: Set "RF On > RF On".



The instrument generates a DAB test signal with the set frequency, and level.

With these first steps, you have gained an impression of the provided functionality.

For a comprehensive description of the full range of capabilities, refer to the user manual "DAB Digital Standard for R&S SMCV100B".

3.4 System Overview

This section helps you to get familiar with the R&S SMCV100B. 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 SMCV100B, refer to Chapter 3.5, "Instrument Control", on page 60.

3.4.1 Brief Introduction to the Instrument's Concept

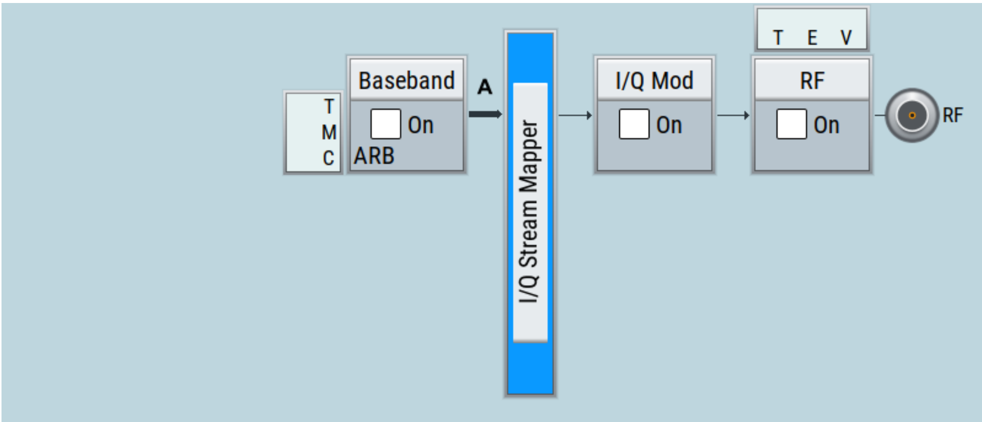
The R&S SMCV100B offers excellent RF and baseband characteristics. The baseband section of the R&S SMCV100B is fully digital. It contains the hardware for generating and processing I/Q signals in realtime or generating signals with an arbitrary waveform generator.

3.4.2 Signal Flow at a Glance

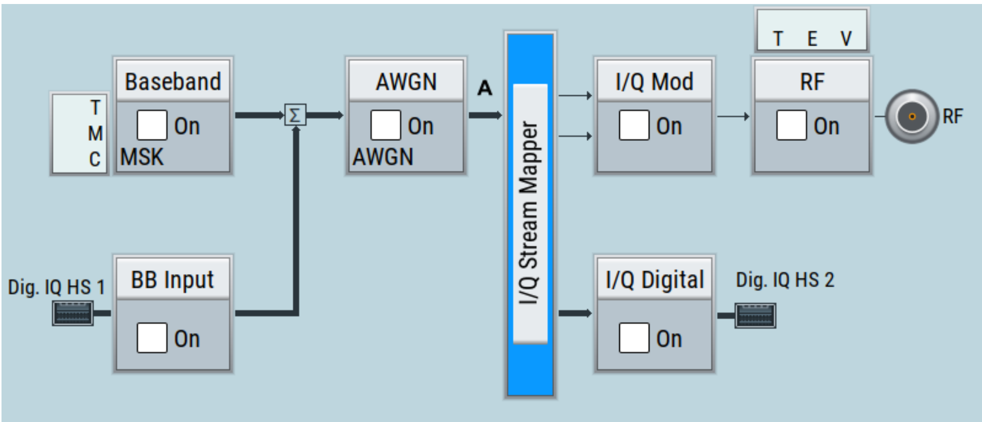
The R&S SMCV100B is equipped with a large touchscreen, that displays a block diagram. The block diagram represents the signal flow and the general stages the signal generation goes through. Depending on the options the R&S SMCV100B is equipped with, the appearance of the block diagram changes.

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

- Minimum configuration example of a base unit and frequency option R&S SMCVB-B103.



- 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.



The cross-reference between the installed options and the displayed settings

The Table 3-7 is an excerpt of the available options and lists only the options required *to display* a functional block in the block diagram. The information assumes R&S SMCV100B minimum configuration comprising base unit and frequency option R&S SMCVB-B103.

For exact information on the available options, and on the minimum requirements and the interdependencies between the provided options, refer to the R&S SMCV100B data sheet.

Table 3-7: Required options per functional block (excerpt)

Functional block	Required option
"Baseband"	-
"BB Input"	R&S SMCVB-K19
"AWGN"	R&S SMCVB-K62
"I/Q Stream Mapper"	-
"I/Q Mod"	-
"I/Q Digital"	R&S SMCVB-K19
"RF"	-

3.4.3 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" requires R&S SMCVB-K199) 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 SMCVB-K162 generates signals according to the ATSC 3.0 standard.
- *The baseband offsets function*
  Signals from the baseband generator can be shifted in frequency and phase.

3.4.4 Digital Baseband Input/Output ("BB Input"/ "I/Q Digital" Block)

The "BB Input" and the "I/Q Digital" blocks are the access point to the settings of the digital interfaces "Dig. IQ HS x".

Equipped with option R&S SMCVB-K19, the R&S SMCV100B is able to receive digital baseband signals and to output digital baseband signals. You can use both interfaces in parallel: "Dig. IQ HS 1" is input and "Dig. IQ HS 2" is output of the digital baseband signals.

The digital baseband inputs and outputs can be used together with other Rohde & Schwarz instruments, like signal generators. A Rohde & Schwarz signal generator for instance can serve as digital signal source in test configuration requiring two baseband sources.

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.

The "I/Q Digital" block is the access point to the settings of the digital I/Q output signals.

3.4.5 Additional White Gaussian Noise ("AWGN" Block)

The "AWGN" block is displayed only in instruments equipped with the option R&S SMCVB-K62. This block controls the additional white Gaussian noise generator (AWGN). An additive white noise is required for measurements of mobile radio base stations.

3.4.6 "I/Q Stream Mapper" Block

As one of the access points to the system configuration settings, the "I/Q Stream Mapper" provides direct access for mapping the generated I/Q streams to the available output connectors. That is, to the analog "RF 50 Ω" output connector and to the digital "Dig. IQ HS 2" output connectors.

3.4.7 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 digital I/Q impairments

3.4.8 RF ("RF" Block)

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

This block is the access point to:

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

3.4.9 Applications Examples of the R&S SMCV100B

The R&S SMCV100B can be optimally adapted to the requirements of different applications:

- Generation of digitally modulated signals using
  - The internal baseband generator
  - The externally applied digital baseband signals
- Generation of wanted signals or interfering signals for receiver tests

- Generation of signals with up to 240 MHz signal bandwidth

3.5 Instrument Control

This chapter provides an overview on how to work with the R&S SMCV100B.

It covers the following topics:

3.5.1 Possible Ways to Operate the Instrument

There are three ways to operate the R&S SMCV100B:

- Manual operation:
  Use the touchscreen, hard keys and rotary knob, or an optional mouse and/or keyboard.
  The description under Chapter 3.5, "Instrument Control", on page 60 shows how to operate the instrument manually.
- Remote control:
  Create programs to automatize repeating settings, tests and measurements. The instrument is connected to a computer running the program.
  This way of operation is described in Chapter 12, "Network Operation and Remote Control", on page 457.
- Remote operation from a computer:
  Remote monitoring and control of the instrument from a connected computer is based on the common cross-platform technology VNC (Virtual Network Computing). On the remote computer, any standard web browser (supporting Java) or a dedicated VNC client (like Ultr@VNC) can be used. See also Chapter 3.5.8, "Remote Operation over VNC", on page 70.

3.5.2 Means of Manual Interaction

For the manual interaction with the R&S SMCV100B, 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.

- 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 touch-screen and navigation keys is described in Chapter 3.5.4, "Accessing the Functionality", on page 65.

Throughout the manual, the term "select" refers to any of the described methods, i.e. using a finger on the touchscreen, a mouse pointer in the display, or a key on the instrument or on a keyboard.

3.5.3 Understanding the Display Information

The block diagram of the R&S SMCV100B displays all main settings and generator states, divided into three main operation areas.

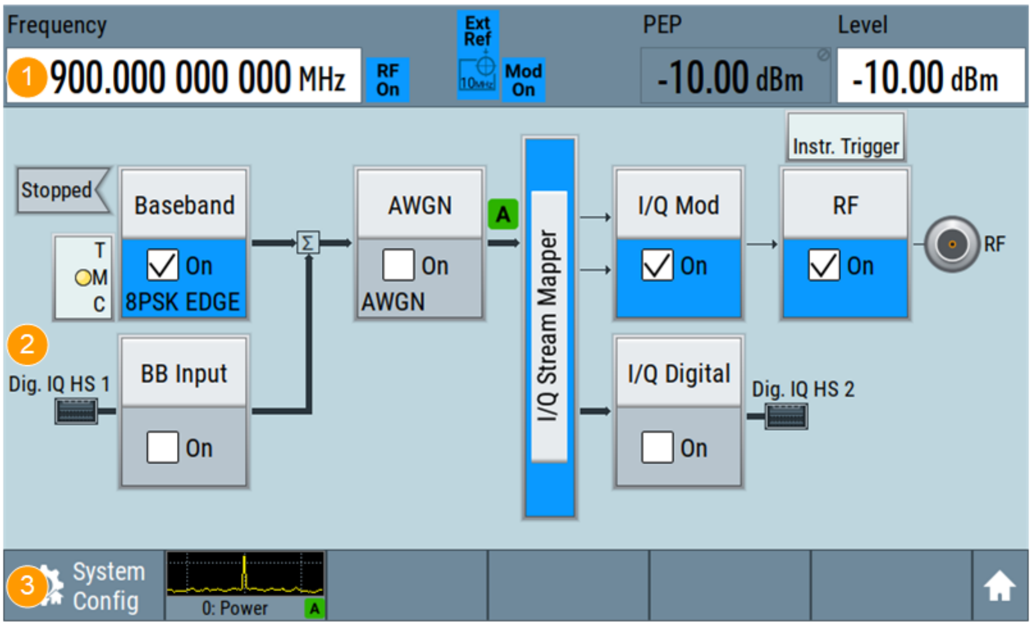
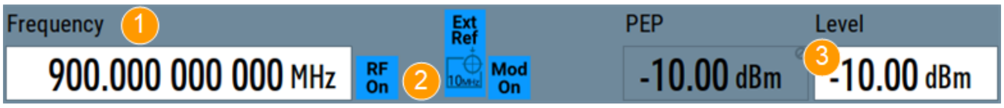


Figure 3-13: Block diagram

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

3.5.3.1 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.

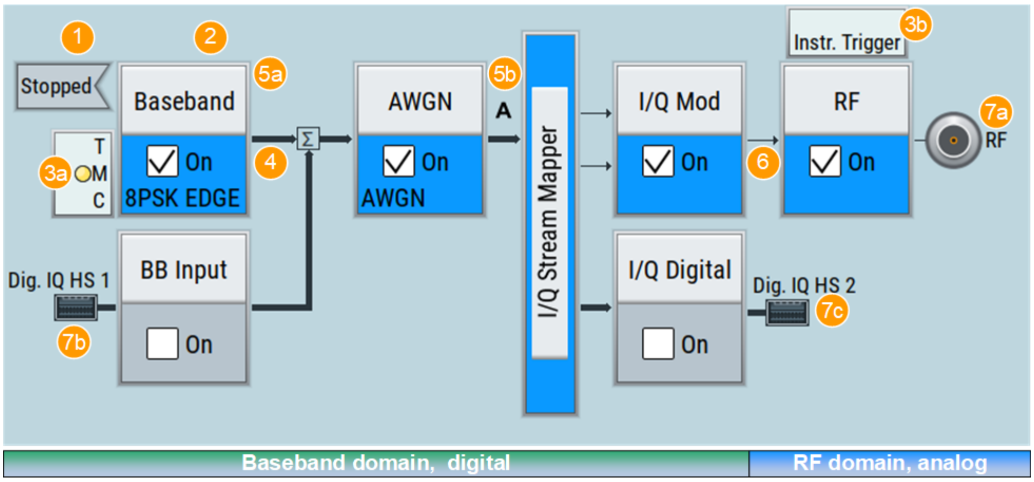


1 = Frequency display
2 = Status buttons
3 = Level display

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

3.5.3.2 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	= Status indicator
2	= Functional block
3a / 3b	= Control signal block
4	= Signal line (digital)

5a / 5b = Graphics indicator
6 = Signal line (analog)
7a / 7b / 7c = Connector icons (RF, digital)

Starting from 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	Status indicator	Indicates whether the signal is running or waiting for a trigger.
2	Functional block	Represents a basic task in signal generation. The push button provides access to any number of associated actions to accomplish the task. The On/Off (checkbox) and the block label quickly activates the basic task.
3	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 for the baseband block (3a) and RF block (3b).
4, 6	Signal lines (digital, analog)	Show the currently configured signal flow. • Thick lines represent the digital I/Q streams, see (4) in the figure above • Thin lines represent the analog signals (6)
5	Graphics indicator	Denotes that the signal is displayed graphically (5a/5b).
7	Connector icons	Represent the interfaces for signal input and output. • RF signal connector output (7a) Icons vary depending on the frequency. • Digital I/Q HS signal connector input and output (7b, 7c)

3.5.3.3 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 activated for graphical representation.

Figure 3-14: 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.

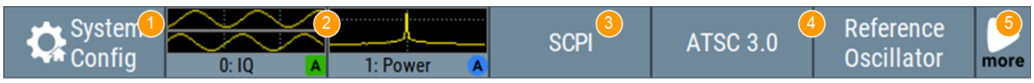


Figure 3-15: Taskbar fully assigned

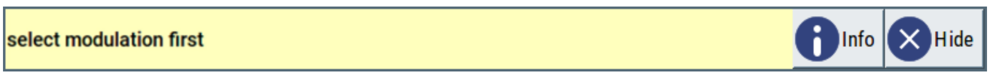
1 = System configuration
2 = Graphics
3 = Remote control connections
4 = Dialogs
5 = Diagram / more

1	SystemConfig	Provides access to general system configurations like setup, display, or remote.
2	Graphics	Shows that a signal is represented graphically.
3	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.
4	Dialogs	Shows a dialog as a thumbnail, the dialog name, and the name of signal channel.
5	Diagram / more	The diagram icon as shown in Figure 3-14 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.

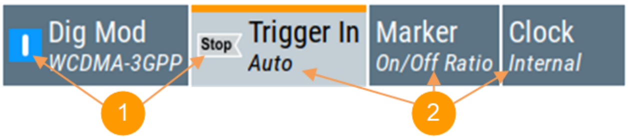
3.5.3.4 Additional Display Characteristics

The following section provides a short insight on the indication of the screen in general, and significant elements that you see under specific operating 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**
  As additional means of interacting with the instrument without having to connect an external keyboard, either a numerical or alphanumerical on-screen keypad appears when you activate an entry field (see Chapter 3.5.5, "Entering Data", on page 66).
- **Info line**
  The "Info line" shows brief status information and error messages. It appears when an event generates a message.

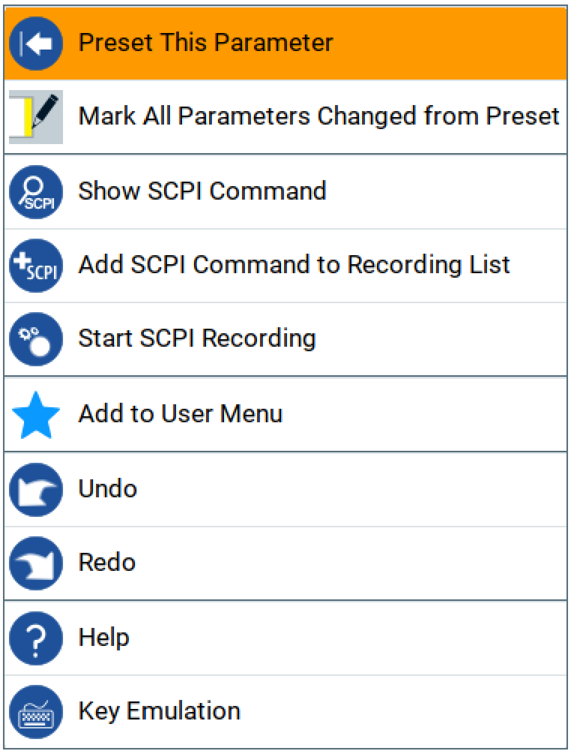


- **Key parameters indicated in tab labels**
  Most dialogs are divided into tabs with logically grouped parameters. The tab label expresses the content and can also contain status indicators or the set value of a key parameter.



1 = Status indicators
2 = Key parameter values

- **Scroll bar handle**
  An arrow icon that appears when you touch a scroll bar helps you to scroll in a dialog or list.
- **Context-sensitive menus**
  Within the entire screen display, including single parameters, you can access context-sensitive menus that provide some additional functions.



3.5.4 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, or with the rotary knob (press and hold).

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

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

To minimize a dialog box

► To return to the block diagram, tap the "Home" button.

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:
  - Tap the "Close" icon in the upper right corner.
  - Press 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

► Tap the required option.

To select an option in a list

If many options are available - for example, for the trigger mode - the options are provided in a list. The current selection is shown on the list button.

1. Tap in the list.
2. To navigate through the list, try out the following:
   - Using a mouse, scroll in the list, tap the required option.
   - Use the rotary knob.

3.5.5 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. Thus, you can always set the parameters via the touchscreen, the front panel, or an external keyboard.

Correcting an entry

1. Using the arrow keys, move the cursor to the right of the entry you want to delete.

2. On the on-screen keyboard, press "Clear".
3. Enter your correction.

Completing the entry

► On the on-screen keyboard, press "Enter" .

Aborting the entry

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

3.5.5.1 Entering Numeric Parameters

To enter 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.
2. Tap the unit button to complete the entry.
   The unit is added to the entry.
3. If the parameter does not require a unit, confirm the entered value by pressing "Enter".

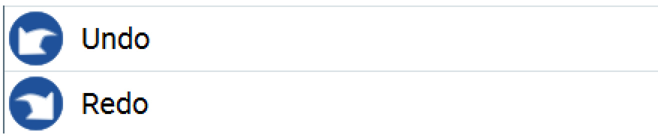
If you edit numeric data in tables, the entry field must be in edit mode: Press the rotary knob to activate the edit mode.

3.5.5.2 Entering Alphanumeric Parameters

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

3.5.5.3 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.



"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 functional description on a setting.
- The general help explains a dialog box, provides instructions, and general information.

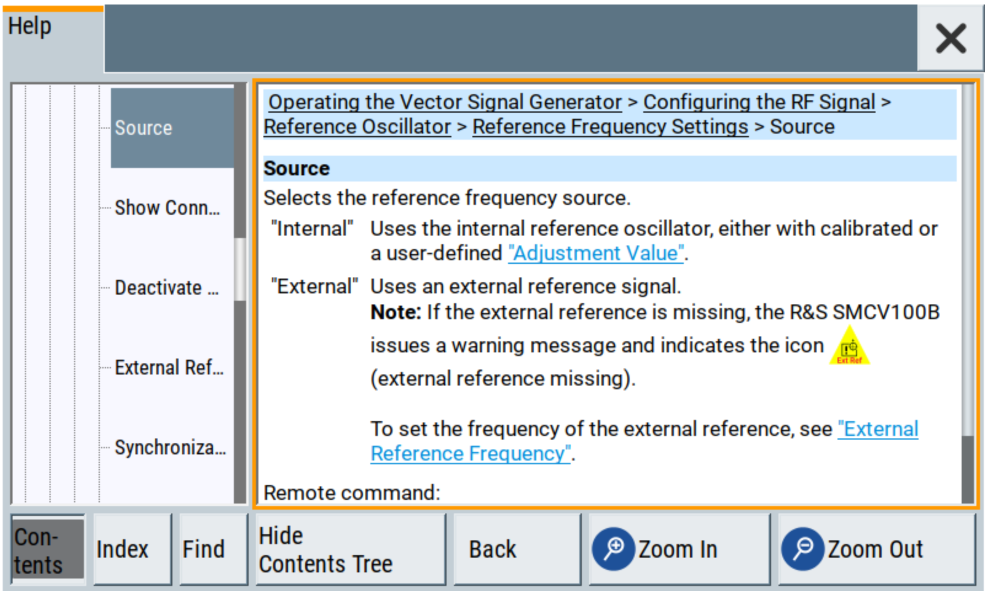
To display context help

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

a) Tap and hold the parameter for which you need information and tap "Help" in the context menu.

b) Tap the parameter and 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 contents entries, tap on an entry and scroll or use a connected mouse.
   Entries with a plus sign contain further entries.
2. To display a help topic, tap on the topic name or double-click 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 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 you are interested in.
   The entries starting with these characters are displayed.
3. Tap on the index entry.
   The corresponding help topic is displayed.

3.5.7 Remote Control

In addition to working with the R&S SMCV100B interactively, located directly at the instrument, it is also possible to operate and control it from a remote PC.

The R&S SMCV100B supports various methods for remote control:

- Connecting the instrument to a LAN (see Chapter 3.1.7, "Connecting to LAN", on page 25)
- Using the LXI browser interface in a LAN

For remote control, you can use the R&S VISA (Virtual Instrument Software Architecture) library provided for download at the Rohde & Schwarz website http://www.rohde-schwarz.com/rsvisa.

How to configure the remote control interfaces is described in Chapter 12, "Network Operation and Remote Control", on page 457.

3.5.8 Remote Operation over VNC

The VNC is an application which can be used to access and control the instrument from a remote computer through a LAN connection. While the instrument is in operation, the instrument screen contents are displayed on the remote computer, and VNC provides access to all applications, files, and network resources of the instrument. Thus, remote operation of the instrument is possible.

Instrument control from a remote computer

To access the basic utility functions of the R&S SMCV100B, perform a right mouse click the block diagram and select "Key Emulation".

A key panel to the right of the block diagram gives access to the utility functions provided by the front panel keys.

The VNC is an add-on program, included in operating system Linux/Unix, and available as a free-of-charge download on the internet.

For more information, refer to Chapter 12.9, "Operating the R&S SMCV100B Remotely via VNC", on page 503.

4 Configuring Internal Baseband Signals

The R&S SMCV100B 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.

4.1 Overview of the Signal Generation Modes

The R&S SMCV100B can generate the signal in the following ways:

- "Generating digital modulated signals according to various broadcast standards" on page 71
- Generating a real-time signal
- Playing a waveform

Generating digital modulated signals according to various broadcast standards

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 Chapter 4.3, "Generating Signals According to Broadcast Standards", on page 73.

Generating a real-time signal

- While utilizing the *internal* signal generator, the R&S SMCV100B generates the digital modulation signals with user-definable characteristics in real time.
  See also Chapter 4.5, "Generating Custom Digital Modulated Signals", on page 102.
- If the required options are installed, the *internal* signal generator of the R&S SMCV100B also generates frequency, phase, amplitude and pulse modulation signals in real time.
  See also Chapter 4.10, "Generating FM/PhiM/AM/Pulse Modulation Signals", on page 227.
- If the required options are installed, *externally supplied real-time* baseband signals can be added to the internally generated signals.
  See also Chapter 5.3, "Digital Baseband Input Settings", on page 256.

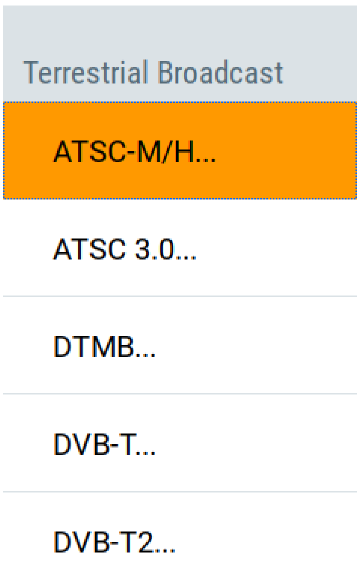
Playing a waveform

The R&S SMCV100B 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 or USB.
  Create waveforms, for example, with the signal generation software R&S WinIQ-SIM2 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 Chapter 4.6, "Using the Arbitrary Waveform Generator (ARB)", on page 130.
  - 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 Chapter 4.9, "Generating Multi-Carrier Signals", on page 209.

4.2 Accessing the Functions in the Baseband Domain

1. In the block diagram, select the "Baseband" block and navigate through the context menu.



The "Baseband" block comprises all functions and settings concerning the baseband signal. The functions and settings include all generation modes as described in the Chapter 4.1, "Overview of the Signal Generation Modes", on page 71.

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

   Note: The internal baseband generator ("Baseband" block) and the external digital baseband input ("BB Input") cannot run simultaneously. They deactivate each other.

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

   For information, see:
   - Chapter 4.5, "Generating Custom Digital Modulated Signals", on page 102
   - Chapter 4.6, "Using the Arbitrary Waveform Generator (ARB)", on page 130
   - The description of the digital standards
   - Chapter 4.11, "Shifting and Boosting the Baseband Signal", on page 234

4.3 Generating Signals According to Broadcast Standards

The R&S SMCV100B generates digital signals in accordance with the specifications of the main audio broadcast standards, terrestrial and satellite broadcast standards. Since the signals are baseband signals, broadcast standards are also denoted digital standards in this chapter.

Signal generation requires the following:

- R&S SMCV100B minimum configuration
  - Base unit
  - Frequency option R&S SMCVB-B103
- Enable broadcast standard option R&S SMCVB-K519
- Digital standard option

For the required digital standard option, see the corresponding digital standard sections below.

ATSC-M/H

The digital standard requires an instrument equipped with the ATSC / ATSC-MH option R&S SMCVB-K161.

The option provides functionality to generate signals in accordance with the ATSC-M/H standard.

For details, see the R&S SMCV100B ATSC-M/H user manual.

ATSC 3.0

The digital standard requires an instrument equipped with the ATSC 3.0 option R&S SMCVB-K162.

The ATSC 3.0 option provides functionality to generate signals in accordance with the ATSC 3.0 standard.

For details, see the R&S SMCV100B ATSC 3.0 user manual.

DTMB

The digital standard requires an instrument equipped with the DTMB option R&S SMCVB-K166.

The option provides functionality to generate signals in accordance with the DTMB (digital terrestrial multimedia broadcast) standard.

For details, see the R&S SMCV100B DTMB user manual.

DVB-T

The digital standard requires an instrument equipped with the DVB-T option R&S SMCVB-K163.

The option provides functionality to generate signals in accordance with DVB-T standard. The standard complies with specification ETSI EN 300 744 (DVB-T and DVB-H).

For details, see the R&S SMCV100B DVB-T user manual.

DVB-T2

The digital standard requires an instrument equipped with the DVB-T2 option R&S SMCVB-K164.

The option provides functionality to generate signals in accordance with DVB-T2 standard. The standard complies with specification ETSI EN 302 755 (DVB-T2).

For details, see the R&S SMCV100B DVB-T2 user manual.

ISDB-T

The digital standard requires an instrument equipped with the ISDB-T/TSB option R&S SMCVB-K165.

The option provides functionality to generate signals in accordance with ISDB-T/ISDB-T_{SB} standard.

For details, see the R&S SMCV100B ISDB-T user manual.

T-DMB/DAB

The digital standard requires an instrument equipped with the DAB/T-DMB option R&S SMCVB-K156.

The option provides functionality to generate signals in accordance with DAB and T-DMB standard.

The DAB standard complies with specification ETSI EN 300 401 "Radio Broadcasting Systems Digital Audio Broadcasting (DAB) to mobile portable and fixed receivers)".

The input interface complies with specification ETS 300 799 "Digital Audio Broadcasting (DAB) Distribution Interfaces; Ensemble Transport Interface".

For details, see the R&S SMCV100B T-DMB/DAB user manual.

DVB-S

The digital standard requires an instrument equipped with the DVB-S / DVB-S2 option R&S SMCVB-K167.

The option provides functionality to generate signals in accordance with DVB-S digital video broadcast standards. It also provides functionality to generate basic DVB-S2 signals.

DVB-S is the first-generation DVB standards for satellite services and complies with specification EN 300 421.

For details, see the R&S SMCV100B DVB-S/DVB-S2 user manual.

DVB-S2

The digital standard requires an instrument equipped with the following options:

- DVB-S / DVB-S2 option R&S SMCVB-K167
- DVB-S2x option R&S SMCVB-K168.

The option provides functionality to generate advanced signals in accordance with DVB-S2 and DVB-S2x standards.

DVB-S2 is the second-generation DVB standards for satellite services.

For details, see the R&S SMCV100B DVB-S2x user manual.

DRM

The digital standard requires an instrument equipped with the DRM option R&S SMCVB-K160.

The option provides functionality to generate signals in accordance with the DRM (digital radio mondiale) standard. The standard complies with specification ETSI ES 201 980.

For details, see the R&S SMCV100B DRM user manual.

AM/FM/RDS

The digital standard requires an instrument equipped with the AM/FM/RDS option R&S SMCVB-K155.

The option provides functionality to generate digital audio broadcast signals, such as AM signals, FM mono signals and FM stereo signals. FM stereo signals require the RDS (radio data system) coder.

For details, see the R&S SMCV100B AM/FM/RDS user manual.

4.4 Common Functions and Settings in the Baseband Domain

Basic signal generation settings that are common to many generation tasks, regardless of the selected baseband source or digital standard, are described here. If you are performing a specific signal generation task, like generating a signal according to a digital standard, be sure to check the specific description for settings that may deviate from these common settings.

4.4.1 Basics on Signals, Modulation Types and Filters Used the Baseband Domain

This section provides general information on common topics and basic principles.

4.4.1.1 Data, Clock and Control Signals and Sources in the Baseband

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

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

- Internal Modulation Data
- "Clock Signals" on page 78
- Control Signals

Signal sources

The data, the clock and the trigger signals can be both internally generated and supplied from an external source. 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.

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

Internal Modulation Data

The R&S SMCV100B uses the following internal modulation data sources:

- **Data lists**
  Data lists are externally or internally created binary lists with modulation data.
  The instrument provides 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 Chapter 4.5.3.7, "Data List Editor", on page 114). A separate file is created for each list and stored on the instrument's 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 (see data sheet). There is no restriction on the number of lists that can be stored.
  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 Chapter 10, "File and Data Management", on page 387).
- **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.

Table 4-1: Overview of PRBS generators

PRBS generator	Length in bits	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.

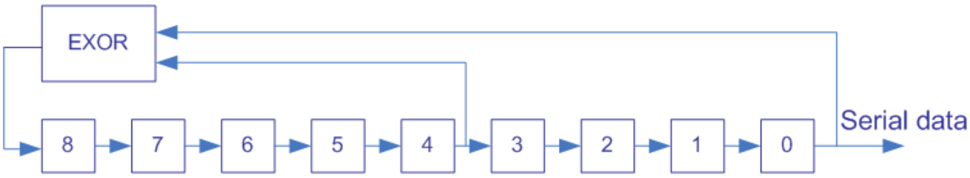


Figure 4-1: A 9-bit PRBS generator

Related settings:
- Chapter 4.5.3.3, "Data Source", on page 106
- Chapter 4.5.3.7, "Data List Editor", on page 114
- Chapter 4.5.3.8, "Control and Marker Lists Editor", on page 116
- "Data Source" selection in the dialogs of the firmware options

Clock Signals

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

Currently, you cannot output the internally generated symbol clock signal.

Synchronizing data signals and clock signals

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

Related settings:
- Chapter 4.4.2.3, "Clock Settings", on page 101
- Chapter 11.2, "Configuring the Global Connectors", on page 420

Control Signals

The following control signals are processed in the R&S SMCV100B:
- "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 Chapter 4.5.3.8, "Control and Marker Lists Editor", on page 116 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 SMCV100B 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 Chapter 4.5.3.8, "Control and Marker Lists Editor", on page 116; the signals can be output on the "User x" 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 79.
- *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:

- Chapter 4.5.3.6, "Power Ramp Control Settings", on page 112

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 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.

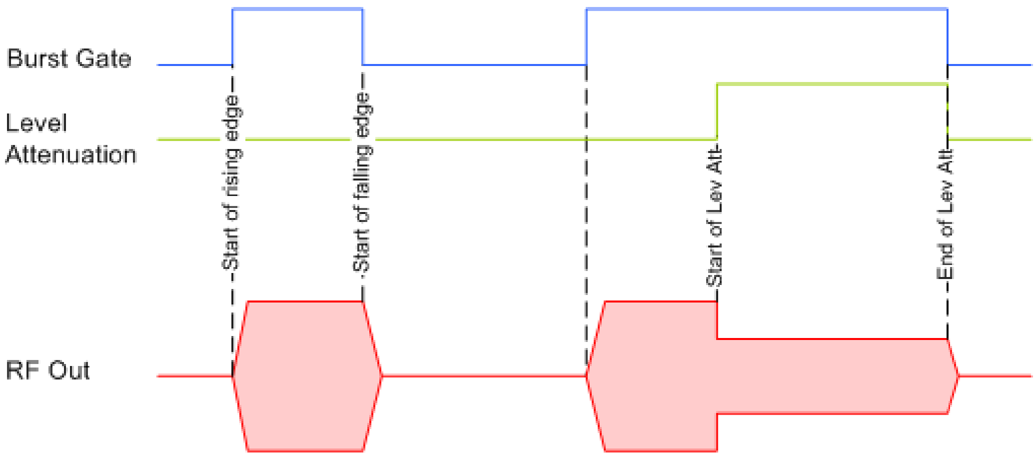


Figure 4-2: Signal behavior when power ramping and level attenuation are enabled

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

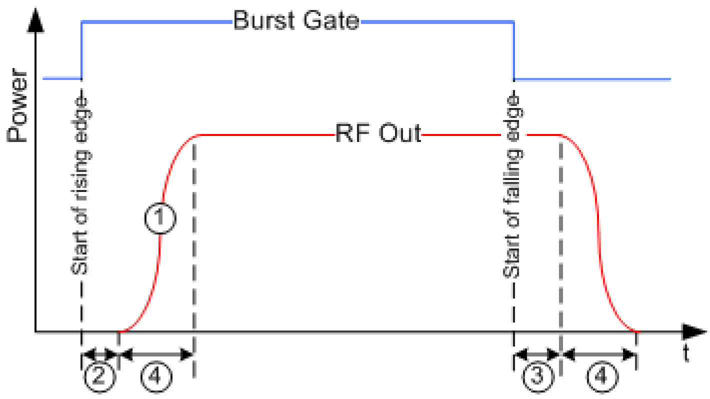


Figure 4-3: Impact of the ramp settings

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

4.4.1.2 Regular Marker Output Signals

The R&S SMCV100B can add *additional signals* to the generated signal. Marker signals (or markers) are digital signals which can be used to synchronize external devices to the generated data stream. For example, with suitable marker settings, a slot clock or frame clock can be selected, or the start of a particular modulation symbol can be marked.

Two marker output signals are available; they can be output at the "User x" connectors.

Related settings:

- Chapter 4.4.2.2, "Marker Settings", on page 100
- Chapter 11.2, "Configuring the Global Connectors", on page 420
- 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 as well as 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 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:

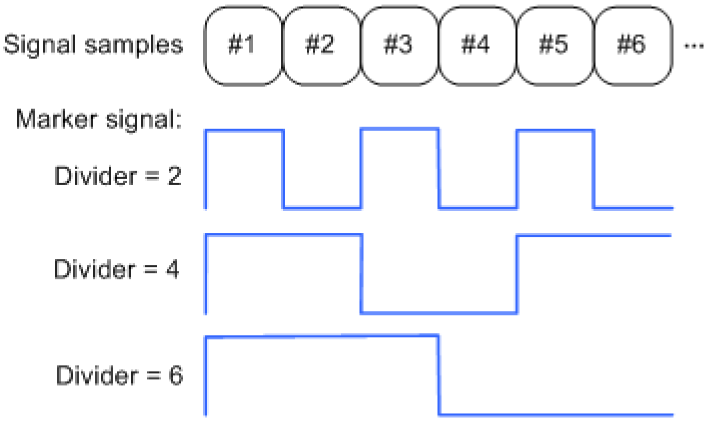
<Frequency> = "Symbol/Sample Rate" / "Divider", respectively

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

Example:

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

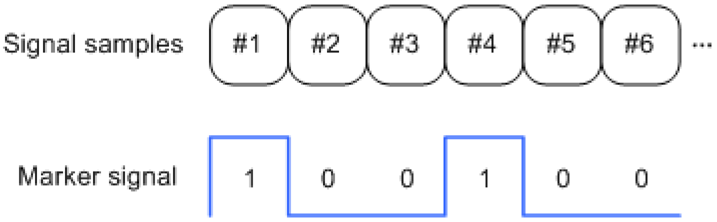
The marker frequency is 500 kHz, corresponding to a marker period of 2 us. Each On and Off period has a length of 1 us, corresponding to one symbol period. With a divider of 4 (6, 8 ...), the length of each On and Off period is increased to 2 (3, 4, ...) symbol periods.



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.

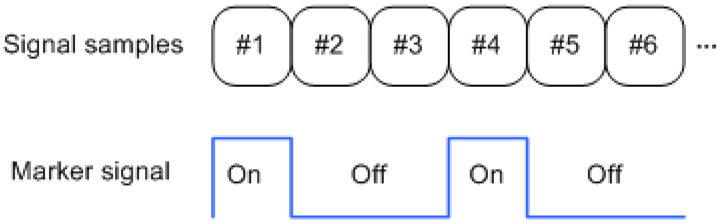
Example:
In the following example, the marker signal is defined by a pattern *100100...*.



Marker mode ON/OFF ratio

Similar to "Pulse" but with independent lengths of the On and Off periods. The length of the periods is entered as a number of symbols/sample periods.

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



Marker mode CList

The instrument generates a marker signal that is defined in the selected control list. The R&S SMCV100B provides a graphical interface for convenient definition of control signals among others also for the marker signals.

Delaying Marker Signals

In all the examples listed in "Marker Modes" on page 81, 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 symbols/sample periods.

4.4.1.3 Baseband Trigger Signals

The R&S SMCV100B 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 Chapter 8.9.1, "Signal Generation and Triggering in the Sweep and List Modes", on page 306.

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 trigger manually. The "Arm" function stops the signal generation until subsequent trigger event occurs.

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 "User x" connectors. Refer to Configuring the Global Connectors for information on how to configure the required settings.

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 "User x" connectors.

Related settings:

- Chapter 4.4.2.1, "Trigger Settings", on page 97
- Chapter 11.2.5, "Global Connectors Settings", on page 426

Impact of the Trigger Modes on the Signal Generation

A trigger event affects the signal generation in different way, depending on the selected trigger mode. The Table 4-2 gives an overview of the provided trigger modes and their impact.

Table 4-2: 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
"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.

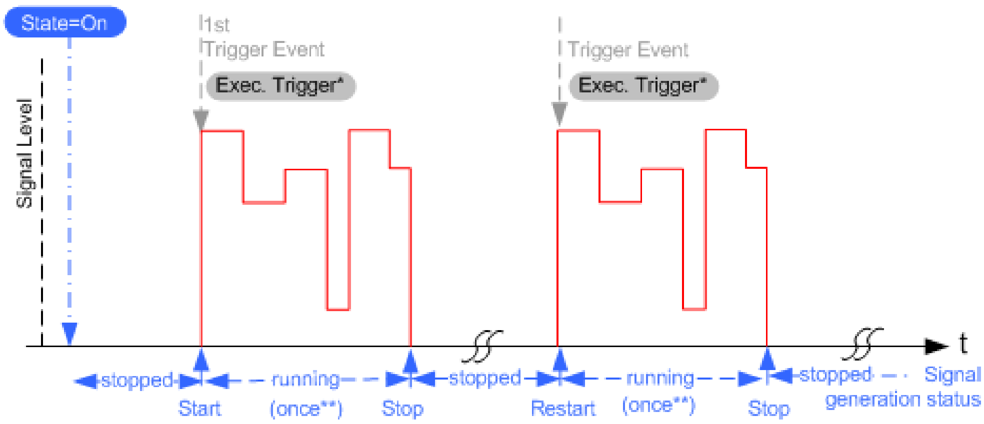


Figure 4-4: Trigger mode single

* = 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.

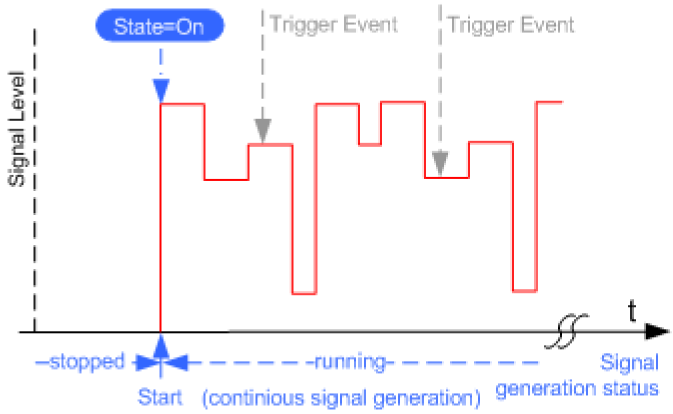


Figure 4-5: Trigger mode auto

- 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.

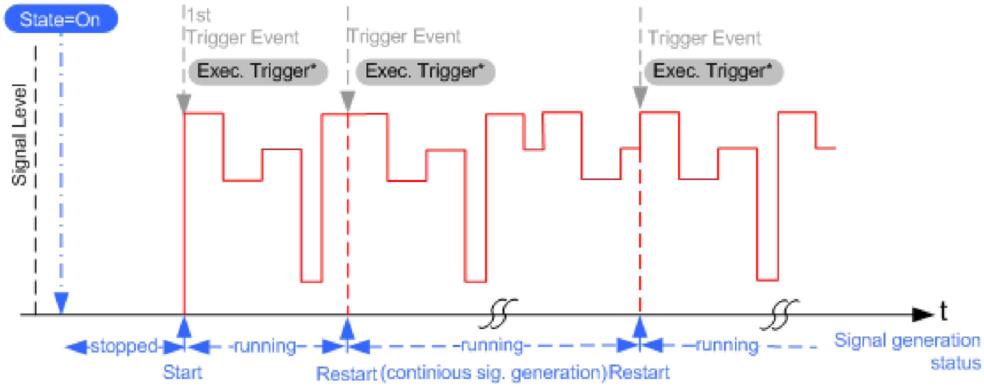


Figure 4-6: Trigger mode retrigger

* = 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.

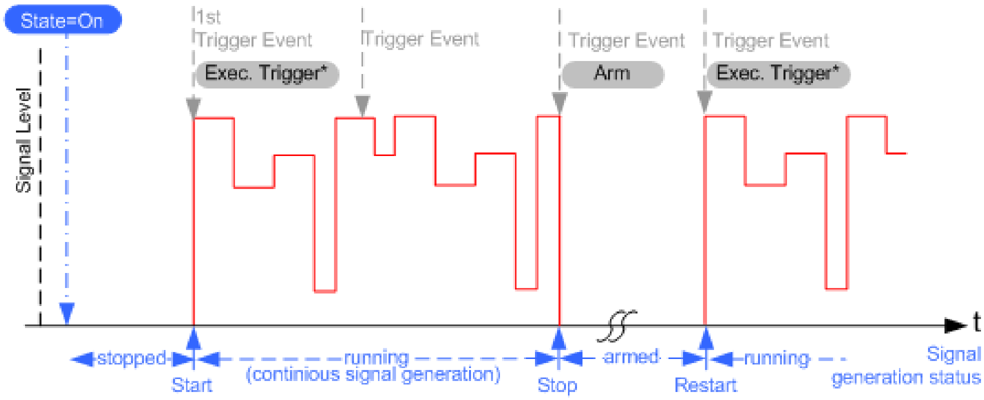


Figure 4-7: Trigger mode armed auto

* = 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.

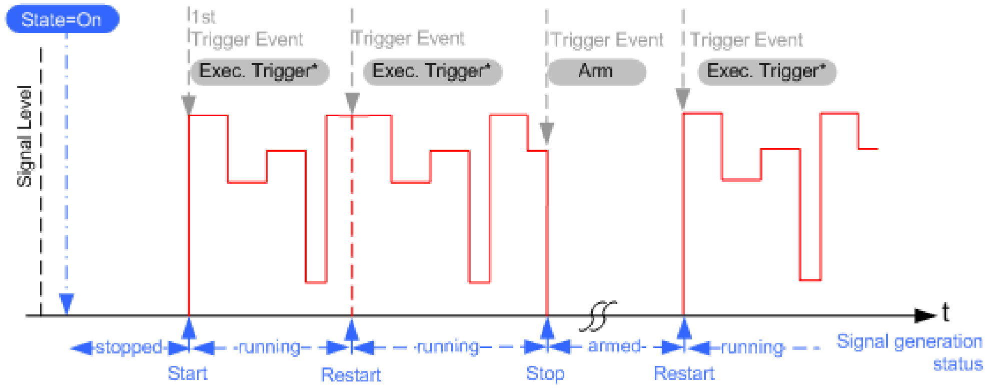


Figure 4-8: Trigger mode armed retrigger

* = Internal trigger event (to simplify the description)

Impact of the Additional Trigger Settings

The R&S SMCV100B 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.

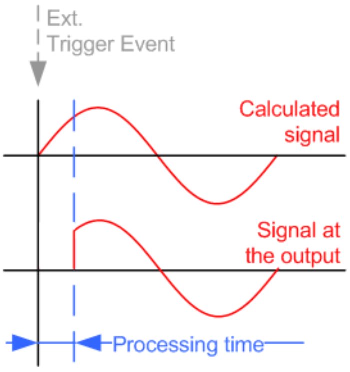
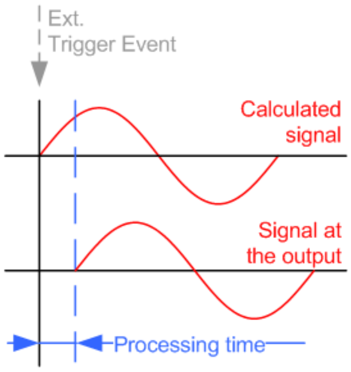
- "Threshold Trigger Input"
  Defines the voltage level of the trigger signal where the R&S SMCV100B generates a trigger event. Trigger signals below the trigger threshold are ignored.
- "Trigger Input Slope"
  Specifies the edge (rising or falling edge) of the trigger signal that is to provide the trigger 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 4-3).

Table 4-3: 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) 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) 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 which would cause a signal generation restart 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.

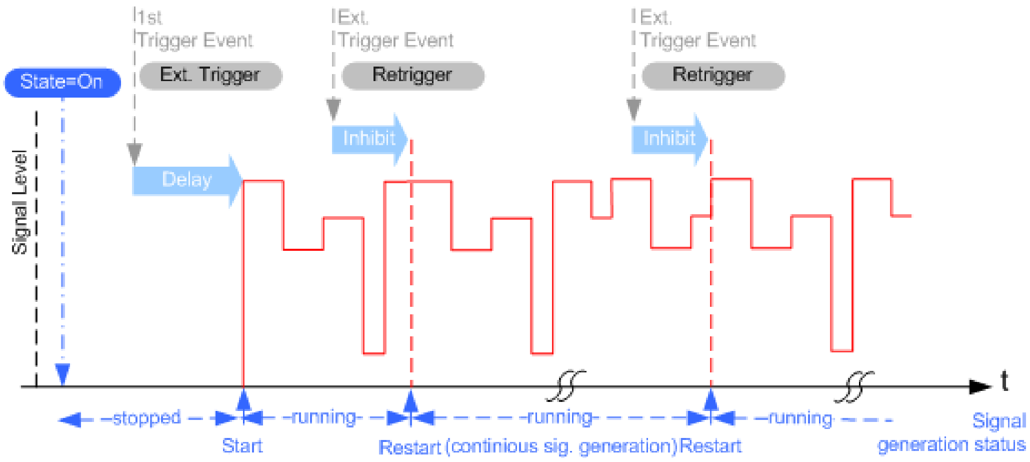


Figure 4-9: Trigger delay and trigger inhibit in trigger mode retrigger

Specifying delay and inhibit values

Trigger delay and inhibit values are expressed in the units of the generated signal, e.g. in samples or symbols. You can also define the exact delay or inhibit period as a time value, e.g. in seconds.

Trigger delay values t_{delay} depend on the instrument hardware. The table illustrates an exemplary instrument configuration and related t_{delay} values in samples (or symbols) and in seconds.

Option	Max. r_s / MHz	t_{delay} / samples	t_{delay} / s
Base unit	750	0 to depends on sample rate	0 to 1466

For more information, see the data sheet.

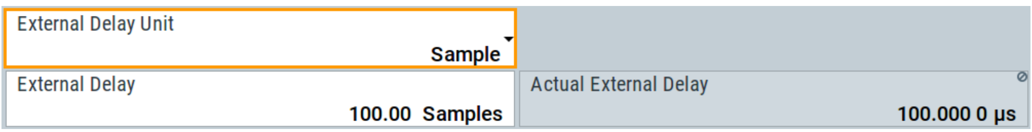
Example: Trigger delay and ARB clock frequency

The example is based on an ARB signal with 1 MHz clock frequency ("Baseband > ARB > Clock Frequency = 1 MHz").

Step 1: Enable the following settings:

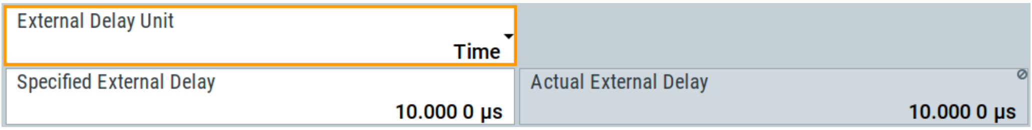
- "ARB > Trigger In > Mode > Armed Auto"
- "ARB > Trigger In > Source > External Global Trigger 1"
- "ARB > Trigger In > External Delay Unit > Samples"
- "ARB > Trigger In > External Delay = 100 Samples"

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



Step 2: Enable the following settings:

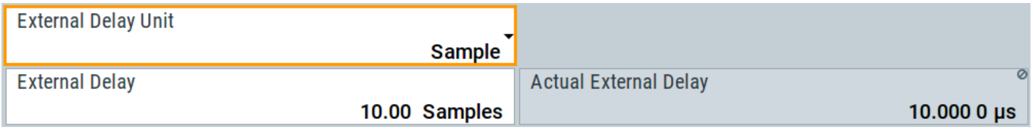
- "ARB > Trigger In > External Delay Unit > Time"
- "ARB > Trigger In > Specified External Delay = 10 us"
  Logically, the "Actual External Delay" changes to 10 us.



Step 3:

- Switch to "ARB > Trigger In > External Delay Unit > Samples".

The value of "ARB > Trigger In > External 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 triggering the R&S SMCV100B externally, see Chapter 3.3.3, "Triggering the Instrument with an External Signal", on page 43.

4.4.1.4 Supported Modulation Types

The R&S SMCV100B supports a range of predefined digital and analog modulation types. All related signals are baseband signals and digitally modulated onto the carrier. Analog modulation signals are output as analog signal via an DAC (digital to audio converter).

In the communication techniques, the 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 used bits per symbol is a modulation parameter. The exact position of the symbols on the constellation diagram is determined by the used coding and can be influenced by additionally applied 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.

In the case of all FSK procedures, you can set the symbol rate f_{SYMB} up to a maximum value (see data sheet). The frequency deviation (FSK deviation) of the MSK modulation is permanently set to ¼ of the symbol rate.

In addition to the common modulation schemes, 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 91).

User mapping

A user-defined modulation mapping file can also be selected as modulation mapping source. The user modulation mapping file must have 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). Its main purpose is the assignment of logical symbol numbers to constellation points and the selection of modulation-specific parameters. Beyond this, it supports the creation of nearly any arbitrarily chosen constellation diagram. The output of mapwiz is a mapping file (`*.vam`) that can be imported to a R&S SMCV100B. The program was developed on a 32-bit Microsoft Windows platform under MATLAB.

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

The remote commands required to define the modulation settings are described in Chapter 13.15.3.2, "SOURce:BB:DM Subsystem", on page 590.

Related settings:

- Chapter 4.5.3.4, "Modulation Settings", on page 108

4.4.1.5 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 methods. This explains why coding schemes are not freely combinable with the modulation methods.

Refer to Chapter 4.5.5.1, "Common Coding Algorithms", on page 126 for overview on the available coding combinations. This section also defines the modulation types for which the various coding procedures can be used.

Related settings:

- "Coding" on page 105

4.4.1.6 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 SMCV100B 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 more steeper edges or change the transition bandwidth. For more information on the provided settings, refer to "Impact of the Filter Parameters" on page 92.

The selection of user-defined filter offers even more flexibility. The later is a useful interface while filters with complex or proprietary form are required. For more information, refer to "User filter" on page 92.

Predefined baseband filters

Refer to Chapter 4.5.5.2, "Predefined Baseband Filters", on page 128 for an overview of the available baseband filters.

User filter

The user filter file must have 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 SMCV100B. 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, refer to the description "Introduction to "filtwiz" Filter Editor" at the Rohde & Schwarz webpage.

The remote commands required to define the filter settings are described in Chapter 13.15.3.2, "SOURce:BB:DM Subsystem", on page 590 and the corresponding section in the user manual of each firmware option.

Related settings:

- Chapter 4.5.3.5, "Filter Settings", on page 110
- Filter settings in the dialogs of the firmware options

Impact of the Filter Parameters

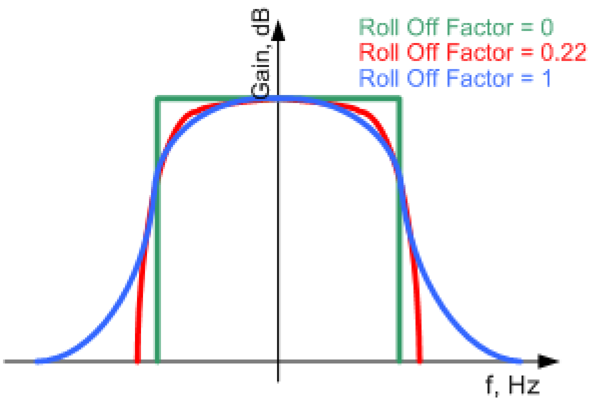
The following is a simple description of the filter parameters and the way they affect the main filter characteristics. Changing filter parameters is an effective way to ensure that the entire bandwidth of the desired signal is allowed to pass and adjust the filter form to reach the spectrum mask requirements.

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

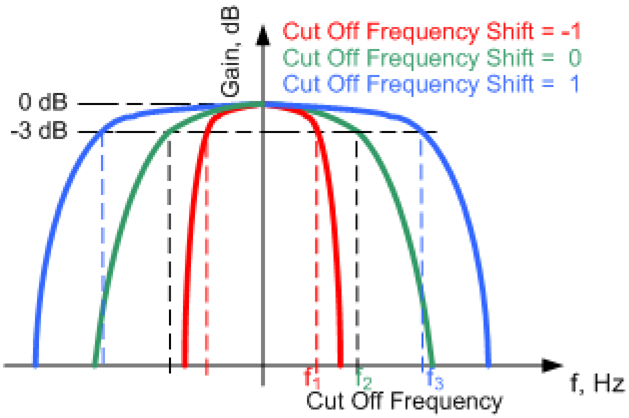
The passband describes the frequency span that the filter passes unchanged. The total passband of a filter is given as follows:

```
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".

4.4.1.7 Methods for Optimizing the Crest Factor

Communication standards utilizing higher order modulation techniques or using multiple carrier 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.

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 instance, when in a multi carrier signal the carriers feature an identical start phase. This is based on the fact that the carriers are periodically superposed that leads to 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 leads to a high quantization noise.

Both effects increase the adjacent-channel power.

Direct approaches

At the individual signal generation stages, the R&S SMCV100B offers different direct approaches aimed 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 the possibility to enable baseband clipping and to select the baseband filter and, when applicable, to adjust the filter characteristics.

- **Clipping** is a technique that applies a wanted distortion to the signal.
  The principle includes specifying a threshold, finding out the signal peaks once the defined limits are exceeded and clipping them off. The level limit is specified as a percentage of the highest peak value. Because clipping is done before filtering, the procedure does not influence the spectrum. The error vector magnitude (EVM) however increases.

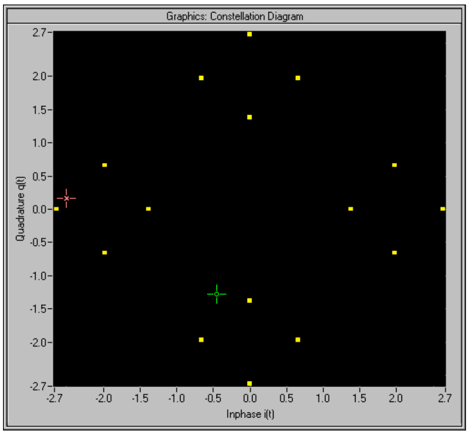
  The instrument offers two clipping modes:
  – **Vector | I + q |**
    The clipping limit is related to the amplitude | I + q |. The I and Q components are mapped together, the angle is retained.
  – **Scalar | I | + | q |**
    The clipping limit is related to the absolute maximum of all the I and Q values | I | + | q | . The I and Q components are mapped separately, the angle changes.

  However, signal clipping not only changes the peak value but also the average value and the effect on the crest factor is unpredictable.

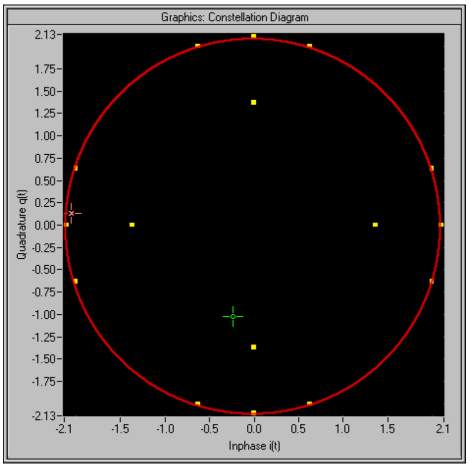
Example:

The following figures demonstrate the effect of the clipping on the crest factor for typical scenarios.

Enabled is clipping with vector mode (|I+q|), using a signal configuration with 2 active channels.



Constellation diagram of the signal without clipping, shows the level mapping



Constellation diagram with clipping level 80%, vector mode (|I+q|) The circle emphasizes the changed constellation points

- **Filtering** is applied subsequently. The used filters are specially designed so that they filter out the distortion.

4.4.2 Common Settings

The start dialog of each digital standard follows a repeating dialog structure that comprises 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 Modulation" dialog to explain the provided common settings. The related remote-control commands are listed in the order "Custom Digital Modulation", "ARB", "Multi Carrier CW".

This section focuses on the available settings.

For more information refer to:

- Chapter 4.4.1.3, "Baseband Trigger Signals", on page 82.
- Chapter 4.4.1.2, "Regular Marker Output Signals", on page 80
- "Clock Signals" on page 78

Routing and enabling a trigger

Use the Global Connector Settings to configure the signal mapping, the polarity, the trigger threshold and the input impedance of the input connectors.

To route and enable a trigger signal, perform the following *general steps*:

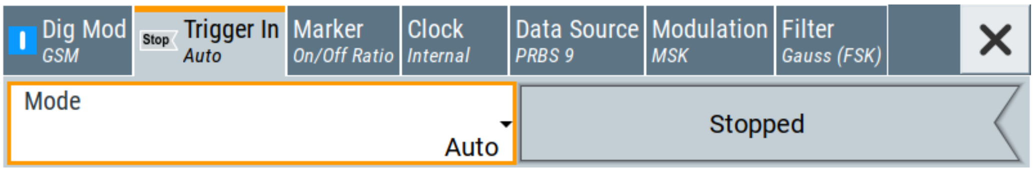
- Define the signal source and the effect of a trigger event.
  Select the "Trigger In > Mode" and "Trigger In > Source".
- Define the connector where the selected signal is provided.
  Use the "Global Connectors" settings.

4.4.2.1 Trigger Settings

Access:

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

This tab comprises the settings for selecting and configuring the trigger, like trigger source, mode, and delay, and to arm or trigger an internal trigger manually. The current signal generation status is displayed in the header of the tab together with information on the enabled trigger mode. As in the "Marker" and "Clock" tabs, this tab provides also access to the settings of the related connectors.



Settings:

Mode

Selects a regular trigger signal: "Auto", "Retrigger", "Armed_Auto", "Armed_Retrigger", or "Single".

Refer to "Impact of the Trigger Modes on the Signal Generation" on page 83 for a detailed description of the provided trigger modes.

Remote command:
[:SOURce<hw>]:BB:DM[:TRIGger]:SEQuence on page 603
[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence on page 651

Signal Duration
Enters the length of the signal sequence to be output in the "Single" trigger mode.

Use this parameter to output part of the signal deliberately, an exact sequence of the signal, or a defined number of repetitions of the signal.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:SLENgth on page 604
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit on page 652

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 604
[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe? on page 651

Arm
Stops the signal generation until subsequent trigger event occurs.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute on page 605
[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute on page 652

Execute Trigger
For internal trigger source, executes trigger manually.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:EXECute on page 605
[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute on page 652

Source
The following sources of the trigger signal are available:

- "Internal"
  The trigger event is executed manually by the "Execute Trigger".
- "External Global Trigger"
  The trigger event is the active edge of an external trigger signal provided and configured at the "User x" connectors.

The polarity, the trigger threshold, and the input impedance of the input connectors can be configured in the "Global Connector Settings" dialog.

See "Trigger Sources" on page 83

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:SOURce on page 603
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce on page 651

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

For a detailed description of the impact of this parameter, see "Impact of the Additional Trigger Settings" on page 87.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut on page 604
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut on page 652

External / Trigger Inhibit
Sets the duration with that any following trigger event is suppressed. In "Retrigger" mode for example, a new trigger event does not cause a restart of the signal generation until the specified inhibit duration does not expire.

Applies for:
- External trigger signal

For more information, see "Impact of the Additional Trigger Settings" on page 87.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit on page 606
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:INHibit on page 654

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

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

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

See also "Specifying delay and inhibit values" on page 89.

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT on page 605
[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT on page 653

(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.

Delays the trigger event provided by:
- The external trigger source

Use the settings to:
- Synchronize the instrument with the device under test (DUT) or other external devices

For more information, see:
- "Impact of the Additional Trigger Settings" on page 87

- "Specifying delay and inhibit values" on page 89

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

Remote command:
`[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay` on page 605
`[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:TDELay` on page 606
`[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:DELay` on page 653
`[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:TDELay` on page 653

Actual Trigger Delay/Actual External Delay
Displays the time (in seconds) an external trigger event or a trigger event form the other path is delayed with.

See also "Specifying delay and inhibit values" on page 89.

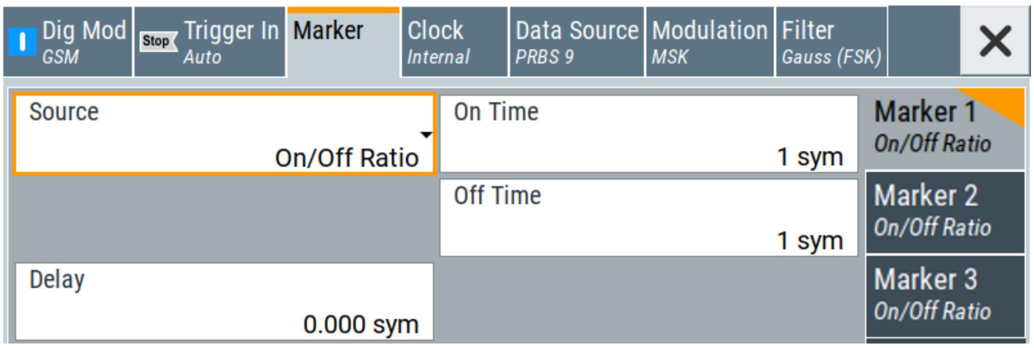
Remote command:
`[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:RDELay?` on page 606
`[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:RDELay?` on page 654

4.4.2.2 Marker Settings

Access:

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

This tab provides access to the settings necessary to select and configure the marker output signal, like the marker mode or marker delay settings.



Settings:

Marker Mode
Basic marker configuration for up to three marker channels. The contents of the dialog change with the selected marker mode.

Use the settings to define the shape and periodicity of the markers. See Chapter 4.4.1.2, "Regular Marker Output Signals", on page 80 for description of the regular marker signals.

The instrument routes the generated marker signals to the selected output connectors.

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

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

Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE on page 607
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider on page 608
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?
on page 608
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern on page 607
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime on page 607
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime on page 607
ARB: see "Marker Mode" on page 144

Marker x 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.

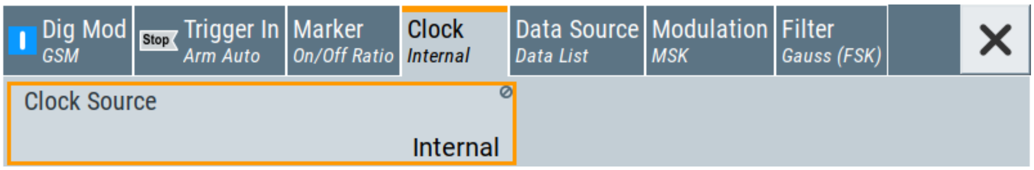
Remote command:
[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay on page 608
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay on page 656

4.4.2.3 Clock Settings

Access:

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

The tab provides clock source settings.



Settings:

Clock Source

Selects the clock source.

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

See also "Clock Signals" on page 78.

Remote command:
[:SOURce<hw>]:BB:DM:CLOCk:SOURce on page 609
[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce on page 656

4.4.2.4 Global Connector Settings

The "Input Signal" dialog, the "Trigger/Marker/Clock" dialog and "Trigger In", "Marker" and "Clock" tabs in "Baseband > ARB/Custom Digital Mod" configuration dialogs provide quick access to the related connector settings. Click the "Global Connectors" button to access the settings.

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

4.5 Generating Custom Digital Modulated Signals

The R&S SMCV100B 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:

- Base unit
- Option custom digital modulation (R&S SMCVB-K199)

4.5.2 About the Custom Digital Modulation

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

- Chapter 4.4.1.6, "Supported Baseband Filters", on page 92
- Chapter 4.4.1.4, "Supported Modulation Types", on page 90
- Chapter 4.4.1.5, "Supported Coding Schemes", on page 91.

Interdependency between selected modulation type and coding scheme and handling of conflicting settings

The applied coding is directly related to the selected modulation methods. The available coding schemes listed in Chapter 4.5.5.1, "Common Coding Algorithms", on page 126 are not freely combinable with modulation methods.

Obviously, having selected a modulation procedure, not every combination of the further modulation parameters "Symbol Rate" and "Coding" is possible. These restrictions inevitably result in conflicting settings if you change a parameter and leads to a prohibited combination.

An inappropriate change of a parameter triggers a settings conflict, which is indicated by a message on the "Info" line in the display. Although the R&S SMCV100B displays the selected settings, the generated modulation signal does not correspond to this display. The displayed message disappears when a conflict-free setting is selected.

Refer to Chapter 14, "Troubleshooting and Error Messages", on page 762 for a list of the possible settings conflicts and messages in digital modulation.

4.5.3 Custom Digital Modulation Settings

Access:

► Select "Baseband > Custom Digital Mod".

The "Custom Digital Modulation" dialog enables direct selection of the data source, standard, symbol rate, coding, modulation type and filter.
The dialog is divided into several tabs. In each case, the current setting is displayed in the tab name.

The remote commands required to define these settings are described in Chapter 13.15.3.2, "SOURce:BB:DM Subsystem", on page 590.

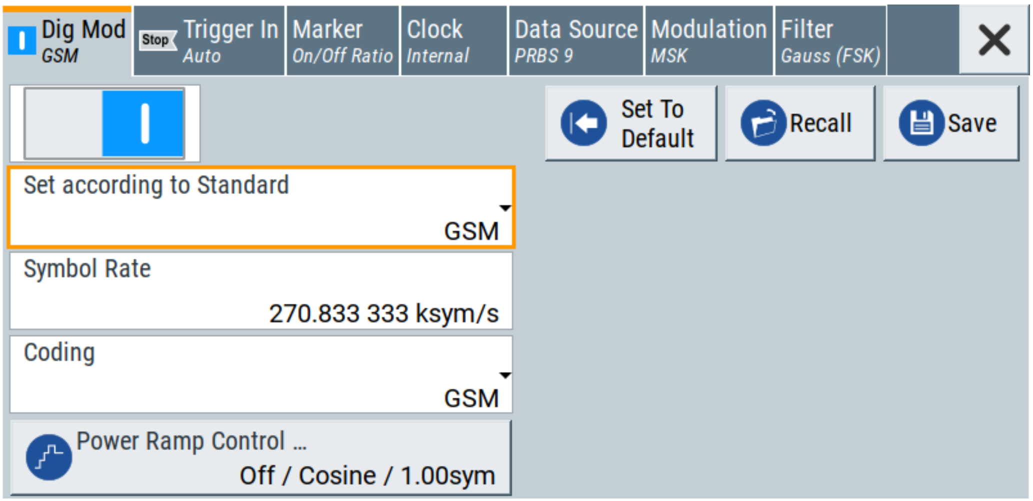
Settings:

4.5.3.1 General Settings

Access:

► Select "Baseband > Custom Digital Mod".

This tab provides access to the default and the save/recall settings, and to a quick selection of a digital modulation according to predefined communication standard.



Settings:

State

Enables/disables 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 593

Set To Default

Calls default settings. The values are listed in Table 4-4.

Remote command:
`[:SOURce<hw>]:BB:DM:PRESet` on page 593

Save/Recall

Accesses 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 filename and the directory, in that the settings are stored, are user-definable; the file extension is however predefined.

See also Chapter 10, "File and Data Management", on page 387.

Remote command:
[:SOURce<hw>]:BB:DM:SETTing:CATalog? on page 595
[:SOURce<hw>]:BB:DM:SETTing:DELete on page 596
[:SOURce<hw>]:BB:DM:SETTing:LOAD on page 596
[:SOURce<hw>]:BB:DM:SETTing:STORe on page 595

Set according to Standard
Selects a predefined communication standard.

"Predefined communication standard"
Selects a predefined communication standard.
A subset of parameters is automatically adjusted: "Modulation Type", "Symbol Rate", "Filter" and "Coding".
Refer to Table 4-5 for an overview of the available standards and the associated 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 store and recall customized settings.

Remote command:
[:SOURce<hw>]:BB:DM:STANdard on page 593

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 593

Coding
Selects the coding (see Chapter 4.4.1.5, "Supported Coding Schemes", on page 91).

The dialog shows only the coding settings that are permissible for the selected modulation type and installed options (see Table 4-7). 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 598

Power Ramp Control
Accesses the power ramp control dialog, see Chapter 4.5.3.6, "Power Ramp Control Settings", on page 112.

4.5.3.2 Trigger, Marker and Clock Setting

These tabs provide standard settings.

For detailed description, see:
- Chapter 4.4.2.1, "Trigger Settings", on page 97
- Chapter 4.4.2.2, "Marker Settings", on page 100
- Chapter 4.4.2.3, "Clock Settings", on page 101
- Chapter 4.4.2.4, "Global Connector Settings", on page 102

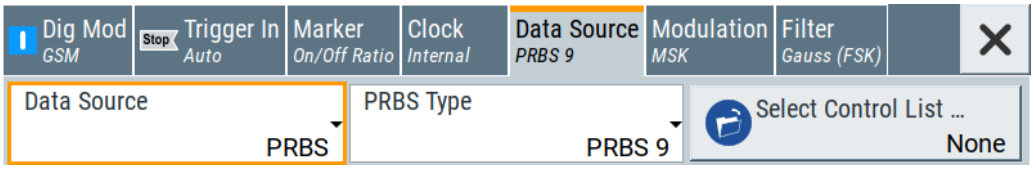
4.5.3.3 Data Source

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 Chapter 4.4.1.1, "Data, Clock and Control Signals and Sources in the Baseband", on page 76.



Settings:

Data Source

Selects the data source (see Chapter 4.4.1.1, "Data, Clock and Control Signals and Sources in the Baseband", on page 76).

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 594

"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 594

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

Remote command:
[:SOURce<hw>]:BB:DM:DLISt:CATalog? on page 609
[:SOURce<hw>]:BB:DM:DLISt:SELect on page 610

Remote command:
[:SOURce<hw>]:BB:DM:SOURce on page 594

Select Data List

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

Data lists can be generated externally or internally in the data editor.

- Select the "Select Data List > navigate to the list file *.dm_iqd > Select" to select an existing data list.
- Use the standard "File Manager" function to transfer external data lists to the instrument.
- Use the "New" and "Edit" functions to create internally new data list or to edit an existing one, see Chapter 4.5.3.7, "Data List Editor", on page 114.

See also Chapter 4.5.4.2, "How to Create and Assign a Data List", on page 121

Remote command:
[:SOURce<hw>]:BB:DM:DLISt:CATalog? on page 609
[:SOURce<hw>]:BB:DM:DLISt:SELect on page 610
[:SOURce<hw>]:BB:DM:DLISt:COPY on page 612
[:SOURce<hw>]:BB:DM:DLISt:DELete on page 610

Select Control List

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

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

- Select the "Select Control List > navigate to the list file *.dm_iqc > Select" to select an existing control list.
- Use the standard "File Manager" function to transfer external lists to the instrument.
- Use the "New" and "Edit" functions to create internally new list or to edit an existing one, see Chapter 4.5.3.8, "Control and Marker Lists Editor", on page 116.

Irrespectively on the way they are created, control lists are not automatically used (see "How to assign and activate control signals from a control list" on page 121).

Remote command:
[:SOURce<hw>]:BB:DM:CLISt:CATalog? on page 609
[:SOURce<hw>]:BB:DM:CLISt:SELect on page 609
[:SOURce<hw>]:BB:DM:CLISt:COPY on page 612
[:SOURce<hw>]:BB:DM:CLISt:DELete on page 610

Connector Settings
Accesses the connectors settings.

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

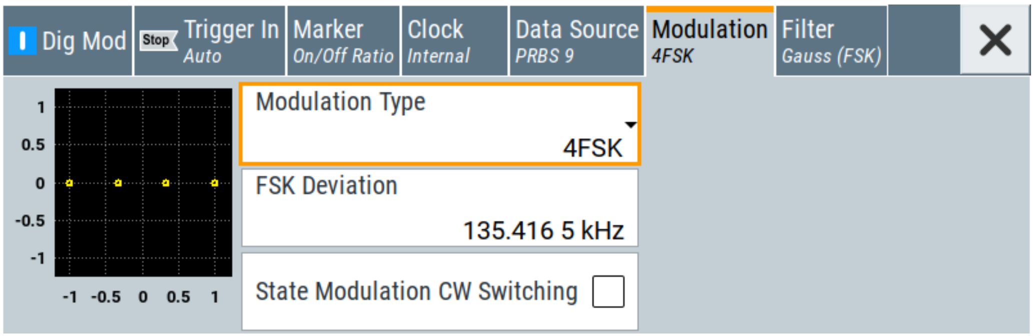
4.5.3.4 Modulation Settings

Access:

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

This tab provides access to the modulation settings, e.g modulation type, FSK deviation, or modulation depth. The dialog 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 Chapter 4.4.1.4, "Supported Modulation Types", on page 90.



Settings:

Modulation Type
Selects a modulation type. The associated symbol mapping is displayed.

If the selected "Coding" is not allowed with the configured modulation type, the value of the parameter Coding is set to "Off".

Refer to Table 4-6 for an overview of the allowed combinations.

Remote command:
`[:SOURce<hw>]:BB:DM:FORMat` on page 598

Load User Mapping
Accesses the "Select List File User Mapping" dialog to select the mapping table (see "User mapping" on page 91). The dialog provides all standard file management functions.

Remote command:
`[:SOURce<hw>]:BB:DM:MLISt:SELect` on page 610
`[:SOURce<hw>]:BB:DM:MLISt:CATalog?` on page 609
`[:SOURce<hw>]:BB:DM:MLISt:DELete` on page 610

ASK Depth
Sets the modulation depth *m* for ASK modulation.

$m = (Amplitude_{max} - Amplitude_{min}) / (Amplitude_{max} + Amplitude_{min})$

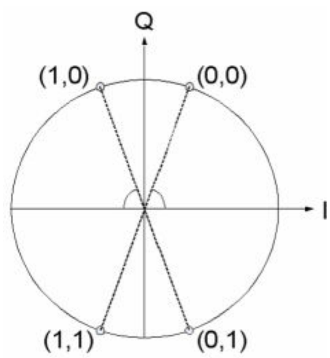
Remote command:
`[:SOURce<hw>]:BB:DM:ASK:DEPTh` on page 599

FSK Deviation
Sets the frequency deviation for FSK modulation. The range of values depends on the selected Symbol Rate (see data sheet).

Whenever "MSK" is selected, the deviation corresponds to 1/4 of the symbol rate and cannot be changed.

Remote command:
`[:SOURce<hw>]:BB:DM:FSK:DEViation` on page 599

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 599

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 600

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.

Remote command:
[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation on page 600

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 600
[:SOURce<hw>]:BB:DM:APSK32:GAMMa on page 601

State Modulation CW Switching
Enables/disables switching between the digitally modulated and an unmodulated (CW) signal.

Remote command:
[:SOURce<hw>]:BB:DM:SWITching:STATe on page 601

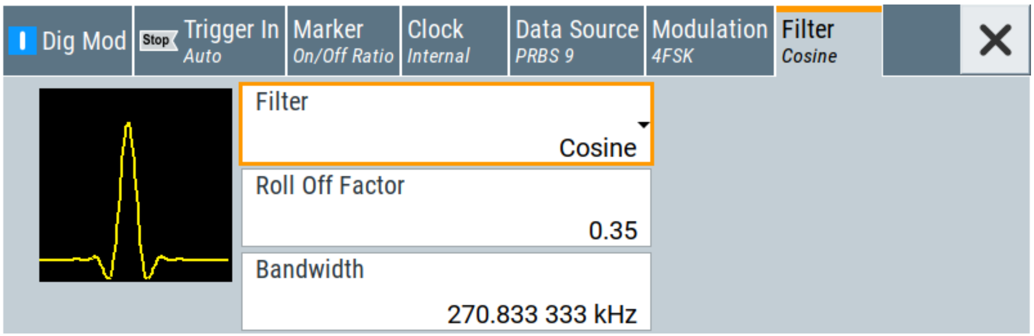
4.5.3.5 Filter Settings

Access:

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

This tab provides access to the filter settings, like filter type and if available further filter settings. A simplified diagram shows the filter characteristic 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 Chapter 4.4.1.6, "Supported Baseband Filters", on page 92.



Settings:

Filter

Selects the baseband filter.

Refer to Chapter 4.5.5.2, "Predefined Baseband Filters", on page 128 for overview of the available filter types, their filter shapes and filter parameters.

Remote command:
[:SOURce<hw>]:BB:DM:FILTer:TYPE on page 596

Filter Parameter

Sets the corresponding filter parameter.

The filter parameter offered ("Rolloff Factor" or "BxT") depends on the currently selected filter type.

Remote command:
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25 on page 597
[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine[:ROLLoff] on page 597
[:SOURce<hw>]:BB:DM:FILTer:PARameter:GAUSs on page 597
[:SOURce<hw>]:BB:DM:FILTer:PARameter:PGAuss on page 597
[:SOURce<hw>]:BB:DM:FILTer:PARameter:RCOSine on page 597
[:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase on page 597

Cutoff Frequency Factor

(available for filter parameter Lowpass and APCO25 (LSM))

Sets the value of the cutoff frequency factor. The cutoff frequency of the filter can be adjusted to reach spectrum mask requirements.

Remote command:
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASs on page 597
[:SOURce<hw>]:BB:DM:FILTer:PARameter:LPASSEVM on page 597
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:GAUSs on page 597
[:SOURce<hw>]:BB:DM:FILTer:PARameter:APCO25Lsm:LOWPass on page 597

Bandwidth
Determines the bandwidth of the cosine filter, so that the function in *H(f) = 0* is fulfilled for *f >= (1 + Rolloff)* Bandwidth /2*.

Remote command:
`[:SOURce<hw>]:BB:DM:FILTer:PARameter:COSine:BANDwidth` on page 597

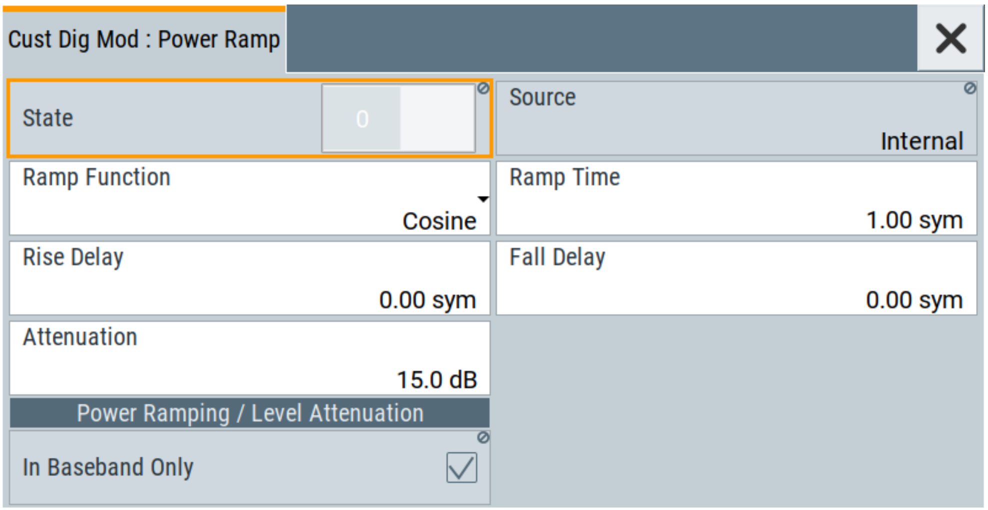
Load User Filter
Calls the dialog "Select User Filter" for selecting a user-defined filter file with extension `*.vaf` (see "User filter" on page 92). The dialog provides access to the standard file management functions, like store, load, delete.

Remote command:
`[:SOURce<hw>]:BB:DM:FLISt:SELect` on page 609
`[:SOURce<hw>]:BB:DM:FLISt:CATalog?` on page 609
`[:SOURce<hw>]:BB:DM:FLISt:DELete` on page 610

4.5.3.6 Power Ramp Control Settings

Access:

► Select "Baseband > Custom Digital Modulation > 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 79.

Power ramping is possible up to a symbol rate of 5 MHz. A higher symbol rate disables the power ramping automatically and an error message is output.

Settings:

State

Enables/disables power ramping.

Remote command:
`[:SOURce<hw>]:BB:DM:PRAMp[:STATe]` on page 603

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 Chapter 4.5.4.1, "How to Create and Assign a Control List", on page 120.

Remote command:
`[:SOURce<hw>]:BB:DM:PRAMp:SOURce` on page 601

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 transmitted power rises and falls linear fashion.

"Cosine" The transmitted 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 601

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 602

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 602

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 602

Attenuation

Determines the level by that the average signal level is attenuated during the signal attenuation period, during the time 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 79.

Remote command:
`[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation` on page 602

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 603

4.5.3.7 Data List Editor

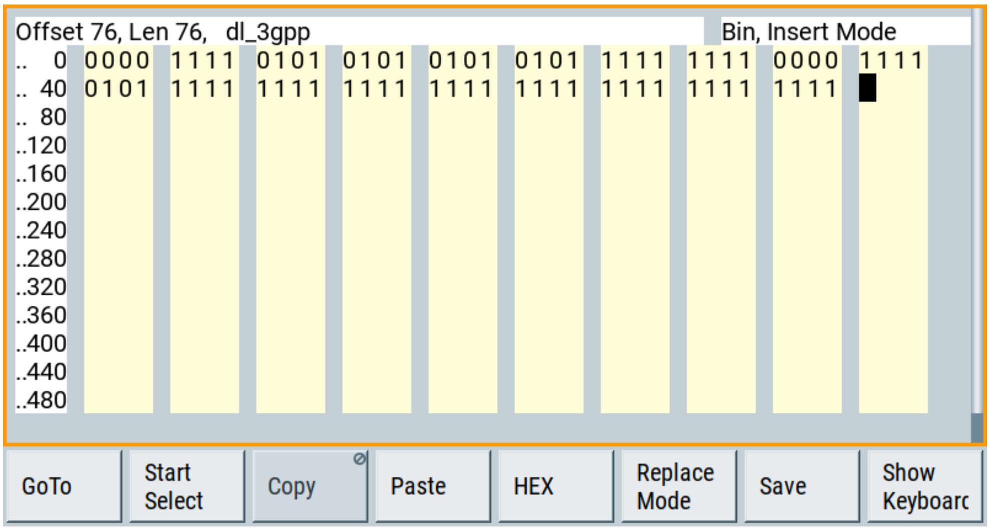
The R&S SMCV100B provides the following ways to create a data list file:

- To use the dedicated "Data List Editor" and create a file with extension `*.dm_iqd`, see "To create data lists manually" on page 122
- To use the tag-oriented format and create a data list file, see "To create a data list file using tag file format" on page 159.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 160.

Access:

1. Select "Baseband > Custom Digital Mod > Data Source > Data List".
2. Select "Select Data List".

3. Navigate to the required directory.
   Select "New" and 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. The current cursor position, 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 610
`[:SOURce<hw>]:BB:DM:DLISt:DATA` on page 613
`[:SOURce<hw>]:BB:DM:DLISt:DATA:APPend` on page 614
The buttons below the binary list simplify the editing.

Settings:

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.

HEX/BIN
Switches between hexadecimal and binary display.

Each 4 bits 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/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

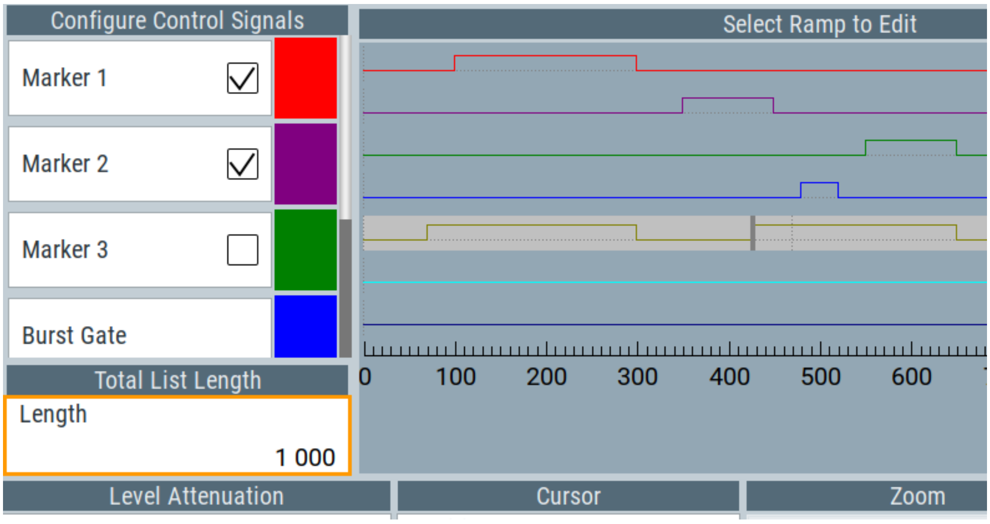
The R&S SMCV100B provides the following ways to create a file containing control signals:

- To use the tag-oriented format and create a control list file, see "To create a control list using tag file format" on page 157.
- To use SCPI commands and create a file in binary format, see "To create a control list in binary format" on page 158.
- To use the dedicated "Control Data Editor" and create a file in ASCII format and with 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 120 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/`.
Select "New".
4. In the "Filename" field, enter the name of the new control list, for example `dl_3gpp`.

5. 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 "Control Signals" on page 78)

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 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 Chapter 4.5.4.1, "How to Create and Assign a Control List", on page 120).

SCPI command:

`[:SOURce<hw>]:BB:DM:CLISt:CATalog?` on page 609

`[:SOURce<hw>]:BB:DM:CLISt:SELect` on page 609

Settings:

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 Chapter 4.5.4.1, "How to Create and Assign a Control List", on page 120).

Remote command:
n.a.

Select Ramp to Edit

Graphical representation for editing of the marker/control signals.

Refer to Chapter 4.5.4.1, "How to Create and Assign a Control List", on page 120 for an overview of the editing capabilities of the display.

Remote command:
`{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}` on page 170
`[:SOURce<hw>]:BB:DM:CLISt:DATA` on page 612

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 166

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; 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 be later shifted as required.

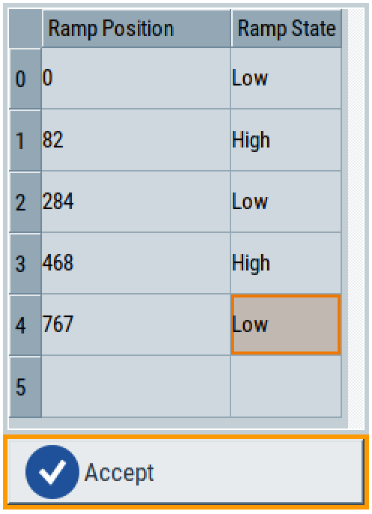
Remote command:
n.a.

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 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 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
Stores the changes in the selected control list file or in a new file.

Remote command:
n.a.

4.5.4 How to Create 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 Chapter 4.5.3, "Custom Digital Modulation Settings", on page 103.

4.5.4.1 How to Create and Assign a Control List

The R&S SMCV100B 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 extension `*.dm_iqc`, see "To create a control list in ASCII format manually" on page 120
- To use the tag-oriented format and create a control list file, see "To create a control list using tag file format" on page 157.
- To use SCPI commands and create a file in binary format, see "To create a control list in binary format" on page 158.

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 an existing file or select "New".

   If the selected file is an existing one, the dialog shows the used settings.
   If a new file has been created, 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.
   On the connected keyboard, press "Del".
   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" function.
   f) Define the "Total List Lenght".
   g) To display only a part of the control list, set the "Visible/Bits Visible" to determines 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.

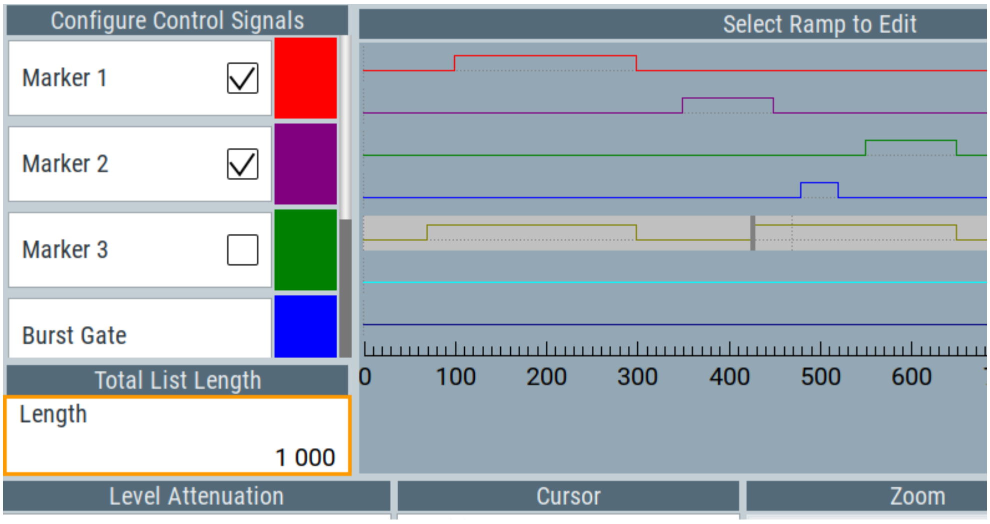


Figure 4-10: Example of control list settings

3. Select "Save" or "Save As" to store 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.

How 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/control signal from a control list and to output this signal at the supported connector, perform the following:

► Enable the R&S SMCV100B to use the control list for marker output 2.
Output this signal at the "User"2 connector:

a) Select "Baseband > Custom Digital Modulation > Marker > Marker 2 Mode > CList".
b) Select "Baseband > Custom Digital Modulation > Marker > Global Connectors > Routing".
Select "User 2 > Direction = Output", "User 2 > Signal = Baseband Marker 2".

4.5.4.2 How to Create and Assign a Data List

The R&S SMCV100B 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 122
- To use the tag-oriented format and create a data list file, see "To create a data list file using tag file format" on page 159.

- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 160.

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 > Data Source > Data List"
   b) Select "Select Data List"
   c) Navigate to the required directory, for example `/var/user/`.
   Select "New" and enter "File Name" = `dl`.

   The "Data List Editor" opens; the data list is empty.
2. Enter a sequence of 0 and 1, for example *01110101*.

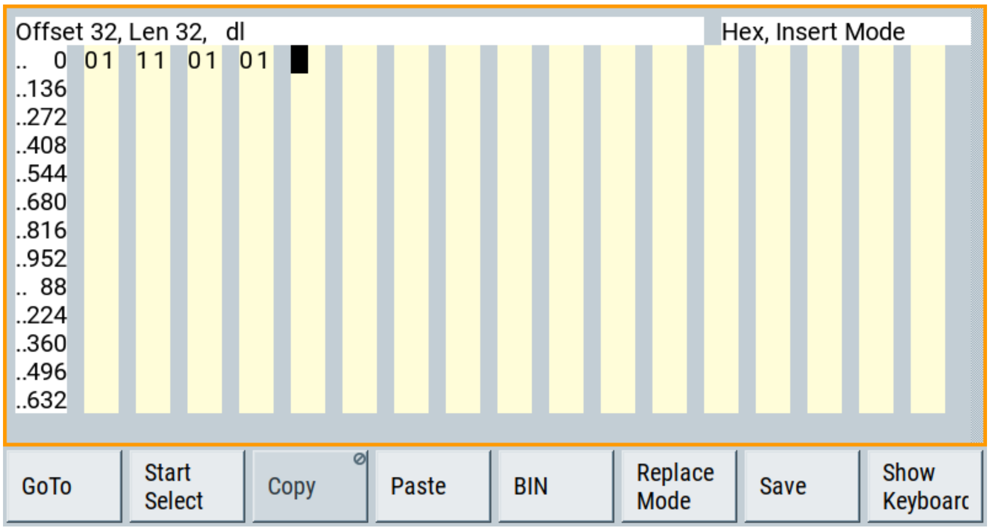


Figure 4-11: Example of data list

3. Select "Save" to store the used settings as a data list file.

   The instrument stores 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.

► To enable the R&S SMCV100B to use the data list as data source for the custom digital modulation:
   a) Select "Baseband > Custom Digital Modulation > Data Source > Data List"
   b) Select "Select Data List"
   c) Navigate through the file system. Select the file and confirm with "Select".

4.5.5 References

Table 4-4: Custom digital modulation default values

Parameter	Value
State	Not affected
Data Source	PRBS 9
Standard	GSM
Symbol Rate	270.833 ksymb/s
Coding	GSM
Modulation Type	MSK
Filter	Gauss (FSK)
Filter Parameter BxT	0.3
Trigger	Mode Auto, Source Internal
Clock	Source Internal
Power Ramp Control	
Attenuation	15 dB
Ramp Time	1 symbol
Ramp Function	Cosine
Fall Delay	0
Rise Delay	0
Source	Internal
State	Off

Table 4-5: Communication standards with their predefined settings

Standard	Modulation	Symbol Rate	Filter	Coding	Parameter for SCPI command
CW in Baseband	BPSK	1 MHz	Gauss, B*T = 0.5	Off	`CWBPsk`
APCO Phase1 C4FM	4FSK, Deviation 1.8 KHz	4.8 ksym/s	APCO25, roll off = 0.2	APCO25(FSK)	`APCOPH1C4fm`
APCO Phase1 CQPSK	pi/4-DQPSK	4.8 ksym/s	Cosine, roll off = 0.2, BW = 4.8 KHz	APCO25(PSK)	`APCOPH1CQpsk`
APCO Phase2 H-CPM	4FSK, Deviation 3 KHz	6 ksym/s	APCO25 (H-CPM)	APCO25(FSK)	`APCOPH2HCpm`
APCO Phase2 H-DQPSK	pi/4-DQPSK	6 ksym/s	Cosine, roll off = 1, BW = 7.2 KHz	APCO25(PSK)	`APCOPH2HDQpsk`
APCO Phase2 H-D8PSK Wide	pi/8-D8PSK	4 ksym/s	Cosine, roll off = 1, BW = 7.2 KHz	APCO25(8PSK)	`APCOPH2HD8PSKW`
APCO Phase2 H-D8PSK Narrow	pi/8-D8PSK	4 ksym/s	Cosine, roll off = 1, BW = 5 KHz	APCO25(8PSK)	`APCOPH2HD8PSKN`

Standard	Modulation	Symbol Rate	Filter	Coding	Parameter for SCPI command
APCO Phase1 LSM	pi/4-DQPSK	4.8 ksym/s	APCO25 (LSM), Gauss Cut Off = 2.04 KHz, Low-pass Cut Off = 6.2 KHz	APCO25(PSK)	`APCOPH1Lsm`
APCO Phase1 WCQPSK	pi/4-DQPSK	4.8 ksym/s	Cosine, roll off = 1, BW = 7.2 KHz	APCO25(PSK)	`APCOPH1Wcqpsk`
Bluetooth	2FSK, Deviation 160.0 kHz	1.0 Msym/s	Gauss, B*T = 0.5	OFF	`BLUetooth`
DECT	2FSK, Deviation 288.0 kHz	1.152 Msym/s	Gauss, B*T = 0.5	OFF	`DECT`
ETC (ARIB STD T55)	ASK, ASK Depth 100%	1.024 Msym/s	Split Phase, B*T = 2.0	OFF	`ETC`
GSM	MSK	270.833333 ksym/s	Gauss, B*T = 0.3	GSM	`GSM`
GSM EDGE	8PSK EDGE (3pi/8 8PSK)	270.833333 ksym/s	Gauss linear	OFF	`GSMEdge`
NADC	pi/4 DQPSK	24.3 ksym/s	Root cosine, alpha = 0.35	NADC	`NADC`
PDC	pi/4 DQPSK	21.0 ksym/s	Root cosine, alpha = 0.50	PDC	`PDC`
PHS	pi/4 DQPSK	192.0 ksym/s	Root cosine, alpha = 0.50	PHS	`PHS`
TETRA	pi/4 DQPSK	18.0 ksym/s	Root cosine, alpha = 0.35	TETRA	`TETRa`
WCDMA 3GPP	QPSK 45° Offset	3.84 Msym/s	Root cosine, alpha = 0.22	WCDMA 3GPP	`W3GPp`
TD-SCDMA	QPSK 45° Offset	1.28 Msym/s	Root cosine, alpha = 0.22	OFF	`TCSCdma`
cdma2000 Forward	QPSK	1.2288 Msym/s	cdmaOne + Equalizer	cdma2000	`CFORward`
cdma2000 Reverse	Offset QPSK	1.2288 Msym/s	cdmaOne	cdma2000	`CREVerse`
Worldspace	QPSK	1.84 Msym/s	Root cosine, alpha = 0.40	OFF	`WORLdspace`
TFTS	pi/4 DQPSK	22.1 ksym/s	Root cosine, alpha = 0.40	TFTS/ TETRA	`TFTS`

Table 4-6: Permissible coding combinations for modulation symbols and modulation type

	OFF	Differ-ential	Phase Diff.	Diff. +Gray	Gray	GSM	NADC, PDC, PHS, TETRA, APCO25 (PSK), PWT	TFTS/ TETRA	INMARSAT, ICO, WCDMA, cdma2000	VDL	APCO25 (FSK)	APCO25 (8PSK)
ASK	X	X		X	X							
BPSK	X	X		X	X							
pi/2 DBPSK	X				X							
QPSK	X	X		X	X				X			
QPSK EDGE	X											

	OFF	**Differ-ential**	**Phase Diff.**	**Diff. +Gray**	**Gray**	**GSM**	**NADC, PDC, PHS, TETRA, APCO25 (PSK), PWT**	**TFTS/ TETRA**	**INMARSAT, ICO, WCDMA, cdma2000**	**VDL**	**APCO25 (FSK)**	**APCO25 (8PSK)**
QPSK45° Off-set	X	X		X	X							
Pi/4 QPSK	X	X			X							
Pi/4 DQPSK	X				X		X	X				
8PSK	X	X		X	X					X		
AQPSK	X	X		X	X							
OQPSK	X	X		X	X							
8PSK_EDGE	X											
Pi/8 D8PSK	X				X							X
MSK	X	X		X	X	X						
2FSK	X	X		X	X	X						
4FSK	X	X		X	X						X	
8FSK	X	X		X	X							
16FSK	X	X		X	X							
32FSK	X											
64FSK	X											
16QAM	X	X	X	X	X							
16QAM EDGE	X											
32QAM	X	X	X	X	X							
32QAM EDGE	X											
64QAM	X	X	X	X	X							
128QAM	X	X	X	X	X							
256QAM	X	X	X	X	X							
1024QAM	X	X	X	X	X							
16APSK	X											
32APSK	X											

4.5.5.1 Common Coding Algorithms

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.

Common coding types are listed in Table 4-7.

Table 4-7: Common coding algorithms

Coding	Coding algorithm	Applicable for K bit/symbol	Required option
"None"	$b_n = a_n$	k = 1...8	-
"Differential"	$b_n = (a_n + b_{-1})$ modulo 2^k	k = 1...7	
"Differential + Gray"	Gray coding with additional differential coding	k = 1...7	
"GSM"	d_n = NOT (d_n EXOR d_{-1})	k = 1	R&S SMCVB-B10
"Phase differential coding"1)	b_{1n} = [NOT (a_{1n} EXOR a_{0n}) AND (a_{1n} EXOR $b_{1(n-1)}$)] OR [(a_{1n} EXOR a_{0n}) AND (a_{1n} EXOR $b_{0(n-1)}$)] b_{0n}= [NOT (a_{1n} EXOR a_{0n}) AND (a_{0n} EXOR $b_{0(n-1)}$)] OR [(a_{1n} EXOR $a_{0(n-1)}$) AND (a_{0n} EXOR $b_{1(n-1)}$)]		R&S SMCVB-B10

1) "Phase differential coding" INMARSAT and PHASE DIFF correspond to system standards Inmarsat-M and DVB according to ETS 300 429. The INMARSAT coding can generally be used for modulation types with 2 bits/symbol, such as QPSK.

Examples

The following examples illustrate how some of the different common coding schemes combined with a modulation method influence the signal.

Example: Differential coding for QPSK modulation with K = 2 bit/symbol

Decimal display; the value range for modulation symbols is $a_n = \{0, 1, 2, 3\}$

According to Table 4-7 and for $k = 2$, the recursive coding is defined as $b_n = (a_n + b_{-1})$ *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 $\mathbf{a_n = 2}$ 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 4-8: 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/4DQPSK

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 4-9 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 4-9: Phase shifts for pi/4DQPSK

Modulation symbol a_n	00	01	10	11
"Coding = OFF"	+ 45°	+ 135°	- 135°	- 45°
"Coding = NADC, PDC, PHS, TETRA, or 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 4-7). The assignment of modulation symbols a_n (binary indication: MSB, LSB) to the phase differences shown in the following table is generated:

Table 4-10: Differential coding according to VDL[1)]

Modulation symbol d_n	000	001	010	011	100	101	110	111
Phase difference	0°	45°	135°	90°	270°	315°	225°	180°

[1)] "Differential coding according to VDL" can be used for modulation types with 3 bits/symbol, e.g. 8PSK.

4.5.5.2 Predefined Baseband Filters

The Table 4-11 shows the filters that are available, together with their associated parameters. The filter characteristic is displayed in graphical form.

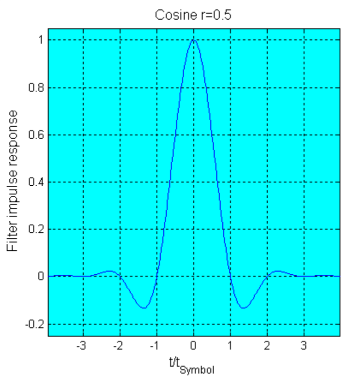
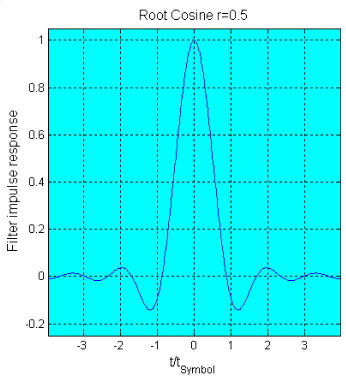
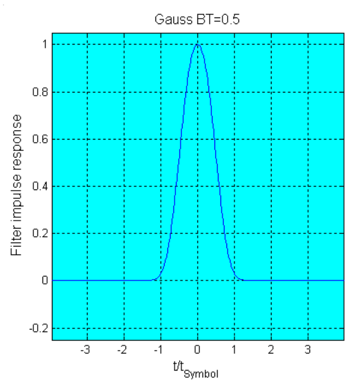
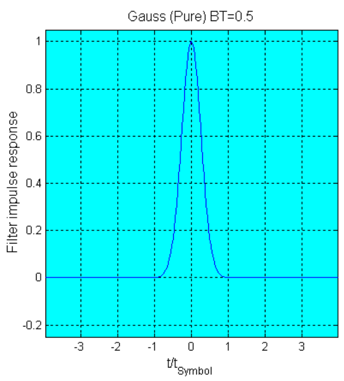
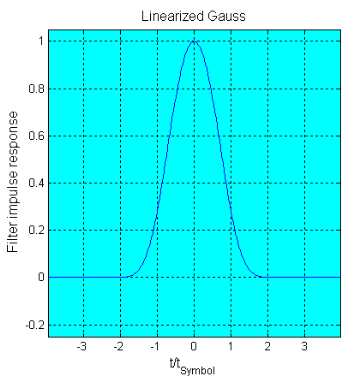
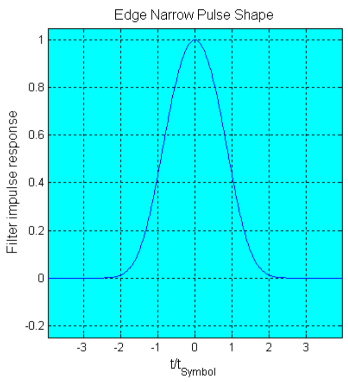
Filter names Cosine and Root Cosine

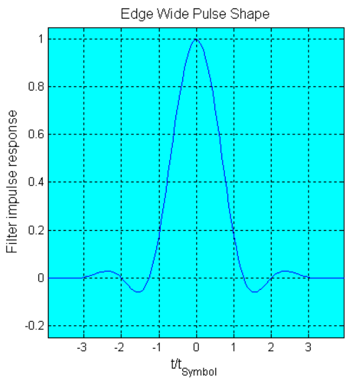
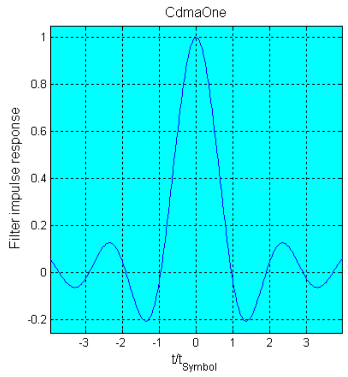
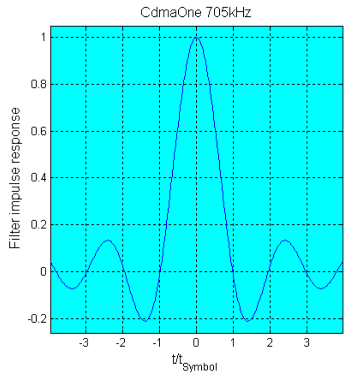
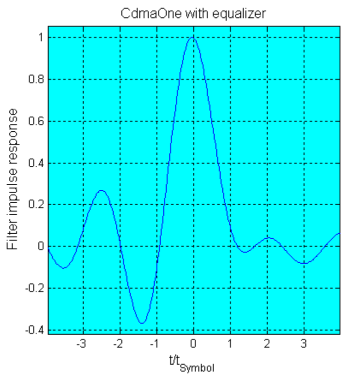
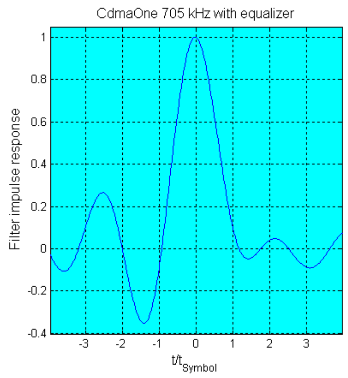
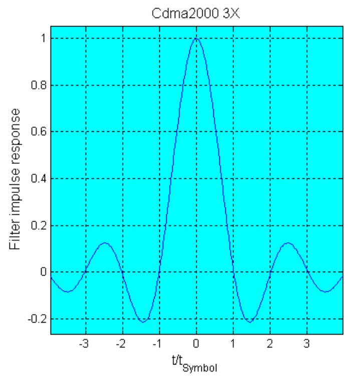
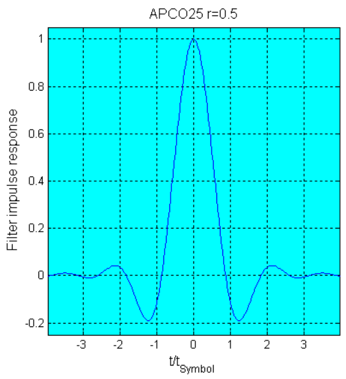
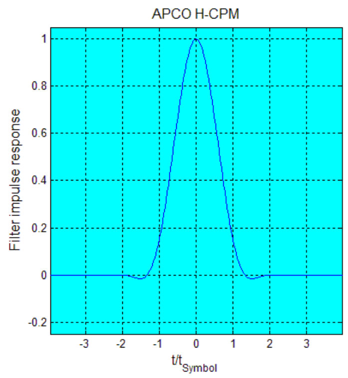
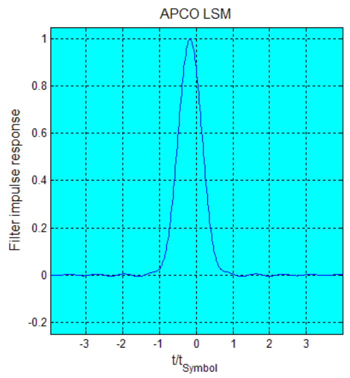
The filter names "Cosine" and "Root Cosine" are used for backwards compatibility with former Rohde & Schwarz signal generators.

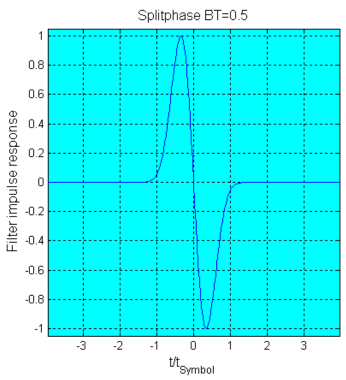
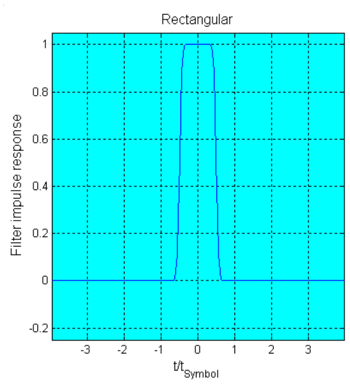
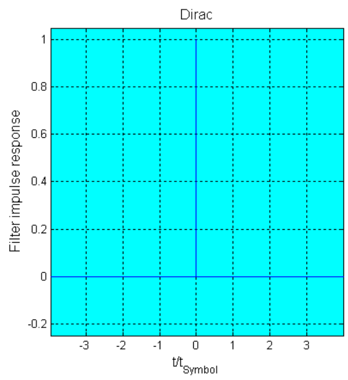
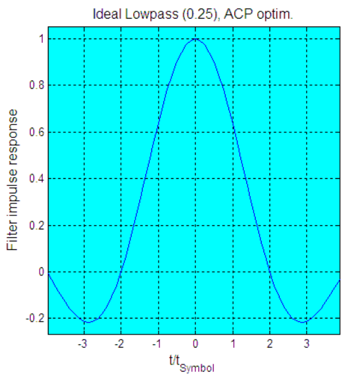
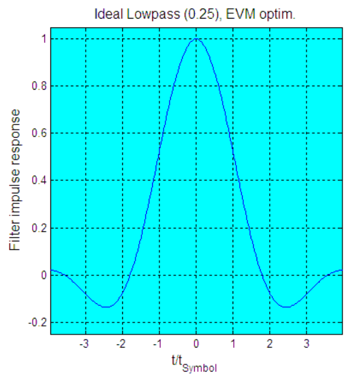
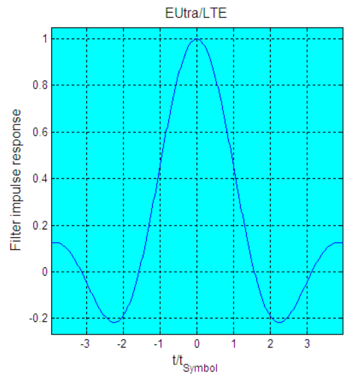
These names do not correspond to the underlying transfer functions the filters use:

- "Cosine" filters use **raised cosine** transfer function.
- "Root Cosine" filters use **root raised cosine (RRC)** transfer function.

Table 4-11: Overview of the baseband filters

Cosine (raised cosine) Rolloff factor Bandwidth	Root cosine (root raised cosine (RRC)) Rolloff factor	Gauss (FSK) BxT
		
Pure gauss BxT	Gauss linearized	Edge narrow pulse shape
		
Edge wide pulse shape	cdmaOne	cdmaOne 705 kHz

		
cdmaOne + Equalizer	cdmaOne 705 kHz + Equalizer	cdma2000 3X
		
APCO25 Rolloff factor	APCO25 (H-CPM)	APCO25 (LSM) Gauss cutoff frequency
		
Split Phase BxT	Rectangular	Dirac

		
Lowpass ACP optimization	Lowpass EVM optimization	EUTRA/LTE
		

4.6 Using the Arbitrary Waveform Generator (ARB)

The arbitrary waveform generator (ARB) is an I/Q modulation source forming part of the R&S SMCV100B. The ARB allows the playback and output of any externally calculated modulation signals in the form of waveform files. The ARB can also generate multi-carrier or multi-segment signals from the waveform files.

4.6.1 Required Options

The equipment layout for processing of waveform files includes:

- Base unit, including arbitrary waveform generator (64 MSample ARB memory, 60 MHz RF bandwidth)
- Corresponding digital standard option (R&S SMCVB-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 SMCVB-K255, you can process EUTRA/LTE waveform file generated by R&S WinIQSIM2.
- Optional, ARB memory extension (R&S SMCVB-K511/-K512/-K513)
- Optional, ARB waveform libraries, see Table B-1.

- Optional ARB waveform streaming (R&S SMCVB-K505)
  Required for direct streaming from a mass memory (internal SSD, external HDD or USB flash memory). Perform streaming at 75 MHz maximum clock frequency with no restrictions to the waveform file length

You can output waveforms at several connectors. Dedicated connector output requires the following options:

- Output at the RF connector: RF frequency option (e.g. R&S SMCVB-B103)
- Output at the "Dig. IQ HS x" connectors: option digital baseband interface (R&S SMCVB-K19)

4.6.2 About ARB

This section provides background information on the ARB functionality and the impact of the provided settings.

For a description of the multi-carrier, multi-segment and multi-carrier continuous wave functions, refer to:

- Chapter 4.9, "Generating Multi-Carrier Signals", on page 209
- Chapter 4.8, "Generating Multi-Segment Waveform Files", on page 179

4.6.2.1 Waveform Files Sources

In ARB mode, the R&S SMCV100B uses ARB waveform files to obtain the digital I/Q data of the baseband signal. The R&S SMCV100B can replay any waveform file stored on a network drive but it can also generate and replay simple waveforms for test purposes.

What is a waveform?

A waveform is a file with specified file format containing raw IQ samples. The IQ values are calculated in advance and stored as waveform files with a predefined extension `*.wv`.

When waveforms are created by the R&S SMCV100B, 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" which are enclosed in braces { }.

For detailed description on all available tags and for information on how to query them or to create waveforms manually, refer to Chapter 4.6.6, "Tags for Waveforms, Data and Control Lists", on page 162.

Waveform file sources

Depending on whether the R&S SMCV100B creates the waveform files itself or not, two waveform files sources can be distinguished:

- **Internally generated waveforms**
  The ARB generator enables the calculation and the generation of multi-segment and multi-carrier waveform files. The ARB generator provides also a built-in func-

tion to create a test waveform (e.g. a sine or rectangle signal) and keep it as a file or in the RAM.
Several digital standards provide the special function "Generate Waveform File". With this function, the calculated signals are stored as a waveform file that can be afterwards played by the ARB generator.

- **Externally generated or created waveforms**
  The ARB can also process externally created waveform files, for example:
  - The *waveform files generated* by the software R&S WinIQSIM2, the R&S ARB Toolbox, the R&S Pulse Sequencer
  - Stream *large waveform files* from an internal solid-state drive (SSD) or an externally connected mass memory (HDD, USB flash drive).
  - *Signals calculated* using a mathematical program such as MATLAB.
    See Chapter 4.6.6, "Tags for Waveforms, Data and Control Lists", on page 162.

  Irrespectively of the way they are created, you can load the externally generated waveform files into the instrument via one of the available interfaces, e.g., USB or LAN. Usually, the waveform file is stored on one of the network drives which are accessible for the operating system.
- **Waveform libraries**
  See Table B-1.

Related settings

See:

- Chapter 4.6.3, "ARB Settings", on page 136

Related step-by-step descriptions

See:

- Chapter 4.6.4, "How to Create, Generate and Play Waveform Files", on page 145
- Chapter 4.6.4.5, "How to Define Periodically Repeating Traces", on page 156
- Chapter 4.6.4.4, "How to Manually Create a Waveform Using Tag File Format", on page 151
- Chapter 4.6.4.6, "How to Create a Control List Using Tag File Format", on page 157
- Chapter 4.6.4.7, "How to Create a Data List Using Tag File Format", on page 159
- Chapter 4.6.4.8, "Editing Waveform Files, Data and Control Lists", on page 160
- Chapter 4.6.5, "How to Stream Waveforms from an External Storage Device", on page 161

4.6.2.2 Playing and Streaming Waveform Files

Depending on the way the loaded waveforms are processed, an ARB works in one of the following modes:

- Play back from the internal memory

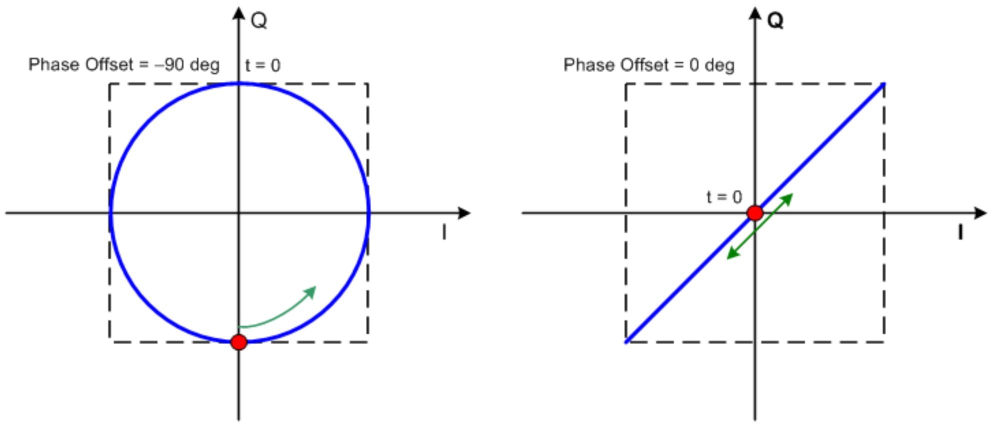
In the most common case, the ARB generator plays back a waveform file with a selectable clock frequency. The R&S SMCV100B loads the entire file into the ARB memory from where the IQ samples are played repeatedly.
Playing back files is limited by the ARB memory size, e.g. 64 MSample, for a R&S SMCV100B base unit. Available ARB memory extensions are listed in the R&S SMCV100B data sheet.

- Streaming
  Perform direct streaming from a mass memory at 75 MHz maximum clock frequency with no restrictions to the waveform file length. If HDD streaming is active, the instrument streams the modulation data directly from an internal solid-state drive (SSD) or an external storage device connected to the instrument via USB.
  We recommend that you use HDD streaming for processing of large files that require more memory than the internal SSD offers.

4.6.2.3 ARB Test Signals

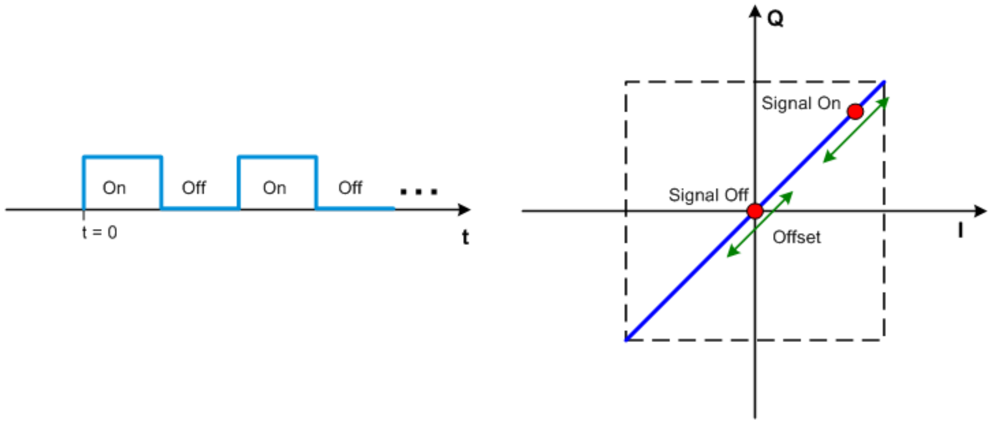
The following test signals are available:

- **Sine Test Signal:** Two sinewave 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, determines the ARB clock frequency: "Clock Frequency" = "Frequency" * "Samples per Period".
  Note: Because the resulting clock rate must not exceed the maximum ARB clock rate (see data sheet), 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 counter-clockwise 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. This 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 IQ 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.
Converted to analog, the signal is output directly at the BNC connectors I and Q outputs of the instrument.

4.6.2.4 Waveform Sample Rate

The Arbitrary Waveform Generator includes a resampling unit that interpolates the input samples to reach a target digital output I/Q sample rate before digital-to-analog conversion (DAC). 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 4-12 depicts the stages involved in the processing and resampling of a waveform in the ARB.

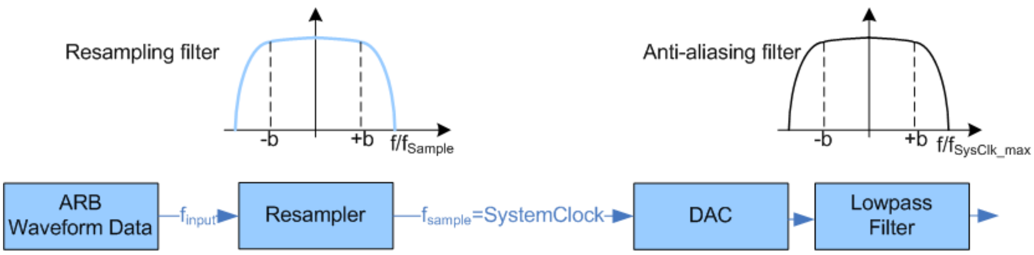


Figure 4-12: Processing of the waveform files in the ARB

f_{input} = Waveform sample rate
b = Usable bandwidth factor
f_{SysClk_max} = $SystemClock_{max}$ = $SampleRate_{max}$

Where:

- f_{SysClk_max} = $SystemClock_{max}$ = $SampleRate_{max}$ = 300 MHz

- b = 0.4165

Impact of the Resampling Filter

As illustrated in Figure 4-12, the filter in the resampling stage is distortion-free for signals with the following maximum baseband bandwidth:

$Usable\_Bandwidth_{max}\ [MHz] = b * f_{input}$.

b is the usable bandwidth factor and 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 required sample rate f_{input} is then calculated as follows:

$f_{input} \geq Usable\_Bandwidth / b$

Thus, a modulation signal with a sample rate f_{input} = 300 MHz fed in the baseband generator ensures the $Usable\_Bandwidth_{max}$. After the DAC, this signal features a $RF\_Bandwidth_{max} = 2{*}b{*}f_{input} = 2{*}b{*}300\ MHz = 240\ MHz$.

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 generators often assume oversampling factors of 4. The ARB generator of the R&S SMCV100B 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 Impact of Enabled Number of Marker Signals on Waveform Length

The R&S SMCV100B 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 in this example assumes R&S SMCV100B equipped with option R&S SMCVB-K511 (512 Msamples).

- Total memory size = 512 MB
- Required memory size (per complex sample) = 32 bits + 4 bits = 36 bits = 4.5 bytes, where:
  - The raw I/Q samples are stored as 16-bit values;
    That is, for I/Q data = 2 x 16 bits = 32 bits (16 bits per I/Q channel)
  - Each software defined marker requires 1 bit;
    That is, for 4 enabled markers = 4 x 1 bit = 4 bits
- Maximum waveform length (with 3 markers) = 512 MB / 4.5 bytes = 113 Msamples
- Theoretical maximum waveform length (no markers) = 512 MB / 4 bytes = 128 Msamples

Hence, a memory size of 512 MB yields a maximum waveform length of 116 Msamples, if three markers are enabled. The maximum waveform length increases to 128 Msamples, if the internal hardware markers are used, and the complete memory is available for I/Q data.

The minimum length of a waveform is 512 samples. A waveform shorter than this value is automatically repeated until it reaches the minimum length.

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 multi-carrier settings.

The remote commands required to define these settings are described in Chapter 13.15.3.3, "SOURce:BB:ARBitrary Subsystem", on page 614.

Settings:

4.6.3.1 ARB General Settings

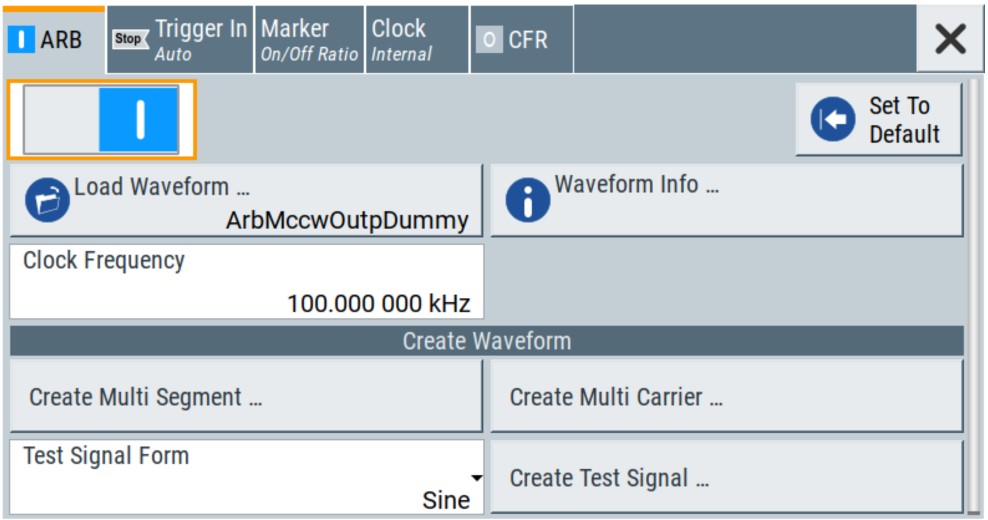
Access:

► Select "Baseband > ARB".

This tab provides access to the default ARB settings, selecting a waveform file and enabling the ARB generator.

Further settings depend on selected "System Configuration" and waveform type:

- If a single segment waveform is used, the tab provides also settings for configuring the test signal and access to the settings for calculating a multi-segment or a multi-carrier waveform.
- If a multi-segment waveform is loaded, the tab expands and displays the dedicated section "Multi Segment Waveform Options".



This section comprises the settings necessary to configure the segment to be output and adjust the trigger for the switch between the segments of the multi-segment waveform. The parameters displayed depend on the selected trigger source. The provided parameters are identical with the parameters in the section "Next Segment Trigger In" in the "Trigger" tab; for information see Chapter 4.8.3.5, "Next Segment Trigger In Settings", on page 197.

Settings:

State

Enables/disables ARB modulation. Switching on the ARB generator turns off all the other digital standards and digital modulation types in the same signal path.

The output is based on the waveform file that is loaded. The name of the waveform file is displayed next to "Load Waveform". When a multi-segment waveform is loaded, the display expands and lists more settings, grouped in the "Multi Segment Waveform Options" section.

Note: ARB generator cannot be activated.
You cannot activate the ARB generator in the following cases:

- **No or empty waveform file**
  If no waveform file is loaded, as in the default state, "None" is displayed next to "Load Waveform". An error message indicates that no or empty waveform file is selected.
  Select a waveform file, before switching on the ARB.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:STATe` on page 623

Set To Default

Calls default settings (see Table 4-12).

Table 4-12: ARB default settings

Parameter	Value
State	Off
Clock Frequency	100 kHz
Trigger Mode	Auto
Trigger Source	Internal
Marker State	Off
Marker Mode	Unchanged
Clock Source	Internal

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:PRESet` on page 623

Load Waveform/File

Accesses the standard "File Select" function of the instrument. The provided navigation possibilities in the dialog are self-explanatory.

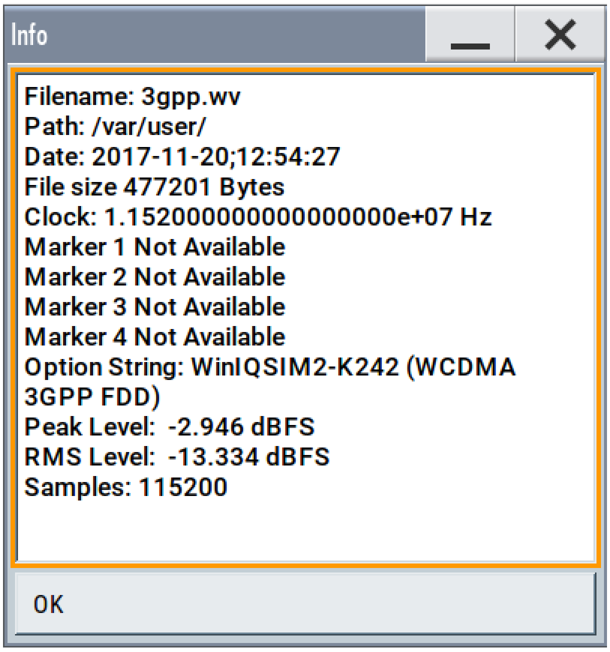
The waveform files are files with predefined file extension `*.wv`. When a file is selected, the dialog displays short information about the selected waveform.

Enable the ARB generator ("ARB > State > On") to trigger the instrument to load and process the selected waveform file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect` on page 628

Waveform Info

Opens a dialog with detailed information about the currently selected waveform. The display depends on whether the selected waveform file is a multi-segment one or not. All parameters are read-only.



Remote command:
For non-multi segment waveform files, use the `Tag` commands (see Chapter 4.6.6, "Tags for Waveforms, Data and Control Lists", on page 162).

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 630

HDD Streaming
Option: R&S SMCVB-K505

Activates ARB waveform streaming from a mass memory. The internal solid-state drive or an external mass memory (HDD, USB flash memory) can provide as memory.

Connect the external memory to one of the "USB" connectors. We recommend that you connect to the "USB" 3.0 connectors on the rear panel, to provide sufficient streaming quality.

How to: Chapter 4.6.5, "How to Stream Waveforms from an External Storage Device", on page 161

If streaming is activated, you can only use trigger modes "Auto" and "Armed Auto" and marker modes "Restart". See also "Mode" on page 97 and "Marker Mode" on page 100.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:STATe` on page 631

Create Multi Segment
Accesses the dialog for creating multi-segment waveforms (see Chapter 4.8, "Generating Multi-Segment Waveform Files", on page 179).

Create Multi Carrier
Accesses the dialog for creating multi-carrier waveforms (see Chapter 4.9, "Generating Multi-Carrier Signals", on page 209).

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....

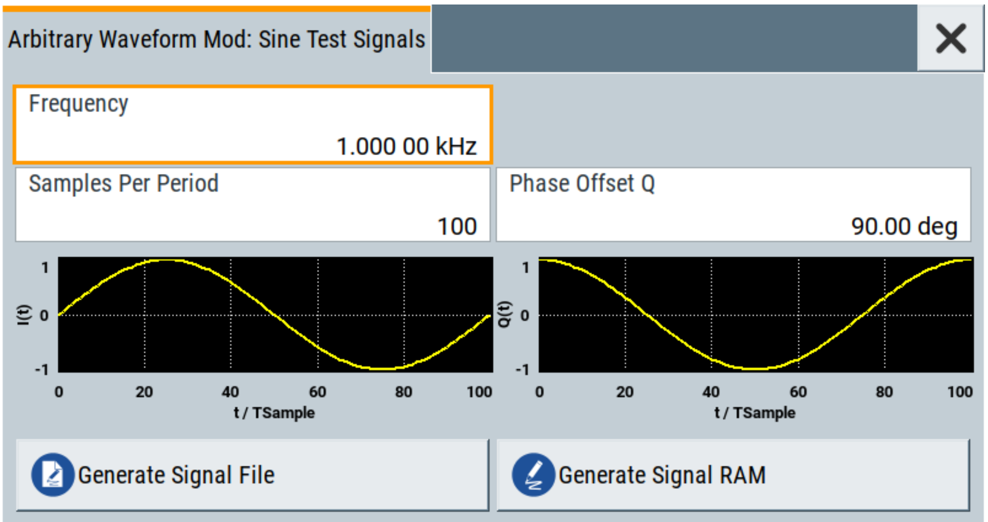
Remote command:
`[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE` on page 624

Create Test Signal...
Opens the dialog with further setting for the selected Test Signal Form, see:
- Chapter 4.6.3.2, "Sine Test Signals", on page 140
- Chapter 4.6.3.3, "Rectangular Test Signal", on page 141
- Chapter 4.6.3.4, "Constant IQ Test Signal", on page 143

4.6.3.2 Sine Test Signals

Access:

► Select "Baseband > ARB > General > Test Signal Form > Sine" and press "Create Test Signal".



This dialog provides settings for configuration of 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 Chapter 4.6.2.3, "ARB Test Signals", on page 133.

The dialog displays the characteristic of the currently selected signal.

Settings:

Frequency

Enters the frequency of the test signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency` on page 626

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 (see data sheet) and the selected frequency.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles` on page 626

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 626

Generate Signal File

Generates a signal and saves it as a waveform file on the hard disk. Use the standard "File Select" function to store this file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed` on page 627

Generate Signal RAM

Generates a signal and uses it as output straight away. The instrument stores the file with a predefined name.

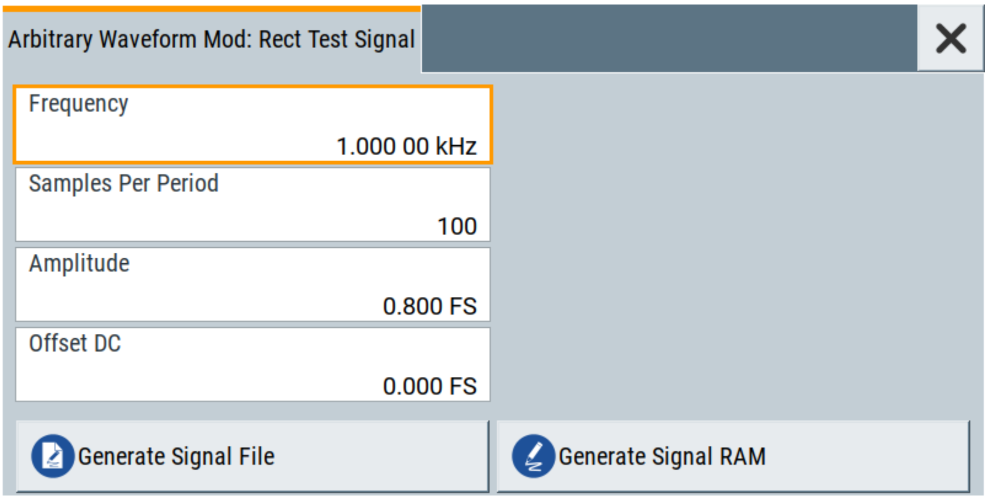
Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate` on page 627

4.6.3.3 Rectangular Test Signal

Access:

1. Select "Baseband > ARB > General > Test Signal Form > Rect".

2. Select "Create Test Signal".



This dialog provides settings for configuration of 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 Chapter 4.6.2.3, "ARB Test Signals", on page 133.

Settings:

Frequency

Enters the frequency of the test signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency` on page 625

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 (see data sheet) and the selected frequency.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:SAMPles` on page 625

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 625

Offset DC
Enters a DC component.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet` on page 625

Generate Signal File
Generates a signal and saves it as a waveform file on the hard disk. Use the standard "File Select" function to store this file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed`
on page 627

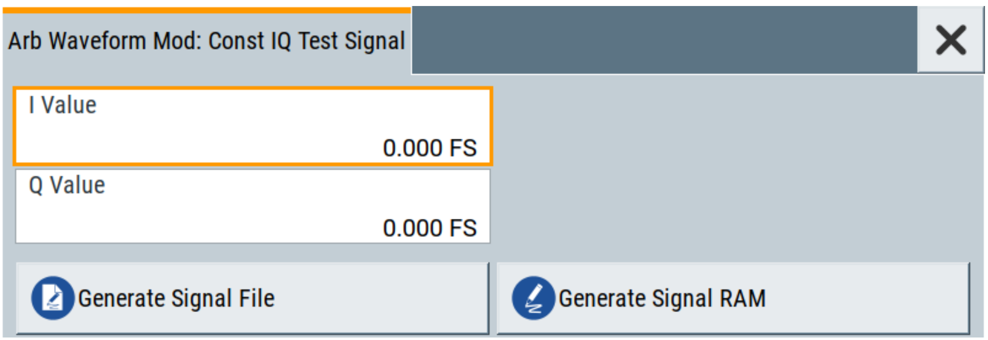
Generate Signal RAM
Generates a signal and uses it as output straight away. The instrument stores the file with a predefined name.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate` on page 627

4.6.3.4 Constant IQ Test Signal

Access:

1. Select "Baseband > ARB > General > Test Signal Form > Const IQ".
2. Select "Create Test Signal".



This dialog provides settings for configuration of a continuous test signal with constant IQ. The I and Q values for each path are adjustable but constant. For more information, refer to Chapter 4.6.2.3, "ARB Test Signals", on page 133.

Settings:

I Value, Q Value
Enters the value for the I respectively Q component of the test signal.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I on page 624
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q on page 624

Generate Signal File
Generates a signal and saves it as a waveform file on the hard disk. Use the standard "File Select" function to store this file

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed on page 627

Generate Signal RAM
Generates a signal and uses it as output straight away. The instrument stores the file with a predefined name.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate on page 627

4.6.3.5 Trigger, Marker and Clock Setting

These tabs provide standard settings.

For detailed description, see:

- Chapter 4.4.2.1, "Trigger Settings", on page 97
- Chapter 4.4.2.2, "Marker Settings", on page 100
- Chapter 4.4.2.3, "Clock Settings", on page 101
- Chapter 4.4.2.4, "Global Connector Settings", on page 102

The following settings are specific to the ARB dialog.

Marker Mode
Basic marker configuration for up to three marker channels. The contents of the dialog change with the selected marker mode.

Use the settings to define the shape and periodicity of the markers. See Regular Marker Output Signals for description of the regular marker signals.

Note: The marker trace in the waveform file remains unchanged in any case. It is not overwritten, even if something else than Unchanged has been selected.

The instrument routes the generated marker signals to the selected output connectors.

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

"Unchanged" The marker signal remains unchanged as defined in the waveform file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE on page 655
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider on page 656
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency? on page 656
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern on page 655

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime on page 655
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime on page 655

4.6.4 How to Create, Generate and Play Waveform Files

This section provides step-by-step instructions on configuring and using the provided settings. For details on individual functions and settings, see Chapter 4.6.3, "ARB Settings", on page 136.

Some test cases do not require a real-time generation of signal according to a digital standard. For these test cases, the replay of a previously generated waveform is sufficient. In such cases, you can generate the required test waveform file in one of the following ways:

- Internally, with the "Create ARB Test Signal" function, see Chapter 4.6.4.1, "How to Create and Store ARB Test Signals", on page 145
- Externally, for example:
  – With the free of charge software R&S WinIQSIM2, see Chapter 4.6.4.3, "How to Create a Waveform File with WinIQSIM2 and Load It into ARB", on page 146
  – With the software R&S ARB Toolbox
  – Calculated using a mathematical program such as MATLAB, see Chapter 4.6.4.4, "How to Manually Create a Waveform Using Tag File Format", on page 151.

Provided the R&S SMCV100B is equipped with the required option, you can load this waveform file and subsequent process it with the instrument.

This section provides examples on the internal waveform file generation and on the external generation with the R&S WinIQSIM2.

4.6.4.1 How to Create and Store ARB Test Signals

If your test case requires a simple sine or square test file, consider to use the provided 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".
   Navigate through the directory tree (e.g. `/var/user/`).
   Enter a filename (e.g. `sine_waveform`).
   Select "Save".

   The R&S SMCV100B stores the generated waveform file and automatically loads it in the ARB.

5. Select "ARB > State > On".

   The R&S SMCV100B processes the waveform file.

4.6.4.2 How to Load and Play Waveform Files

Irrespectively on the way a waveform file is generated, you can transfer it on 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 Chapter 10.8, "How to Transfer Files from and to the Instrument", on page 406
2. Select "Baseband > ARB"
3. Select "Load Waveform File".
   Navigate to the directory with the stored file.
   Select the waveform file (e.g. `/var/user/lte_waveform`).
   Press "Select".

   The "ARB" dialog confirms that the waveform file is loaded.
4. Select "ARB > State > On".

   The R&S SMCV100B processes the waveform file.

4.6.4.3 How to Create a Waveform File with WinIQSIM2 and Load It into ARB

The following is an example on how to use R&S WinIQSIM2 to generate an EUTRA/LTE waveform and load it in the ARB of the R&S SMCV100B.

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 SMCV100B
- Generating of a waveform file with the required settings
- Transferring the waveform file to and playing it with the R&S SMCV100B.

This section does not describe the R&S WinIQSIM2 but focuses only the task-related settings.

For more information on configuration and working with the R&S WinIQSIM2, refer to description "R&S WinIQSIM2 User Manual".

To configure the R&S SMCV100B as destination instrument in the R&S WinIQSIM2

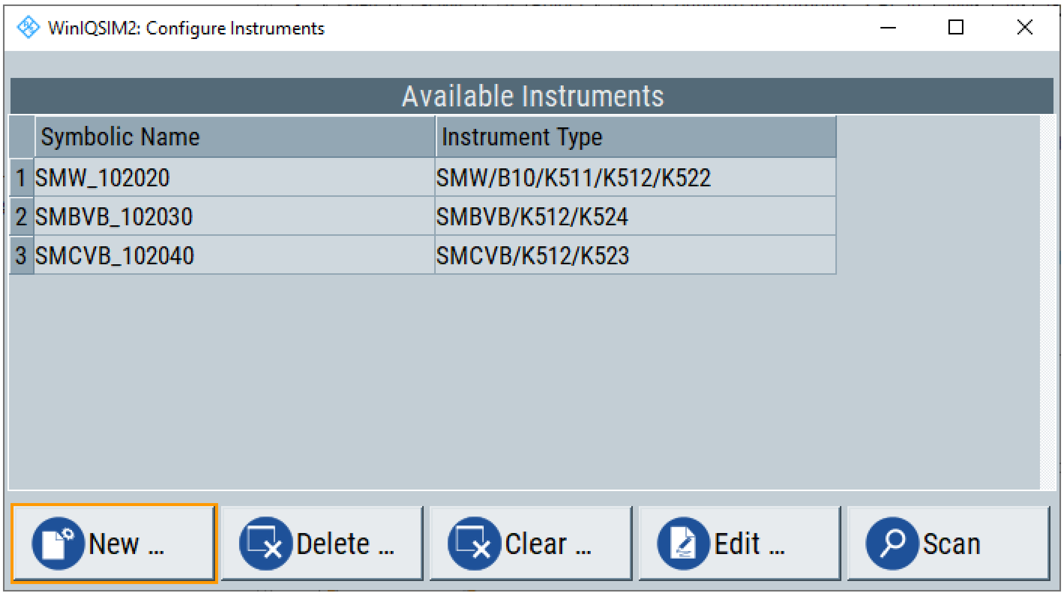
In this example, we assume that the R&S WinIQSIM2 is installed on a remote controller. This remote controller is connected over LAN to the R&S SMCV100B.

The general instrument settings of the destination instrument affect various functions, like, the maximum size of the file the waveform is stored in. We recommend that you configure the destination instrument before you generate the waveform with the R&S WinIQSIM2.

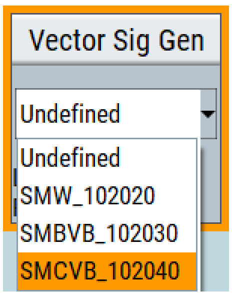
1. In the R&S WinIQSIM2, select "File > New" to preset the software to a defined state.
2. In the block diagram, select "Vector Sig Gen > Instruments".

   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.

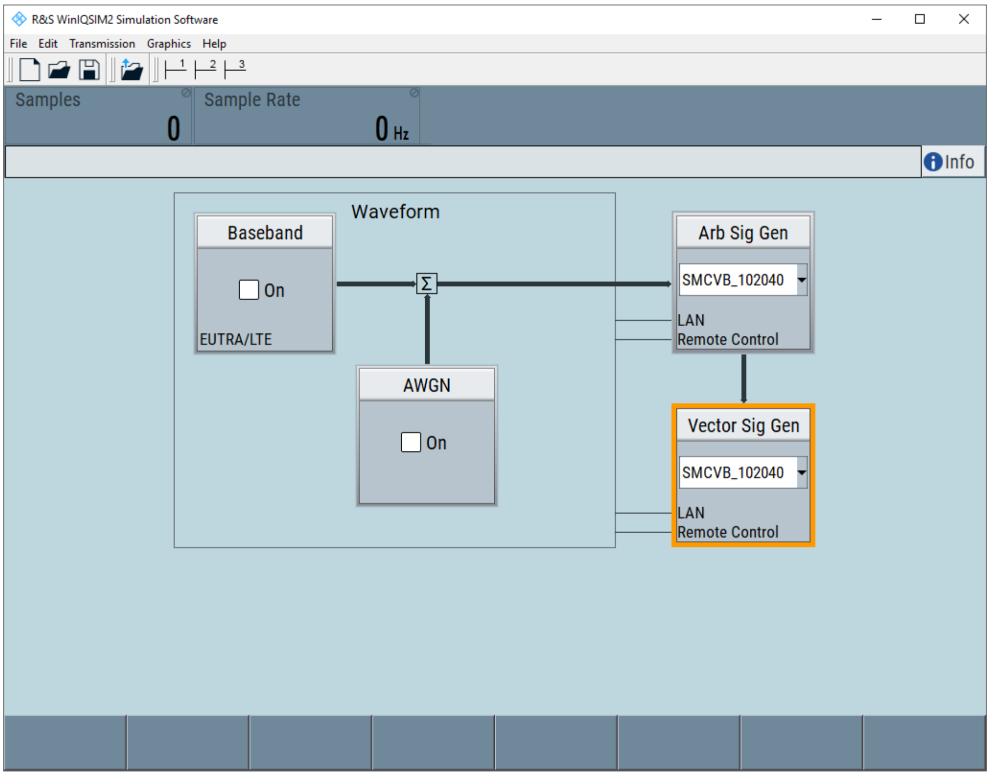
   

   Alternatively, use the "New" function to add the R&S SMCV100B manually to the list of instruments.
4. Close the dialog.
5. In the block diagram, select "Vector Sig Gen" block and select the R&S SMCV100B form the list.

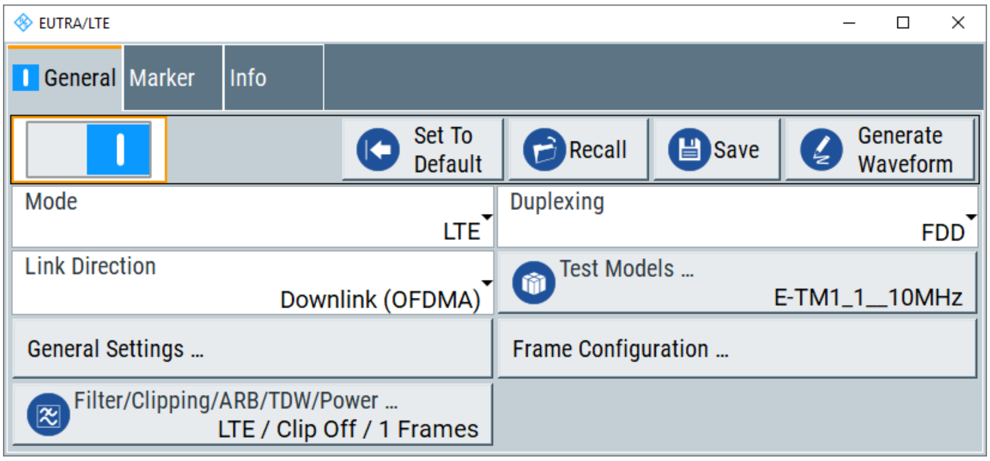
6. In the block diagram, select "ARB Sig Gen" block and select the R&S SMCV100B form the list.

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 SMCV100B is established.

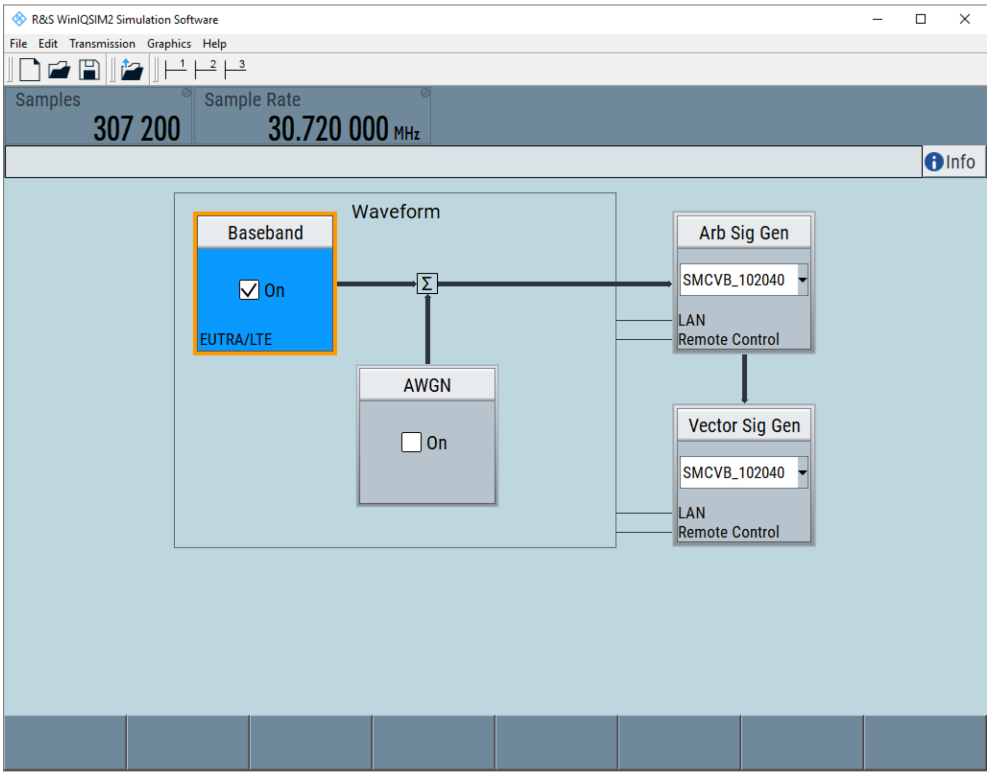


To generate a waveform file with R&S WinIQSIM2

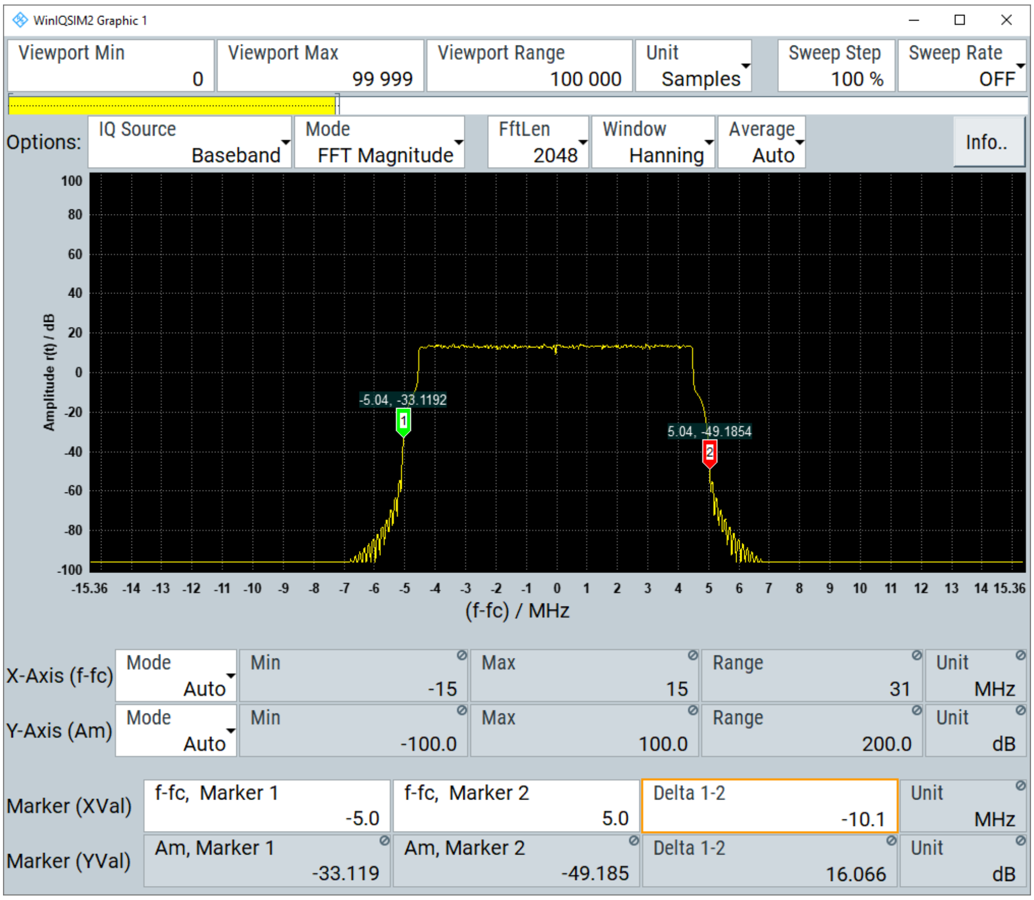
1. In the block diagram of R&S WinIQSIM2, select "Baseband > EUTRA/LTE/IoT".
2. Adjust the settings as required, for example:
   a) Select "Link Direction > Downlink (OFDMA)"
   b) Select a predefined test model, "Test Models > E-TM1_1__10MHz"
3. Enable "EUTRA/LTE/IoT > State > On".



The R&S WinIQSIM2 calculates the signal and displays important signal parameters, like the used "Sample Rate" and "Number of Samples".



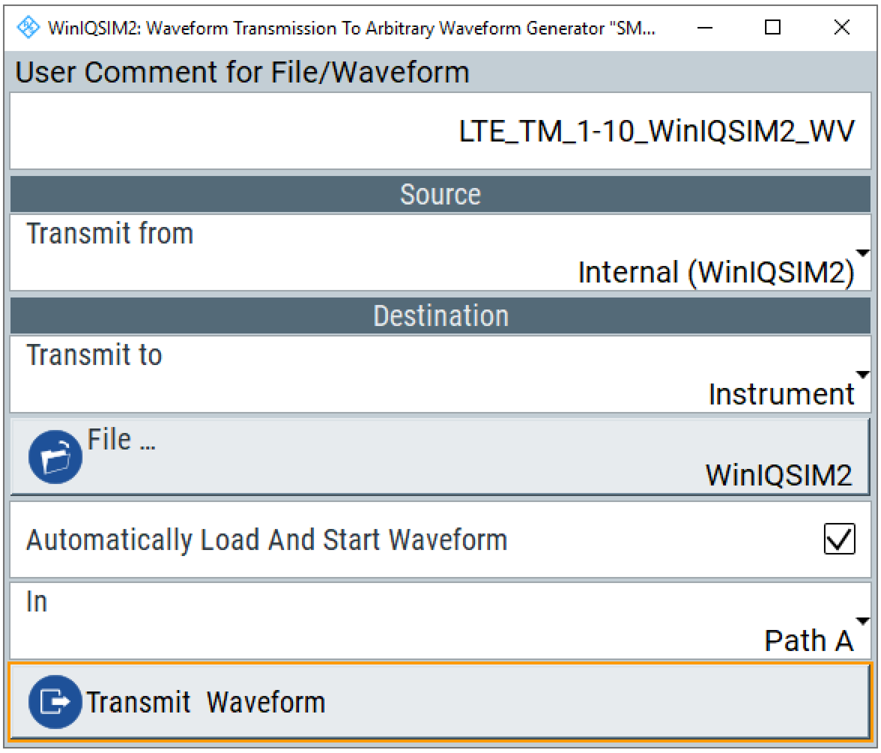
Use "Graphics > Graphic 1 (Complete)" view to retrieve more information on the generated signal.



The display confirms the expected EUTRA/LTE 10 MHz spectrum.

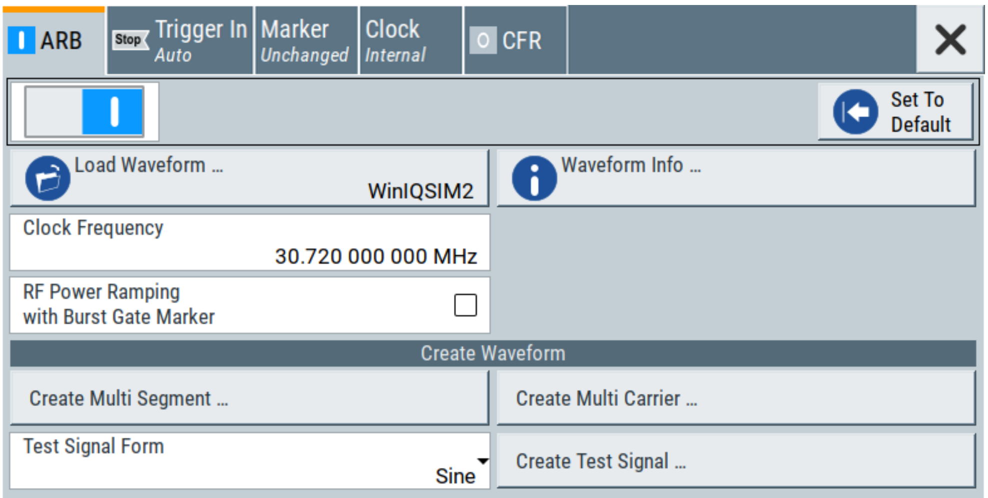
To transfer the generated file to the R&S SMCV100B

1. In the R&S WinIQSIM2, select "Transmission > Transmit".
2. In the "Waveform Transmission to Arbitrary Waveform Generator" dialog, select:
   a) "Transmit from > Internal (WinIQSIM2)"
   b) "Transmit to > Instrument".
   c) Select "File" and define the filename the transmitted file is stored as.
   d) Enable "Automatically Load and Start Waveform > On" and select the required baseband, e.g. "Path A"
   e) Add a comment to the waveform.
   f) Select "Transmit".



The waveform is transmitted to the default directory of the R&S SMCV100B.

3. In the R&S SMCV100B, select "Baseband > ARB".



The dialog confirms that the ARB is enabled and plays the transmitted waveform.

4.6.4.4 How to Manually Create a Waveform Using 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 154). They are stored 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 4-13 illustrates this general workflow.

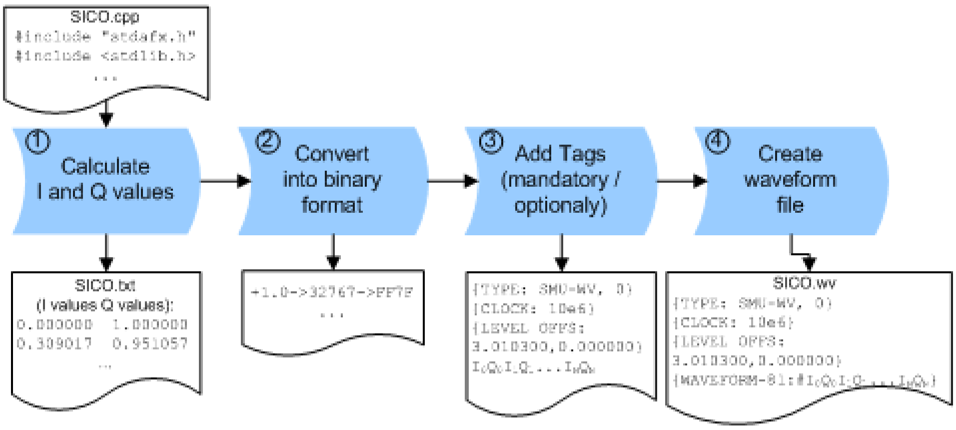


Figure 4-13: Principle of creating a waveform manually

The following steps outline how to create the waveform file `SICO.wv`:

1. Calculate the sine and cosine values, e.g. use the `SICO.cpp` program.

   The result is stored 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 4-14: 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 4-15 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 4-15: 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.

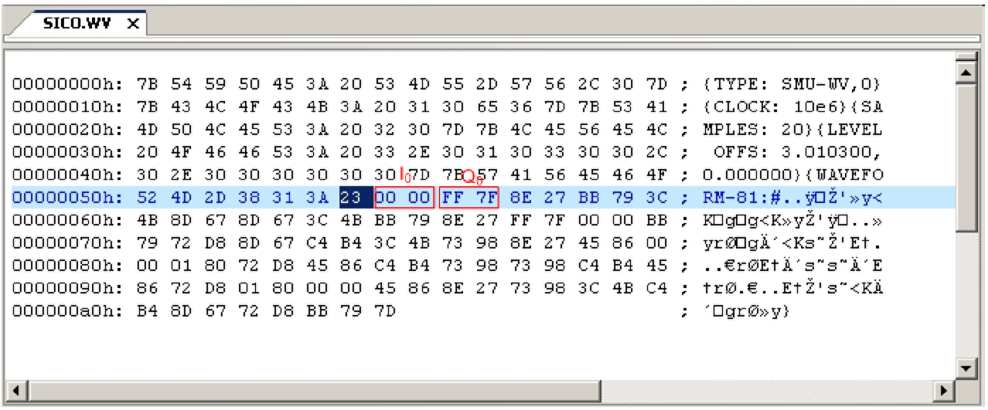
4. Pack the binary data into a `WAVEFORM` tag with the described structure.

   ```
   {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}`
Note: There is no readable representation for binary values in this document. This is why we use the sequence `I0Q0I1Q1...InQn` to characterize the binary code in the present example.
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;
}
```

4.6.4.5 How to Define Periodically Repeating Traces

If a marker trace is required that marks for example each frame start, it is sufficient to define the trace ones and repeat it over the length of a waveform. This is useful if you describe a long waveform and a periodical marker is required.

The following examples use marker traces; control lists are processed in the same way.

To define periodical marker trace

The waveform in the example on Figure 4-16 consists of 3 frames, each frame is 100-samples long. The waveform is processed continuously ("Trigger Mode > Auto").

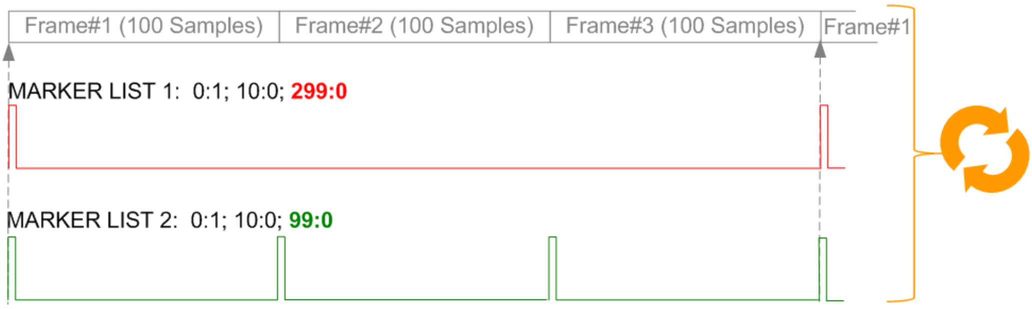


Figure 4-16: Example: Defining marker traces (CONTROL LENGTH tag is not used)

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: How the CONTROL LENGTH tag influences the processing of the traces

For the example on Figure 4-16, use the same marker traces and set the `CONTROL LENGTH` tag, e.g. `{CONTROL LENGTH: 150}`.

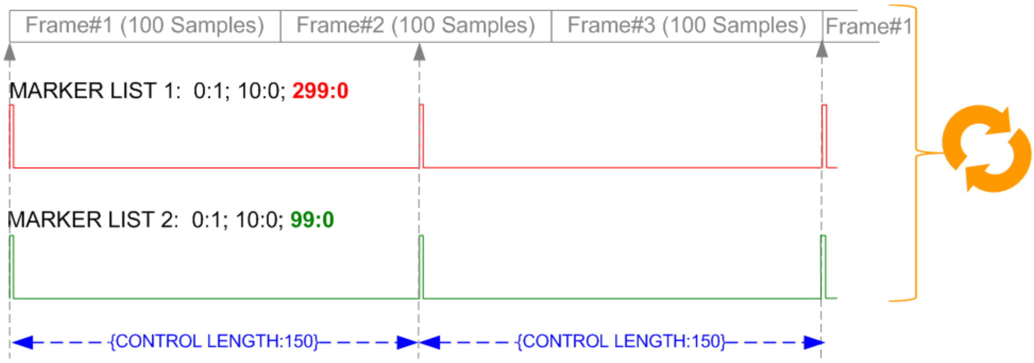


Figure 4-17: Example: Processing of control signals if the CONTROL LENGTH tag is used

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 each 150 samples.

4.6.4.6 How to Create a Control List Using Tag File Format

The R&S SMCV100B 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 extension `*.dm_iqc`, see "To create a control list in ASCII format manually" on page 120
- To use the tag-oriented format and create a data list file, see "To create a data list file using tag file format" on page 159.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 160.

To create a control list using tag file format

To create an ASCII control list file directly, use the provided tag commands.

1. Use a hex data editor and 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`).
2. Use a hex data editor and create the **recommended** tag `CONTROL LENGTH`.

   This tag defines the *periodicity* of the total control list
3. Add the required optional tags.

They can be inserted after the `TYPE` tag in arbitrary order.

An example of the control list file contents could be:

```
{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 4-10 shows the representation of the created control list in the "Control Data Editor".
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 "How to assign and activate control signals from a control list" on page 159.

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 609 and the example in `[:SOURce<hw>]:BB:DM:CLISt:DATA` on page 612).

See also Example "How to assign and activate control signals from a control list" on page 159.

Example: How to assign and activate control signals from a control list

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 stored in the directory `/var/user/temp/`.

The following example shows how to enable the R&S SMCV100B to:

- Use the control list for a particular marker output, e.g. the "Custom Digital Modulation > Marker 2".
- 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:OUTPut2:MODE CLISt

SOURce1:BB:DM:PRAMp:SOURce INTernal
```

4.6.4.7 How to Create a Data List Using Tag File Format

The R&S SMCV100B 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 122.
- To use the tag-oriented format and create a data list file, see "To create a data list file using tag file format" on page 159.
- To use SCPI commands and create a file in binary format, see "To create a data list in binary format" on page 160.

To create a data list file using tag file format

► Use a hex data editor and create the mandatory tags: `{TYPE}`, `{DATA BITLENGTH}` and `{DATA LIST}`

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 4-11 for representation of the created data list in the "Data List Editor".
- Example "How to assign and activate a data list" on page 160

To create a data list in binary format

► Use the commands `BB:DM:DLISt:...`, see "Handling List Files" on page 609.

```
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 "How to assign and activate a data list" on page 160.

Example: How to assign and activate a data list

Note: Irrespectively on the way they are created, generated data lists are not automatically used.

We assume, that a data list `dl.dm_iqd` is created and stored in the directory `/var/user/`.

The following example shows how to enable the R&S SMCV100B 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"
```

4.6.4.8 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 (waveforms, data and control lists)

- **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, if you add a tag or add bytes to an existing tag, reduce the length information by the number of newly introduced bytes.

4.6.5 How to Stream Waveforms from an External Storage Device

This section provides step-by-step instructions on how to set up the R&S SMCV100B for streaming large waveform files from an externally connected hard disc drive (HDD).

Required options

See Chapter 4.6.1, "Required Options", on page 130.

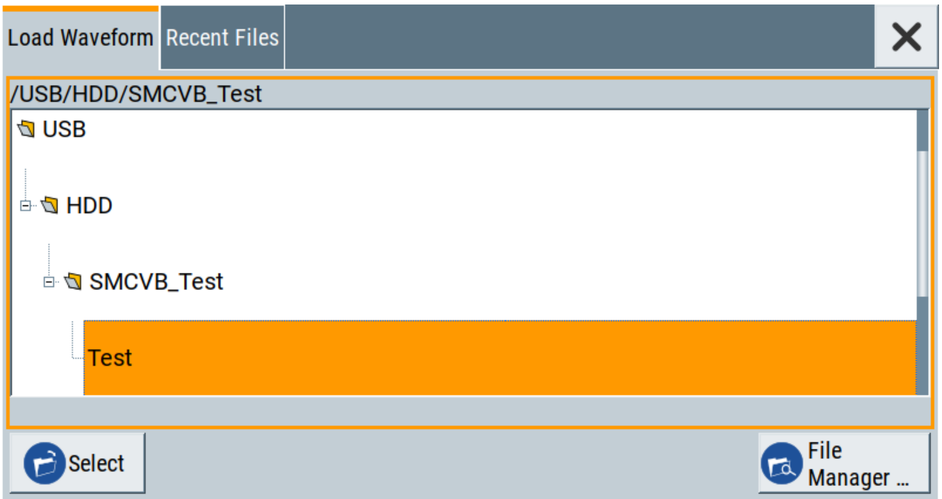
The following procedures help you to set up the R&S SMCV100B for ARB waveform streaming.

To set up and connect the external waveform source

1. Provide an HDD as waveform streaming source.
   The R&S SMCV100B supports the following storage formats: ext2/ext3/ext4, FAT16/FAT32, NTFS (read-only), ISO9660, UDF
2. Store the waveform file, on the HDD.
3. Connect the HDD to one of the "USB" 3.0 connectors on the rear panel of the instrument. See Chapter 3.1.9, "Connecting USB Devices", on page 26.

To activate waveform streaming

1. Select "Baseband > ARB".
2. In the "ARB" tab, load the waveform file:
   a) Select "Load Waveform".
   b) In the "Load Waveform" dialog, navigate to the directory of the HDD:
   `/USB/HDD`
   c) On the HDD, select the waveform file, e.g. "Test.wv":
   `/USB/HDD/SMCVB_Test/Test.wv`



3. Select "HDD Streaming > On".
4. Optionally, configure trigger and marker settings.

a) In the "Trigger In" tab, select "Mode > Auto".
b) In the "Marker" tab, select "Mode > Restart".

5. Select "ARB > State > On".

   The R&S SMCV100B processes the waveform stream signal.

To output the waveform stream signal

1. Specify RF frequency and RF level.
2. In the block diagram, select "RF > On".

   The waveform stream signal is modulated onto the RF carrier and output at the "RF 50 Ω" connector.

4.6.6 Tags for Waveforms, Data and Control Lists

The R&S SMCV100B 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. These files are transmitted as a binary data block, using SCPI command `[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA`, `[:SOURce<hw>]:BB:DM:DLISt:DATA`, and `[:SOURce<hw>]:BB:DM:CLISt:DATA`.

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 legibility.

- 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 may be included (optional).

Unknown tags are not analyzed by the R&S SMCV100B; 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 SMCV100B 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 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 decriptions

See:

- Chapter 4.6.4.5, "How to Define Periodically Repeating Traces", on page 156
- Chapter 4.6.4.4, "How to Manually Create a Waveform Using Tag File Format", on page 151
- Chapter 4.6.4.6, "How to Create a Control List Using Tag File Format", on page 157
- Chapter 4.6.4.7, "How to Create a Data List Using Tag File Format", on page 159
- Chapter 4.6.4.8, "Editing Waveform Files, Data and Control Lists", on page 160

Tags description

4.6.6.1 Common Tags

The following tags are common to all file types. For description of the dedicated tags, see

{TYPE: magic, xxxxxxxx}

(mandatory, must be the first tag in the file)

Identifies the file as a valid R&S SMCV100B 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 SMCV100B waveform.

SMU-MWV
A valid R&S SMCV100B multi-segment waveform.

SMU-DL
A valid R&S SMCV100B data list.

SMU-CL
A valid R&S SMCV100B 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 SMCV100B. 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 SMCV100B. It is used to store 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. The year must be expressed 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

4.6.6.2 Tags for Single and Multi-Segment Waveforms

The following tags apply to waveforms and multi-segment wavefroms, additionally to the tags listed in Chapter 4.6.6.1, "Common Tags", on page 163.

{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 4-18.

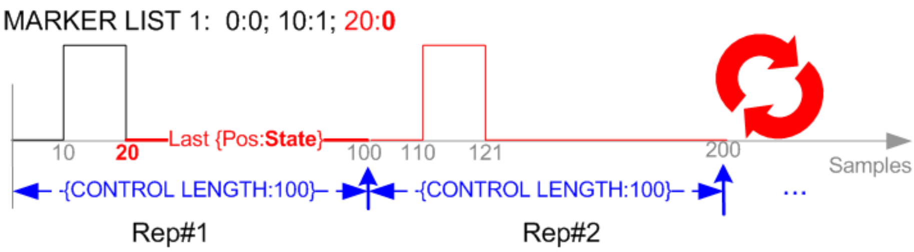


Figure 4-18: Example: Processing of MARKER TRACE if CONTROL LENGHT is specified

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 4-19.

Figure 4-19: 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 Chapter 4.6.4.5, "How to Define Periodically Repeating Traces", on page 156.

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 118

{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 Chapter 4.6.4.5, "How to Define Periodically Repeating Traces", on page 156.

{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.

Traces are processed different, depending on the selected `CONTROL LENGTH`. See for example Chapter 4.6.4.5, "How to Define Periodically Repeating Traces", on page 156.

The processing of the marker traces (`MARKER LIST`) depends additionally on the presence of the tag `MARKER MODE`.

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 effect from which the binary `State` of the marker or of the control signal changes.
If the tag `MARKER MODE` is used, the maximum number of marker states is 64, i.e. Pos_{63}:$State_{63}$.

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 = 1.

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 118

{WAVEFORM-Length: #I0Q0I1Q1...IxQx...IN-1QN-1…}

(mandatory for waveforms)

Setting parameters:

Length
Specifies the number of bytes in a `WAVEFORM` tag and is calculated as follows:
`Length` = `Number of I/Q pairs * 4` (2 bytes per I and 2 bytes per Q value) + `1 byte` (the length of the `#`)

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 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 collectively 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 bit = 4 bytes

Usage: Setting only

{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, that was used for calculation of the multi-segment output waveform (see also "Clock" on page 192).

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 may 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, 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: RMS level of segment 0 is 3 dB below full scale;
RMS level of segment 1 is 6dB below full scale.
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 file names 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 bit, 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` should be equal to the number of I/Q samples. The `CONTROL LENGTH` tag has to contain the number of all marker elements `m`.

MSB 7	Byte						LSB 1
Marker element m_x (synchronous to I/Q Sample x)				Marker element m_{x+1} (synchronous to I/Q Sample x+1)			
Marker 4	Marker 3	Marker 2	Marker 1	Marker 4	Marker 3	Marker 2	Marker 1

Figure 4-20: 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 collectively marker stream.

Setting parameters:

Length
: Defines 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

4.6.6.3 Tags for Data Lists

The following tags apply to data lists, additionally to the tags listed in Chapter 4.6.6.1, "Common Tags", on page 163.

{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

4.6.6.4 Tags for Control Lists

The following tags apply to control lists, additionally to the tags listed in Chapter 4.6.6.1, "Common Tags", on page 163.

{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 4-18.

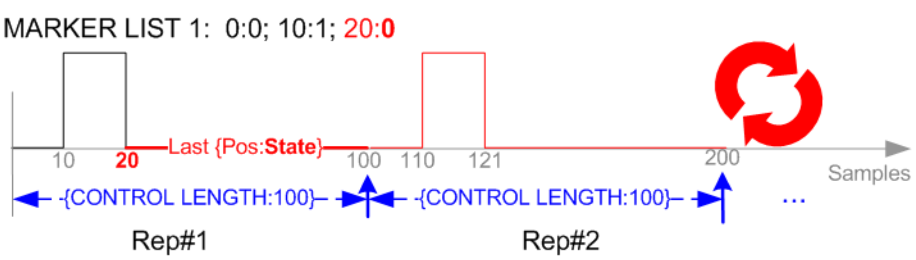


Figure 4-21: Example: Processing of MARKER TRACE if CONTROL LENGHT is specified

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 4-19.

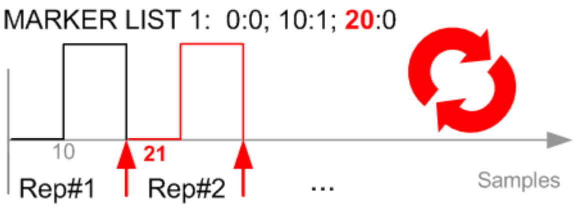


Figure 4-22: Example: Processing of MARKER TRACE if CONTROL LENGHT is not used

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 Chapter 4.6.4.5, "How to Define Periodically Repeating Traces", on page 156.

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 118

{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.

Traces are processed different, depending on the selected CONTROL LENGTH. See for example Chapter 4.6.4.5, "How to Define Periodically Repeating Traces", on page 156.

The processing of the marker traces (MARKER LIST) depends additionally on the presence of the tag MARKER MODE.

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 effect from which the binary `State` of the marker or of the control signal changes.
If the tag `MARKER MODE` is used, the maximum number of marker states is 64, i.e. Pos_{63}:$State_{63}$.

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 = 1.

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 118

4.7 Reducing the Crest Factor

Reducing the crest factor of waveforms is a function that requires the additional option Crest Factor Reduction (R&S SMCVB-K548).

See user manual R&S SMCVB-K548 Crest Factor Reduction.

4.8 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 SMCV100B provides the functionality to generate multi-segment waveform files.

This section introduces the concept of the multi-segment waveform files, together with description of the provided settings and some typical configuration examples.

4.8.1 Required Options

See Chapter 4.6.1, "Required Options", on page 130.

Multi-segment waveform files require the corresponding Digital Standard options (R&S SMCV100B-K2xx) of all included standards.

4.8.2 About the Multi-Segment Waveforms

A multi-segment waveform is a composed signal that contains several multiple independent waveforms called segments. Each segment is an independent waveform that can be output with its own marker and clock settings.

The Figure 4-23 shows the principle of building a multi-segment waveform.

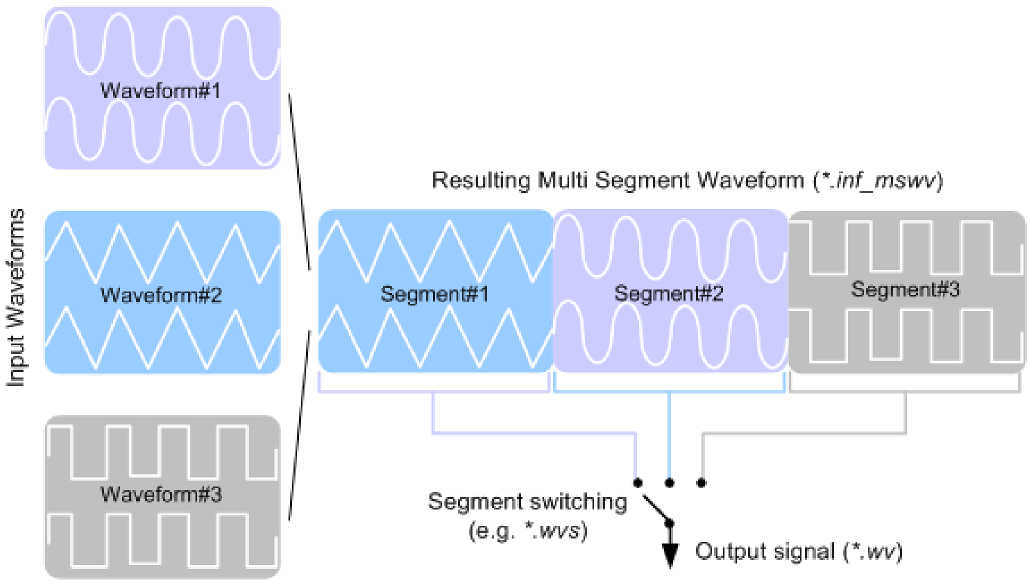


Figure 4-23: ARB Multi-Segment Waveform Concept

It is also possible to create and output a blank segment, i.e. segments containing a zero signal.

Typical applications for the multi-segment mode are described in section Chapter 4.8.4, "How to Create and Work with Multi-Segment Waveform Files", on page 201.

4.8.2.1 Multi-Segment Waveforms 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.

4.8.2.2 ARB Sequencer Mode

If high switch over speeds is required, the test signals can be continuously scrolled through with the aid of an external trigger or by applying a predefined “Play List”. The R&S SMCV100B provides the possibility to define a sequence of different segments and to determine whether a segment is played once or repeated several times and to adjust the transition between the segments.

For the correct and fast processing and for seamless transition between the multiple waveforms, segments with a common sample rate are required. If the combined waveforms features different sample rates, they have to be adapted to 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.

4.8.2.3 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 SMCV100B creates and stores a dedicated file. The following files are used:

- **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.
- **Output file:** is the created output multi-segment waveform file. The R&S SMCV100B stores it under a user definable name; as with the standard waveforms, the used file extension is `*.wv`. The instrument appends additional information to the header of the composed waveform file, e.g. user comments.
- **Sequencing list:** are files created in the "Multi Segment Waveform Sequencing" dialog, i.e. when the ARB sequencer mode is used (see Chapter 4.8.2.2, "ARB Sequencer Mode", on page 181).
  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 whether the assigned sequencing list files are still valid. A message is displayed to inform about necessary corrections in the “play list”.

4.8.2.4 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.

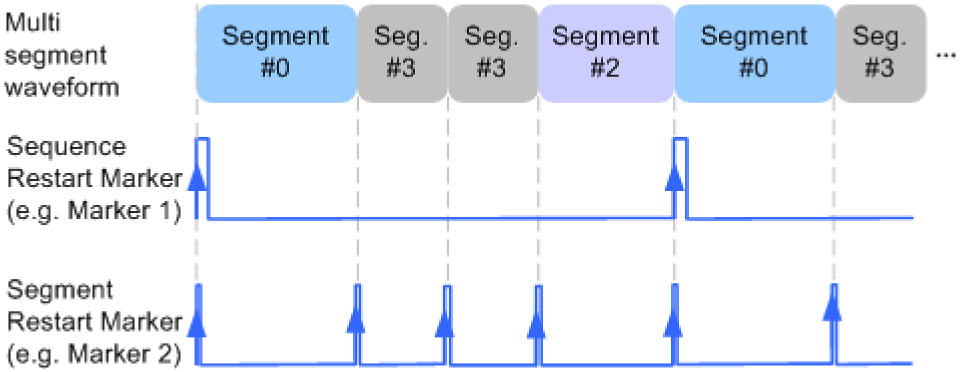
  

  Figure 4-24: Example of marker signals

  The segment begin 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 provides also access to the standard marker settings. Settings other than "unchanged" overwrite existing marker in the waveforms or markers defined for the multi-segment waveform.

The Figure 4-25 shows schematically how the instrument evaluates the priorities of the different marker signals, if multiple marker signals are mapped to the same connector.

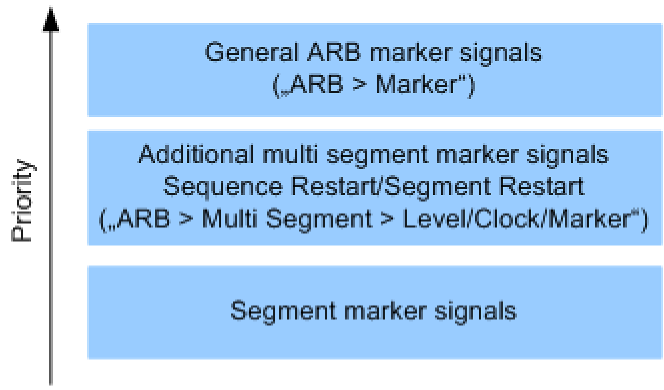


Figure 4-25: Marker priority used by assigning of marker signals to a hardware connector

4.8.2.5 Impact of the Trigger Settings and Next Segment Settings

The ARB dialog is equipped with the standard (regular) trigger settings. These settings are provided for triggering of the composed multi-segment waveform as a **sequence**, i.e. as one file. The functions provided in the "Trigger" tab and their effect are described in Chapter 4.4.1.3, "Baseband Trigger Signals", on page 82.

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 4-26 illustrates how trigger events affect the processing of the multi-segment waveforms.

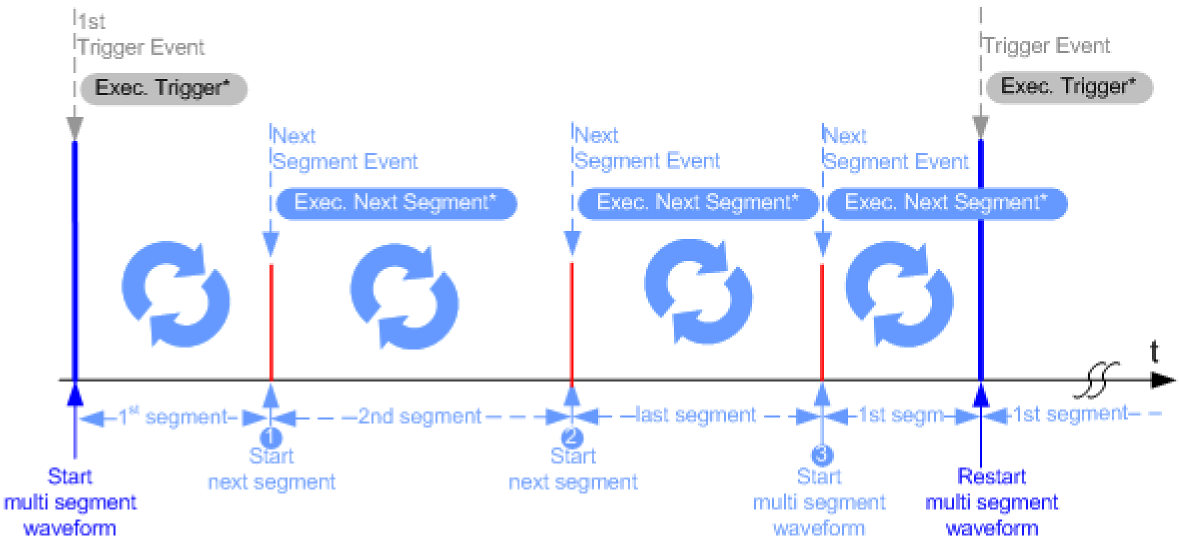


Figure 4-26: Principle of segment triggering

* = 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 currently 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 subsequent trigger event. Hence, a sequence of external next segment trigger events can be used to cyclically output the segments in the multi-segment file.

Defining 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 the Subsequent Segment

By default, the instrument replays the segments in incremental order, e.g. Segment#1, Segment#2, etc. If other order is required, use one of the following possibilities to define the segment to be played next:

- **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.

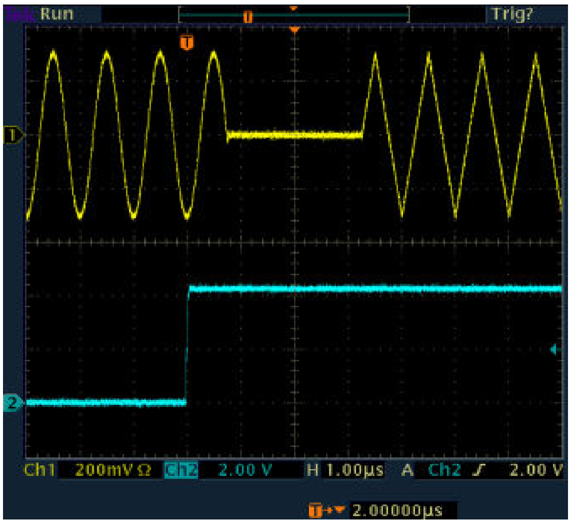
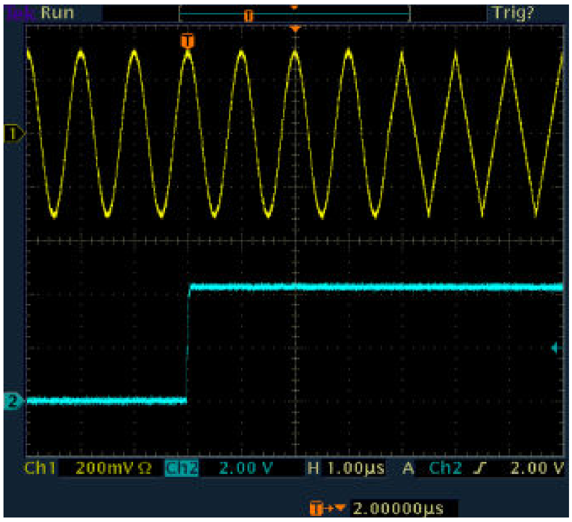
Defining the Transition between the Segments

The R&S SMCV100B provides the parameter "Next Segment Mode" to define the transition to the subsequent segment (see the graphs in Transition examples).

- **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 Chapter 4.8.3.4, "Multi-Segment Waveform Sequencing", on page 193).

The Table 4-13 shows two examples of the transition from a sine-wave signal segment to a sawtooth segment (I channel, upper curve) in the case of next segment external triggering. The left graphic displays an abrupt transition; the right graphic, the **seamless** transition case.

Table 4-13: Transition examples

Next Segment switching	Next Segment Seamless
	

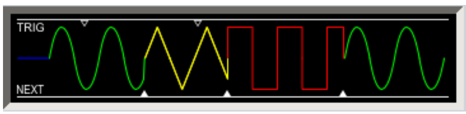
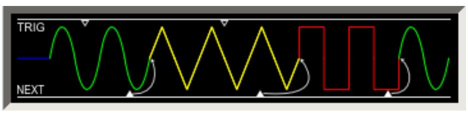
Understanding the Trigger Examples

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

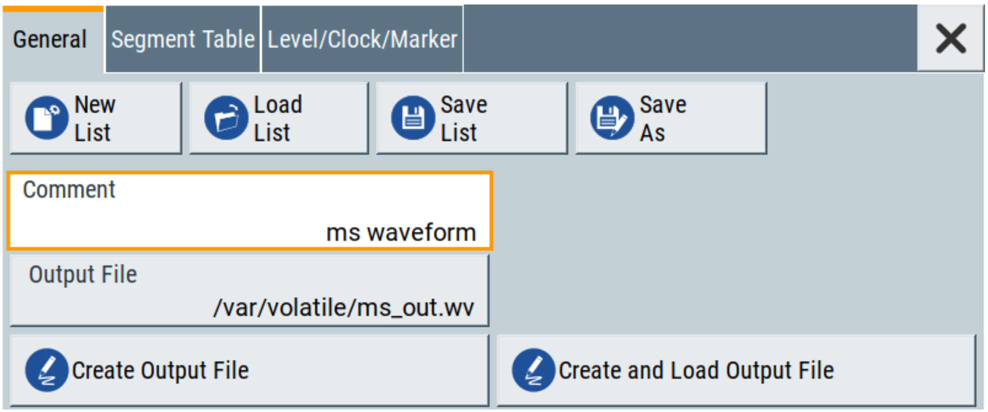
"Next Segment Mode = Next Segment"	"Next Segment Mode = Next Segment Seamless"
	

4.8.3 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:
Chapter 4.8.3.1, "Setting for Handling the Multi-Segment Files and Output File Settings", on page 187,
Chapter 4.8.3.2, "Segment Table", on page 189 and
Chapter 4.8.3.3, "Level / Clock / Marker Settings", on page 191

2. Select "ARB: Multi Segment > General" > **"Create and Load Output File"** to store and load 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 Chapter 4.8.3.4, "Multi-Segment Waveform Sequencing", on page 193.
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 for instance requires that:
   - Multi segment file is created, i.e. you have executed **"Create Output File/ Create and Load Output File"**.
   - "Sequence Table" contains **more than one segment**.
5. Select "Baseband > ARB > Trigger In (MSW)".
   For a description of the provided settings, refer to Chapter 4.8.3.5, "Next Segment Trigger In Settings", on page 197.
6. Select "Baseband > ARB > General > State > On" to process the configured multi-segment waveform.

The remote commands required to define these settings are described in Chapter 13.15.3.3, "SOURce:BB:ARBitrary Subsystem", on page 614.

4.8.3.1 Setting for Handling the Multi-Segment Files and Output File Settings

Access:

1. Select "Baseband > ARB > General > Create Multi Segment".

   The "General" tab comprises 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 and select "Output File" to define the filename the multi-segment waveform is created at.

   Note: The provided settings depend on the current waveform.
   The "Sequencing List" function for instance requires that:
   - Multi segment file is created, i.e. you have executed**"Create Output File/ Create and Load Output File"**.
   - "Sequence Table" contains **more than one segment**.

Settings:

New List

Accesses 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 639

Load List

Accesses the standard "File Select" function to select the configuration file to be edited.

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?` on page 637
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect` on page 639

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 Chapter 4.8.2.3, "File Concept", on page 181.

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
Accesses the dedicated dialog for configuring the associated play lists, see Chapter 4.8.3.4, "Multi-Segment Waveform Sequencing", on page 193.

This function is enabled, if a multi segment file is created or created and loaded.

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 638

Output file
Accesses 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 638

Create/Create and Load
- "Create"
  Creates a multi-segment waveform using the current entries in the Segment Table.
- "Create and Load"
  Creates a multi-segment waveform and loads it in the ARB generator.

The R&S SMCV100B stores the multi-carrier waveform as file with filename as specified with parameter Output file.

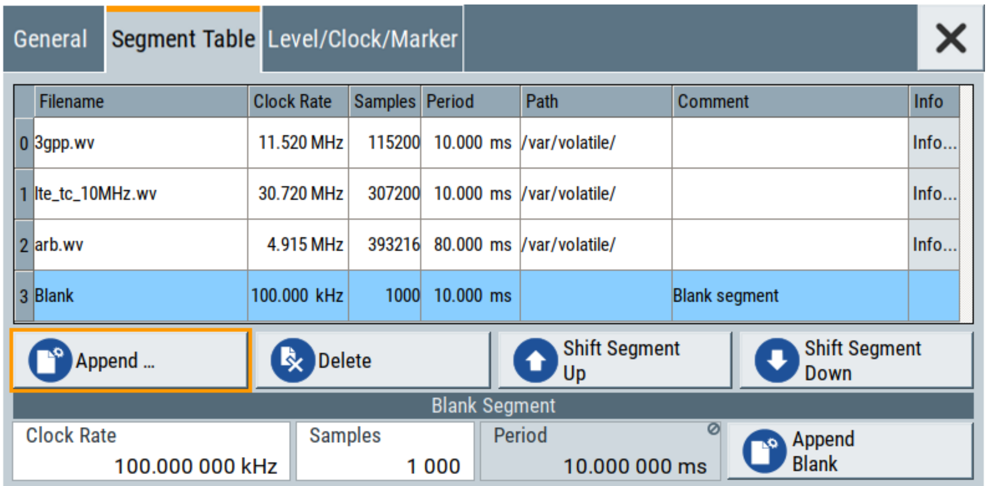
Depending on the configuration of the multi-carrier waveform, calculation takes some time. Use the "Abort" function, to interrupt the calculation.

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`

4.8.3.2 Segment Table

Access:

1. Select "Baseband > ARB > General > Multi Segment".
2. In the "ARB: Multi Segment > General" dialog, select an existing list.
3. Select "ARB: Multi Segment > Segment Table".
4. Select "Append" to add *existing* waveform segments.
5. Select "Append Blank" to add a bank segment and configure the "Blank Segment Settings" as required.



This section explains the settings, necessary to create and adjust the contents of the multi-segment file.

Settings:

Multi 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 comment contained in the waveform.

"Info"
Indication of the possible comment contained in the waveform.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?`
on page 633

Append/Delete/Shift Seg. Up/Down

Standard handling functions:

"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.

"Delete" Removes the selected entry from the table. The waveform file itself is however not deleted.

"Shift Seg.# Up/Down"
Rearranges the segments, i.e. moves the selected segment up and down.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend`
on page 638
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete` on page 638

Blank Segment

Comprises the settings of a blank segment. A blank segment is a zero signal with defined clock rate and number of samples.

"Clock Rate" Selects the clock rate of the blank segment.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend`
on page 636

"Samples" Selects the number of samples for the blank segment.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend
on page 636

"Period" Displays the resulting period for the blank segment.

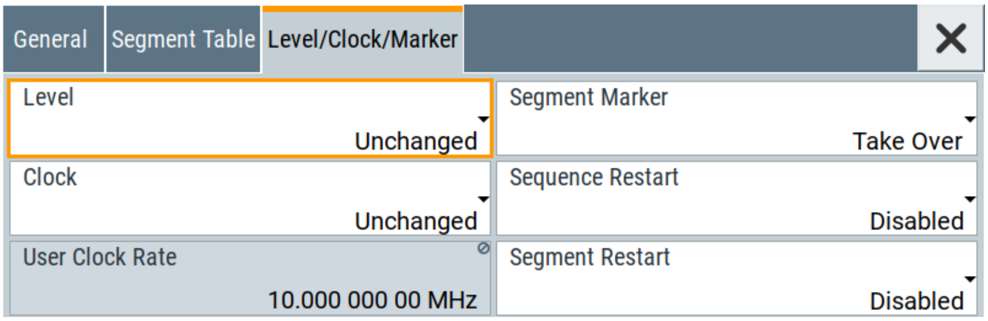
"Append Blank"
Adds the blank segment to the multi-segment file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend
on page 636

4.8.3.3 Level / Clock / Marker Settings

Access:

1. Select "Baseband > ARB > General > Multi Segment".
2. In the "ARB: Multi Segment > General" dialog, select an existing list.
3. Select "ARB: Multi Segment > Segment Table" and configure the segments.
4. Select "ARB: Multi Segment > Level/Marker/Clock".



The "Level/Marker/Clock" tab provides the parameters necessary to adjust the level, marker and clock settings for the selected multi-segment waveform file.

Settings:

Level

Defines the way 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" Segments are output so that all segments have the same RMS value. The "Level" display applies to all segments.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE]`
on page 638

Clock

Defines the way the instrument determines the clock rate of each of the multiple waveforms.

"Unchanged" Each segment is output with the clock rate defined in its waveform file.

Note: Segments with equal clock rates are required for "Next Segment Mode > Next Segment Seamless".

"Highest" All segments are output at the highest available clock rate.

Note: Trade-off between fast switch over and computing time. This mode provides short switch over times between segments. However, the computing time increases because the individual segments are resampled.

"User" All segments are output at the clock rate defined by the parameter "User Clock".
This mode is a trade-off between fast switch over and computing time, too.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE`
on page 637

User Clock Rate

Defines the sample rate used for multi-segment waveform output, if "Clock Mode > User" is selected.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk` on page 637

Segment Marker

Defines the way the marker information within the separate segments is processed, see also Chapter 4.8.2.4, "Impact of the Marker Settings", on page 182.

"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 635

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 Chapter 4.8.2.4, "Impact of the Marker Settings", on page 182.

"Disable" No additional marker is generated.

"Marker 1, 2, 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 635

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 Chapter 4.8.2.4, "Impact of the Marker Settings", on page 182.

"Disable" No additional marker is generated.

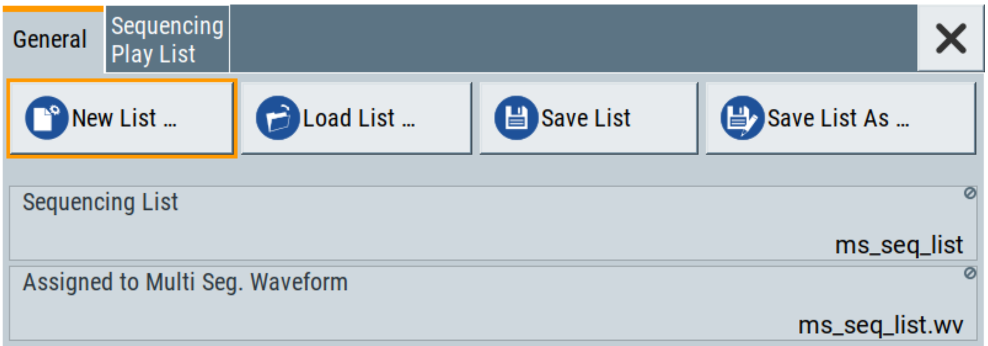
"Marker 1, 2, 3"
Generates a restart marker signal at the beginning of each segment. The segment begin is defined by the low-high slope of the marker signal, which applies for switching between two segments and if there is a segment replay.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment`
on page 635

4.8.3.4 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" and configure a waveform with more than one segment.
4. Select "ARB: Multi Segment > Level/Marker/Clock" and adjust the clock settings so that all segments use the same clock rate.
5. Select "ARB: Multi Segment > General" > **"Create Output File/Create and Load Output File"**.
6. Select "Sequencing List..."
7. Select "New" or "Load" to load a sequencing list file.

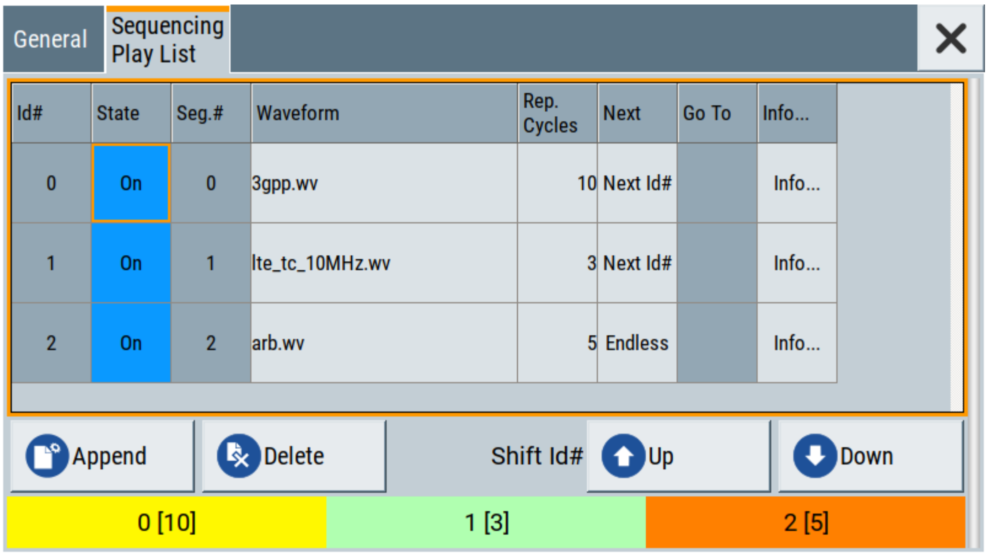


8. Select "ARB: Multi Segment Waveform Sequencing > Sequencing Play List" to create a “play list”.

   A new sequencing list contains no information.

9. Use the "Append/Delete" and "Up/Down" functions to configure the order the segments are processed.

   The user interface shows the configured play list in form of a "Sequencing Graphic".



   Refer to "Sequencing Play List Settings" on page 196 for description of the provided settings.

10. Select "ARB: Multi Segment Waveform Sequencing > General > Save" to store the "play list".

11. Select "ARB: Multi Segment > General > Create and Load Output File" to store and load current multi-segment file.

12. To enable the instrument to use the configured “play list”, select "ARB > Next Segment Waveform Options > Next Segment Mode > Sequencer".

All segments in a “play list” must have the same clock rate.

Settings:

General Settings

Access:

► Select "Baseband > ARB > General > Multi Segment > Sequencing List...".

Settings:

New/Load Sequencing List

Accesses 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 634

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 Chapter 4.8.2.3, "File Concept", on page 181).

Remote command:
n.a.

Assigned to Multi Seg. Waveform

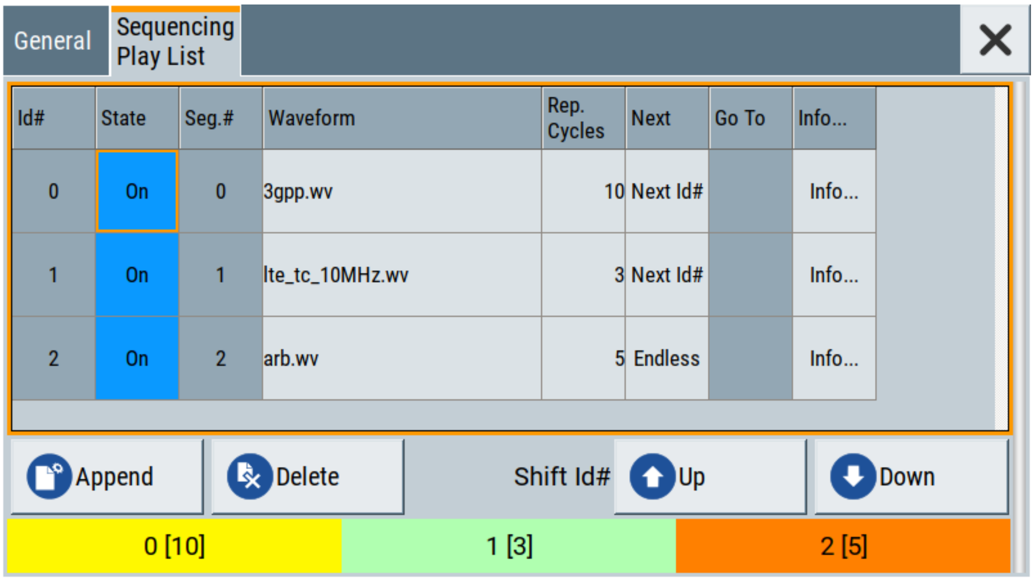
Displays the name of the multi-segment waveform file the current sequencing list file is assigned to.

Remote command:
n.a.

Sequencing Play List Settings

Access:

► Select "Baseband > ARB > General > Multi Segment > Sequencing List... > Sequencing Play List".



Settings:

Sequencing Play List

The "Sequencing Play List" table defines the sequence order the waveform file segments are processed and how many times each of them is repeated.

"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 corresponding filenames are retrieved form the assigned multi-segment waveform file.
"Waveform"	Indicates the waveform file mapped to the corresponding segment. The filename is retrieved form the assigned 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 197

Next ← Sequencing Play List

Determines the action after completing the current one, like for instance which segment is processed after the processing of the current one is finished.

"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 634
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend` on page 634

Delete ← Sequencing Play List

Deletes the selected row.

Shift Id# Up/Down ← Sequencing Play List

Rearranges the rows, i.e. moves the selected row up and down.

Sequencing Graphic

Displays the play list graph according to the current configuration.

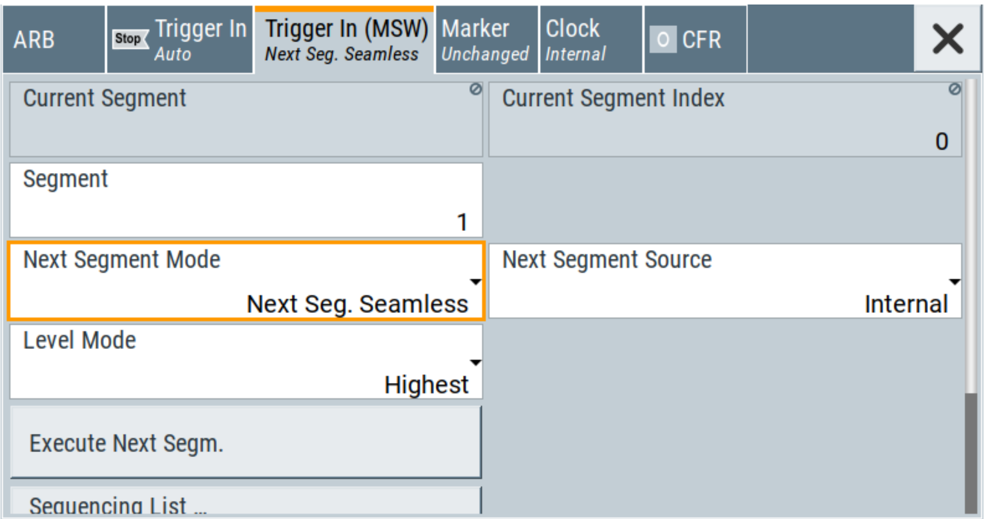
The graph shows the segment sequence, the segment number, and the number of times, the segment is repeated; considered are only the active segments.

4.8.3.5 Next Segment Trigger In Settings

The "Next Segment Trigger" settings are enabled only if a multi-segment waveform is loaded into the ARB.

Access:

1. Enable and load a multi-segment waveform in the ARB, see Chapter 4.8.3, "Multi-Segment Settings", on page 185.
2. Select "Baseband > ARB > Trigger In (MSW)".



The "Next Segment Trigger In" section comprises the settings necessary to adjust the trigger for switching between the segments of a multi-segment waveform. The parameters displayed depend on the selected trigger source.

Settings:

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 632

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME?` on page 632

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:

- An external next segment trigger event

- 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 Chapter 4.8.2.5, "Impact of the Trigger Settings and Next Segment Settings", on page 183.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT` on page 632

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 Chapter 4.8.2.5, "Impact of the Trigger Settings and Next Segment Settings", on page 183.

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 Chapter 4.8.5, "Reference to Triggering of Multi-Segment Waveforms", on page 206.

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, i.e. there is no switching to consecutive segment 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 the whole of the current segment has been 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 636

Next Segment Source
Determines whether the next segment is switched upon receiving of an external trigger signal or upon executing of software next segment trigger (see Figure 4-26).

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 Chapter 11.2, "Configuring the Global Connectors", on page 420.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce on page 633

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 633

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 633

Sequencing List
Opens a dialog box for defining the “play lists”, see Chapter 4.8.3.4, "Multi-Segment Waveform Sequencing", on page 193.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect on page 634

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.

4.8.4 How to Create and Work with Multi-Segment Waveform Files

This section provides step-by-step instructions on how to configure and use the multi-segment settings. The Figure 4-27 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 trigger signal.

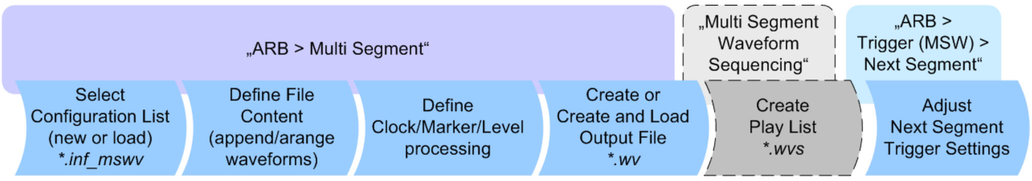


Figure 4-27: Basic workflow for generation of multi-segment waveforms

Generating a multi-segment waveform file (basic workflow)

1. In the "ARB > 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 two or more waveform files.
3. In the "ARB: Multi Segment > Level/Clock/Marker" dialog, adjust the "Level", "Clock", and "Segment Marker" settings.
4. Select the "ARB > Multi Segment > General > Output File" and enter filename.
5. Select "ARB > Multi Segment > General > Save List" to store the configuration file.
6. Select "ARB > Multi Segment > General > Create Output File" or "Create and Load Output File" to create and load the multi-segment waveform.
7. Select "ARB > Multi Segment > General > 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 4-28.

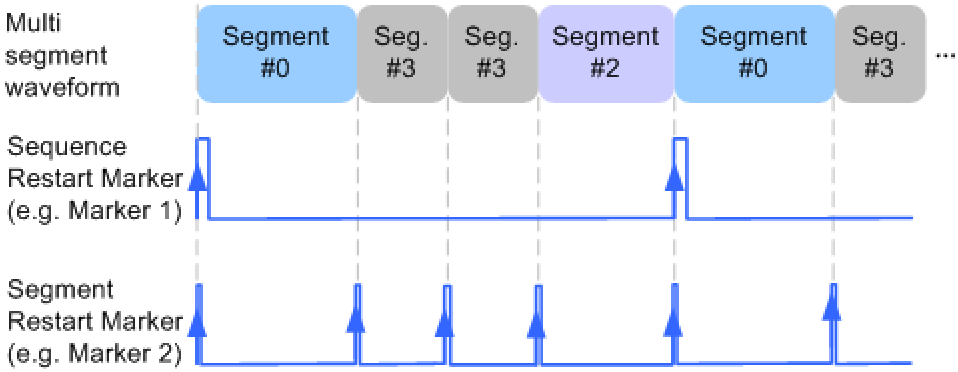


Figure 4-28: Example: multi-segment sequence with marker signals

See how to:

- "To apply a manual segment switch to the output segments in the required order" on page 202
- "To generate a multi-segment signal without signal interruptions" on page 203
- "To enable an external triggering for high-speed switch over" on page 204
- "To configure a multi-segment sequence using the play list function" on page 205
- "To add marker signals" on page 206

To apply a manual segment switch to the output segments in the required order

When testing DUTs using different test signals, it may be necessary to switch dynamically and flexibly between any of the test signals, for instance depending on 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 "Generating a multi-segment waveform file (basic workflow)" on page 201). The required output order of the segments is Seg#0, Seg#3 [2], Seg#2. The instrument is operated manually, the ARB generator is in active state, and the instrument output is switched 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, select "ARB > Trigger In > Mode = Armed Auto". Select "ARB > Trigger In > Source = Internal".

4. Execute "ARB > Trigger In > Execute Trigger" to trigger the signal generation.

The "ARB > Trigger In (MSW)" settings display the currently output segment: "Current Segment Name = Seg#0" and "Curent Segment Index = 0". Seg#0 is output continuously.

5. Set "ARB > Trigger In (MSW) > Segment = 3" to output the second segment in the sequence order.

   The parameter "ARB > Trigger In (MSW) > Current Segment Index" changes to segment index 3. Seg#3 is output continuously.

6. Execute "ARB > Trigger In > Execute Trigger" to restart Seg#3.

7. Set "ARB > Trigger In (MSW) > Segment = 2" to output the third segment in the sequence order.

   Seg#2 is output continuously.

   To switch over to Seg#0, change the "ARB > Trigger In (MSW) > Current Segment Index", etc.
   Tip: The ARB sequencer mode provides the necessary settings to achieve the same goal in a more convenient way, see "To configure a multi-segment sequence using the play list function" on page 205

Faster flexible dynamic switch over

When using **remote control** via an external computer, the following settings enable switching times of approx. 20 ms for segments with the same sample rate and approx. 200 ms for segments with different sample rates:

- "ARB > Trigger In (MSW) > Next Segment Mode = Next Segment"
- "ARB > Trigger In > Trigger Mode = Auto"
- "ARB > Trigger In > Trigger 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 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 > Trigger Mode = Auto"
3. Select "ARB > Trigger In > Trigger Source = Internal"

4. A segment ("Current Segment") is output continuously as long as the value of the parameter "Segment" is not changed. Change the value of the parameter "ARB > Trigger In (MSW) > Segment" to select the segment index processed after completing the current one.
5. The seamless transition between the segments requires waveforms with equal clock rate.
   If the waveforms feature different sample rates, select "ARB > Multi Segment > Level/Clock/Marker > Clock Mode = Highest" or "Clock Mode = User" to resample the waveforms.

To enable an external triggering for high-speed switch over

To test DUTs/chips using different test signals at high throughput requires fast switch over (for instance when testing ATE devices during manufacture).

We assume, that the required multi-segment sequence is created and loaded in the ARB (see "Generating a multi-segment waveform file (basic workflow)" on page 201). The segments are *output in incremental order*. The instrument is operated manually, the ARB generator is in active state, and the instrument output is switched 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 approx. 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 (NEXT)".
3. Do not change the displayed segment index (parameter "ARB > Trigger In (MSW) > Segment").
4. Enable "ARB > Trigger > Trigger Mode = Auto"
5. Select "ARB > Trigger > Trigger Source = External Global"
6. If the waveforms in the multi-segment file feature different sample rates, select "ARB > Multi Segment > Level/Clock/Marker > Clock Mode = Highest" or "Clock Mode = User" to resample the waveforms.

   The switch over between the segments is triggered by receiving of an external trigger event. The segments are output in incremental order, i.e. Seg#0, Seg#1, etc. The currently processed segment ("Current Segment") is output continuously as long as a new trigger event is received. 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 configure a multi-segment sequence using the play list function" on page 205.
   For general description on the configuration of the trigger and connector settings: See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

To configure a multi-segment sequence using the play list function

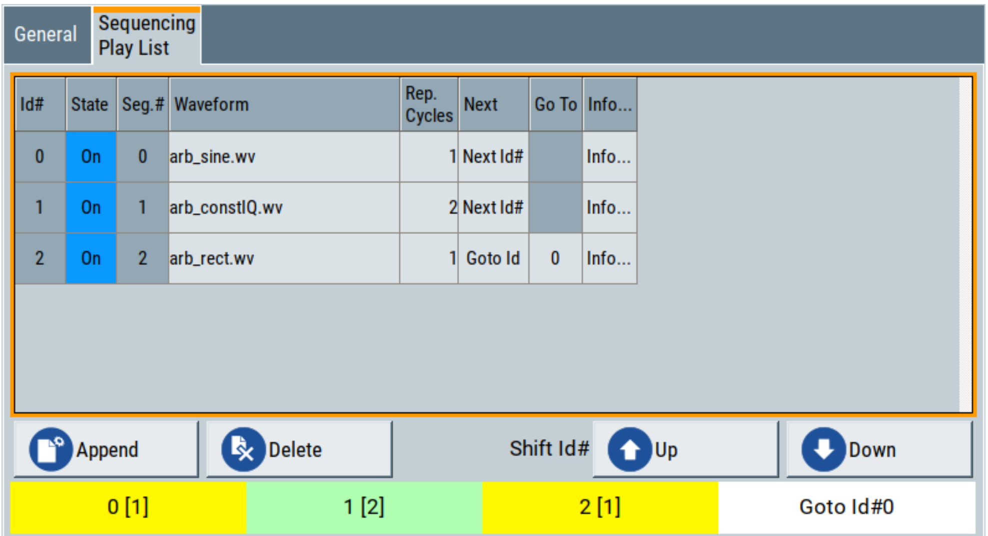
The ARB Sequencer mode requires waveform files with equal clock rate!

We assume, that a multi-segment sequence composed of four segments (Seg#0, Seg#1, Seg#2 and Seg#3) is created and loaded in the ARB (see "To apply a manual segment switch to the output segments in the required order" on page 202). The required output order of the segments is Seg#0, Seg#3 [2], Seg#2. The instrument is operated manually, the ARB generator is in active state, and the instrument output is switched 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, load the previously created list and execute "Create and Load".
2. Select "ARB > Multi Segment > General > Sequencing List".

   The "Multi Segment Waveform Sequencing" dialog opens. A new play list is created and assigned to the current multi-segment waveform file.
3. Select "ARB: Multi Segment Waveform Sequencing > Sequencing Play List" and use the "Append" function to add new rows to the list and 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" (creates a loop to the first segment in the sequence)



4. Select "ARB: Multi Segment Waveform Sequencing > General > Save List" to store the configured play list.

5. To enable the instrument to use this play list, select "ARB > Trigger (MSW) > Next Segment Mode > Sequencer".
6. Select "ARB > Trigger (MSW) > Trigger Mode = Armed Auto"
7. Select "ARB > Trigger (MSW) > Trigger Source = Internal"

   The segments are played back (output) as defined in the sequencing list, i.e. 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 configure a multi-segment sequence using the play list function" on page 205). The multi-segment sequence starts with Seg#0 and this segment is output once. The instrument is operated manually, the ARB generator is in active state, 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 4-28), two additional marker signals, "Marker 2" and "Marker 1", are enabled and inserted into the multi-segment waveform.

1. Select "ARB > Marker > 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 "Block Diagram > Trigger/Marker/Clock" and 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.

4.8.5 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 Chapter 4.8.2.5, "Impact of the Trigger Settings and Next Segment Settings", on page 183 for background information.

4.8.5.1 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.

4.8.5.2 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 outputting 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 outputting 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 over to outputting 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 description of the "Retrigger" and "Armed_Retrigger" trigger modes, see Table 4-15.

4.8.5.3 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 description of the "Retrigger" and "Armed_Retrigger" trigger modes, see Table 4-15.

4.8.5.4 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.

4.9 Generating Multi-Carrier Signals

To simulate complex multi-carrier scenarios with different baseband signals, the R&S SMCV100B provides the possibility to generate multi-carrier waveforms. These waveforms can consist of up to 512 carriers, each modulated by the same or by different user-selectable baseband signal.

The multi-carrier waveform is a practical solution for the generation of a complex broadband signal, for example:

- Multi-carrier waveforms build from signals *of different* communication standards (e.g. CDMA2000 or 3GPP FDD)

- Multi-carrier waveforms composed of several signals from *the same* communication standard as in LTE Advanced.

4.9.1 Required Options

See Chapter 4.6.1, "Required Options", on page 130.

Multi-carrier waveform files require the corresponding Digital Standard options (R&S SMCV100B-K2xx) of all included standards.

4.9.2 About the Multi-Carrier Waveforms

This chapter provides background information on the ARB functionality for generating of multicarrier signals and the impact of the provided settings. Refer to Chapter 4.9.4, "How to Use the Multi-Carrier Function", on page 224 for information on how to use the provided settings to configure a multicarrier signal.

The multi-carrier waveforms are convenient way to configure the broadband test signals required for transmitter or receiver tests. Even complex multi-carrier scenarios composed of signals from different digital standards can be created and used for these tests.

Because the multi-carrier files are processed by the ARB generator, the composed waveform file must be created before it is loaded to and played by the ARB. The R&S SMCV100B stores the created multi-carrier waveform file under 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.

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. The total RF bandwidth of the composed multicarrier signal may not exceed the available RF bandwidth (see data sheet).
- Another possibility is to define the center frequency of each of the carrier individually, see also Chapter 4.9.2.1, "Defining the Carrier Frequency", on page 211.
- Each carrier can be separately defined in terms of power, phase and modulated input signal.
  To define the leveling of the composed multicarrier signal, use the parameter Power Reference
- Optionally, crest factor optimization can be applied (see Chapter 4.9.2.2, "Optimizing the Crest Factor", on page 211).

- After all multi-carrier 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.

4.9.2.1 Defining the Carrier Frequency

There are two ways to define the carrier frequency of the individual carriers in the multicarrier signal:

- Enabling the **arbitrary carrier frequency** distribution and specifying the carrier frequency of each carrier individually.
- Using the built-in **equidistant carrier spacing** distribution function.
  That is, enabling the carriers to be 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.
  The maximum carrier spacing is a function of the available total bandwidth and the selected number of carriers. It is calculated as follows:
  Max Carrier Spacing = Total bandwidth /(Number of Carriers - 1)
  To avoid wrap-around problems, the effective applied carrier spacing can be slightly modified.

  The value of the carrier spacing is rounded in that way that the carrier closest to the center RF frequency shows no phase jump. It is assumed that the carrier is unmodulated.
  - For odd number of carriers:
    *RoundedCarrierSpacing = 1/OutputSignalDuration*round(CarrierSpacing*OutputSignalDuration)*
  - For even number of carriers:
    *RoundedCarrierSpacing = 2/OutputSignalDuration*round(0.5*CarrierSpacing*OutputSignalDuration)*

The R&S SMCV100B provides the parameter Mode for this purpose.

4.9.2.2 Optimizing the Crest Factor

An introduction to the topic is provided in Chapter 4.4.1.7, "Methods for Optimizing the Crest Factor", on page 94. This section focuses on the settings provided for and related to the multicarrier signals.

The R&S SMCV100B provides a crest factor reduction in form of an automatic optimization upon selected values for the following parameters:

- **Crest factor optimization mode**: determines whether the phase settings are selectable or internally calculated to fulfill a requirement for the crest factor value.
- **Clipping:** reduces the peak power of the resulting multicarrier signal according to the input parameter "Target Crest Factor"
  The resulting clipped peak power is the sum of the RMS level of the unclipped multicarrier signal and the parameter "Target Crest Factor".
  Because clipping reduces also the RMS level, the resulting crest factor of the clipped signal is slightly above the "Target Crest Factor".

- **Target Crest Factor:** determines the Target Crest Factor. A value above the crest factor of the unclipped multicarrier signal has no effect.
- **Filter cutoff frequency:** determines the filter parameter of the final lowpass filter. When the cutoff frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multicarrier signal. However, it can also increase the resulting crest factor.

4.9.3 Multi-Carrier Settings

Access:

► Select "Baseband > ARB > General > Create Multi Carrier".

The "ARB: Multi Carrier" dialog enables direct configuration of the carrier distribution around the center frequency and adjusting some parameters for improving the signal characteristics.
The dialog is divided into several tabs. In each case, the current setting is displayed in the tab name. The tab "Carrier Table" enables the selection of the waveform files to be processed. Use the "Carrier Graph" to visualize the configured signal.

The remote commands required to define these settings are described in Chapter 13.15.3.3, "SOURce:BB:ARBitrary Subsystem", on page 614.

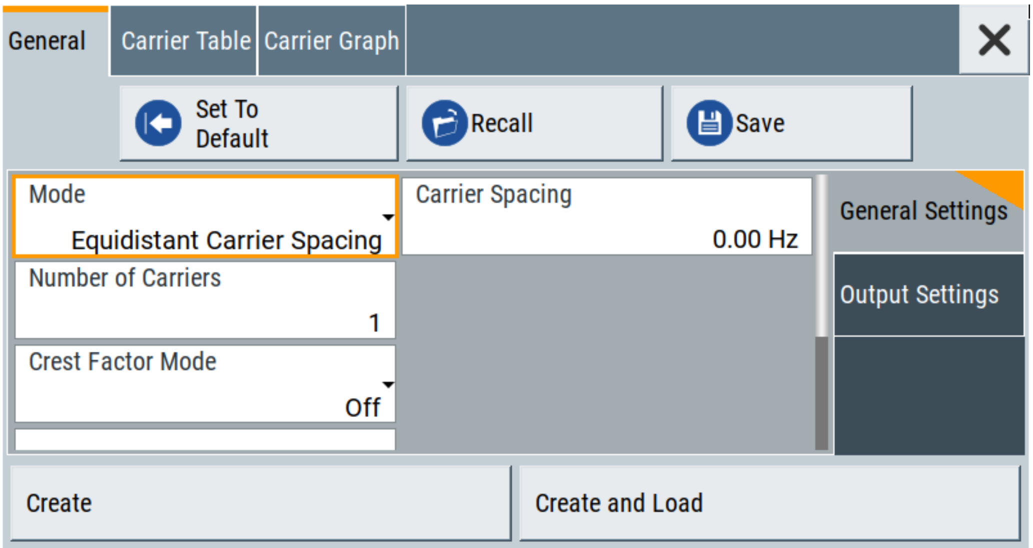
Settings:

4.9.3.1 General Settings

Access:

► Select "Baseband > ARB > General > Create Multi Carrier".

This tab comprises settings for selecting the output waveform file, enabling the generation, and the configuration of the carrier distribution.



Settings:

Set to Default

Calls the default settings.

Parameter	Value
Number of Carriers	1
Carrier Spacing	0 MHz
Crest Factor Mode	Off
Signal Period Mode	Longest file wins

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet` on page 640

Save/Recall Frame
Accesses the standard "Save/Recall" dialog, i.e. the standard instrument function for storing and recalling the complete dialog-related settings. Refer to Chapter 10.4, "Saving and Recalling Instrument Settings", on page 395 for a detailed description.

The multi-carrier settings are stored as files with the predefined file extension `*.arb_multcarr`. The filename and the directory they are stored in are user-definable.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog?` on page 640
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD` on page 640
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe` on page 641

Mode
Selects the way 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"
Enables the specification of the carrier frequency of each carrier individually.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE` on page 641

Number of Carriers
Sets the number of carriers for the multi-carrier waveform. By default the multi-carrier 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 Chapter 4.9.2.1, "Defining the Carrier Frequency", on page 211.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt` on page 641

Carrier Spacing
Sets the frequency spacing between adjacent carriers of the multi-carrier waveform.

The carriers are arranged symmetrically around the RF carrier and the maximum carrier spacing is limited to:

"Carrier Spacing" = Baseband bandwidth /("Number of Carriers" - 1).

The baseband bandwidth depends on the installed options (see the data sheet).

For more information, see Chapter 4.9.2.1, "Defining the Carrier Frequency", on page 211.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing` on page 641

Crest Factor Mode
Selects the mode for optimizing the crest factor by calculating the carrier phases. For more information, refer to Chapter 4.9.2.2, "Optimizing the Crest Factor", on page 211.

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 642

Clipping
Switches the baseband clipping on and off.

Clipping reduces the peak power of the resulting multicarrier signal according to the input parameter "Target Crest Factor". For more information, refer to Chapter 4.9.2.2, "Optimizing the Crest Factor", on page 211.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe]` on page 643

Target Crest Factor
Sets the value of the target crest factor, if baseband clipping is enabled.

A "Target Crest Factor" above the crest factor of the unclipped multicarrier signal has no effect. For more information, refer to Chapter 4.9.2.2, "Optimizing the Crest Factor", on page 211.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor` on page 643

Filter Cutoff Frequency
Sets the cutoff frequency of the final lowpass filter, if baseband clipping is enabled.

When the cutoff frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multicarrier signal. This process can increase the resulting crest factor. See also Chapter 4.9.2.2, "Optimizing the Crest Factor", on page 211.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff` on page 643

Signal Period Mode
Defines the way the resulting signal period of the multi-carrier 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.
  (In this case, the other carriers are for interfering the signal only.)

These problems do not arise with signals of the same standard (e.g. 3GPP).

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. Only the first part of longer I/Q files is used.

"User"
The signal period is set manually (Signal Period). Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

"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 644

Signal Period

Sets the signal period in Signal Duration Mode "User". Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME` on page 642

Power Reference

Defines the way the individual carriers in a composed multi carrier signal are leveled. The difference between the provided modes is especially important if signals with different crest factors are composed together into a multi carrier signal.

"RMS"
The individual carriers are leveled based on their RMS power and the configured "Carrier Gain".

Example:

A multi carrier signal is composed from two waveform files.

First carrier "Gain" = 0 dB

Second carrier "Gain" = -3 dB

In the resulting multi carrier 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 multi carrier signal is composed from two waveform files.

First carrier "Gain" = 0 dB

Second carrier "Gain" = -3 dB

In the resulting multi carrier signal, the *peak power* of the second carrier signal is 3 dB lower than the peak power of the first carrier signal.

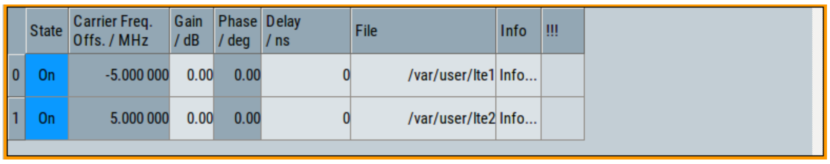
Example: Multi carrier signal composed of waveforms with different crest factor

A multi carrier signal is composed from two waveform files with the following characteristics:

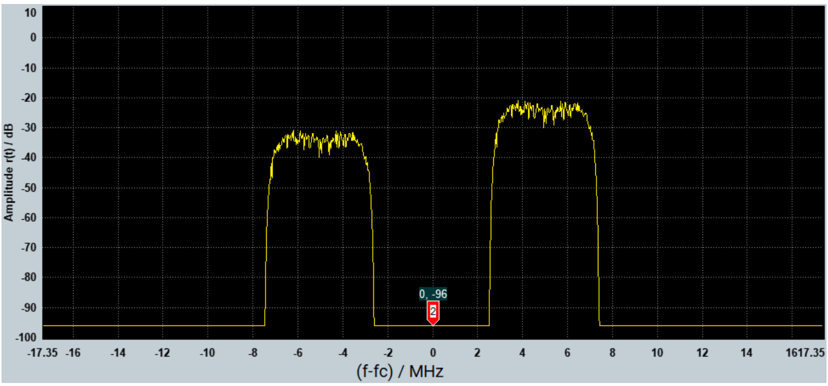
3GPP FDD signals with the same "Sample Rate" but *different "Crest Factors"*.

"Peak" = 0 dBFS

"Carrier Gain" = 0 dB



	State	Carrier Freq. Offs. / MHz	Gain / dB	Phase / deg	Delay / ns	File	Info	!!!
0	On	-5.000 000	0.00	0.00	0	/var/user/lte1	Info...	
1	On	5.000 000	0.00	0.00	0	/var/user/lte2	Info...	



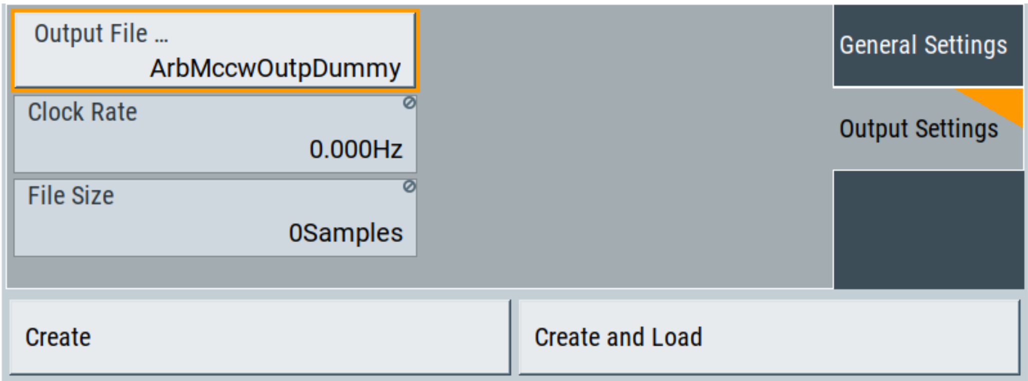
The Peak values of the carrier signals are equal, the RMS values are different.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence on page 644

Output Settings

The output settings indicate the name, the file size, and the clock rate of the currently calculated multi-carrier output file.



Output File ← Output Settings

Accesses the standard "File Select" function to specify the output filename of the multi-carrier waveform to be calculated. As with normal waveforms, the file extension is `*.wv`.

To trigger the calculation and storage of this multi-carrier waveform, select "Create" or "Create and Load".

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe` on page 644

Clock Rate ← Output Settings

Displays the resulting sample rate at which the multi-carrier waveform is output by the ARB generator.

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 645

File Size ← Output Settings

Displays the resulting number of samples of the multi-carrier waveform.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?` on page 642

Create/Create and Load

Creates a multi-carrier waveform defined by the multi-carrier table and general setting entries.

If you start calculation with the "Create and Load" function, the instrument creates the waveform and loads it in the ARB generator.

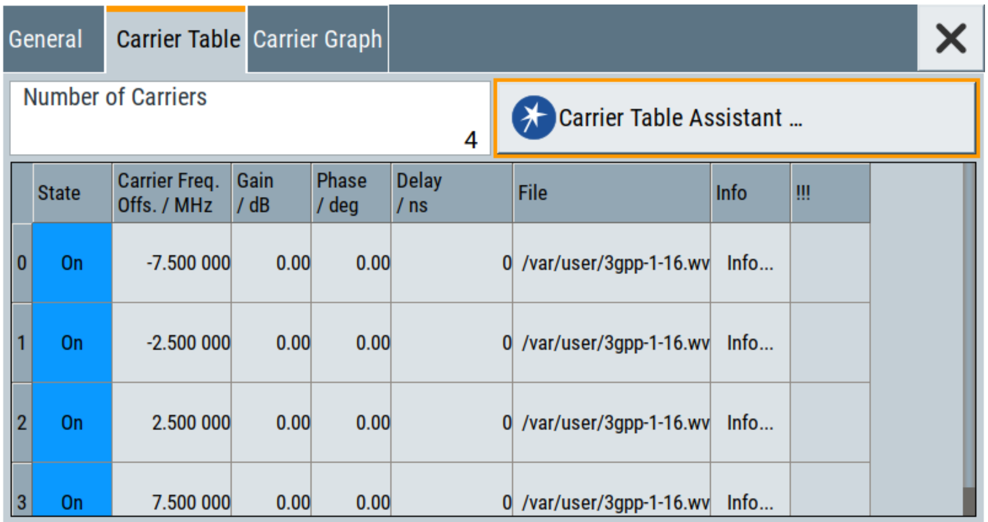
This multi-carrier waveform is stored with filename specified in "Output File". Depending on the configuration of the multi-carrier waveform, calculation can take some time. To stop the calculation, use the "Abort" function.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate` on page 645
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad` on page 644

4.9.3.2 Carrier Table Settings

Access:

1. Select "Baseband > ARB > General > Multi Carrier".
2. Select "ARB: Multi Carrier > Carrier Table"



This tab comprises the settings of the individual carriers. A selectable carrier range can be set with the aid of the optional "Carrier Table Assistant".
The settings of all available carriers are displayed in table form. Previously applied assistant settings can be further refined. The number of lines corresponds to the number of carriers.

The "Phase / deg" settings are only valid if optimization of the crest factor is disabled ("Crest Factor Mode" = Off).

Use the "Carrier Graph" tab to visualize the selected multi-carrier configuration.

Settings:

Number of Carriers
Defines the number of carriers of the multi-carrier waveform.

This parameter is identical to the one in the "General Setting" section.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt on page 641

No
Indicates the carrier index ranging from 0 to (number of carriers -1).

Remote command:
Individual carriers are set by the index at the keyword CARR

State
Switches On/Off a carrier.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe on page 645

Carrier Freq [MHz]
Sets the carrier frequency.

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 646

Gain
Sets the gain of a carrier.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer on page 646

Phase
Sets the starting phase of a carrier.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe on page 646

Delay
Sets the starting delay of a carrier.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay on page 647

File
Accesses 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 647

Info

Indicates the sample rate, number of I/Q value pairs (number of samples), and the signal period of the selected file.

Remote command:

n.a.

!!!

Indicates an occurred conflict by means of a warning triangle. A conflict arises when the carriers overlap and is also indicated in the header of the "Carrier Table" tab.

Remote command:

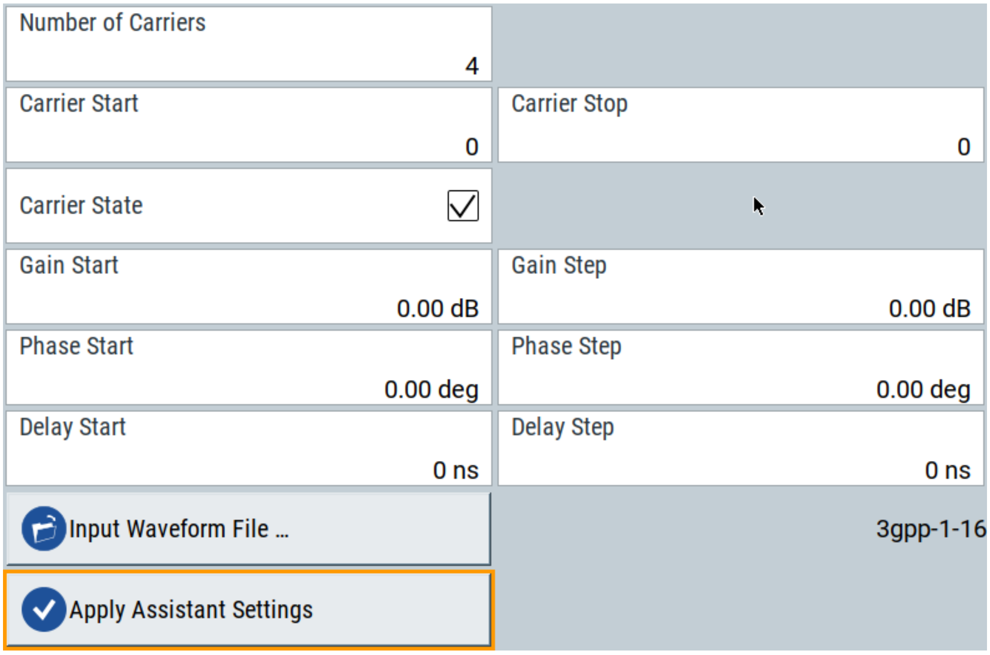
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?`

on page 647

4.9.3.3 Carrier Table Assistant

Access:

1. Select "Baseband > ARB > General > Multi Carrier".
2. Select "ARB: Multi Carrier > Carrier Table > 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 multi-carrier scenario within a specified carrier range.

Settings:

Carrier State

Switches the carriers in the range "Carrier Start" to "Carrier Stop" on/off.

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe` on page 647

Carrier Start/Start

Defines the start/stop index of the carrier range to which the assistant settings are intended to apply.

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt` on page 648
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP` on page 648

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 648

Gain Step

Sets the step width that is used to increment the gain.

The resulting carrier gain in the carrier table equals:

Gain = "Gain Start" + n"Gain Step".*

Where *n* is a value between 0 and ("Carrier Stop" - "Carrier Start").

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP`
on page 648

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 649

Phase Step

Sets the step width that is used to increment the phase.

The resulting phase in the carrier table equals:

Phase = "Phase Start" + n"Phase Step"*

Where *n* is a value between 0 and ("Carrier Stop" - "Carrier Start").

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP` on page 648

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 650

Delay Step

Sets the step width that is used to increment the delay

The resulting delay in the carrier table equals:

Delay = "Delay Start" + n"Delay Step"*,

Where *n* is a value between 0 and ("Carrier Stop" - "Carrier Start").

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP` on page 649

Input Waveform File

Accesses the standard "File Select" function for selecting the input file. The input file contains the I/Q signal to be modulated onto*all carriers* of the selected carrier range.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE` on page 650

Apply Assistant Settings

Transfers the assistant settings to the carrier table.

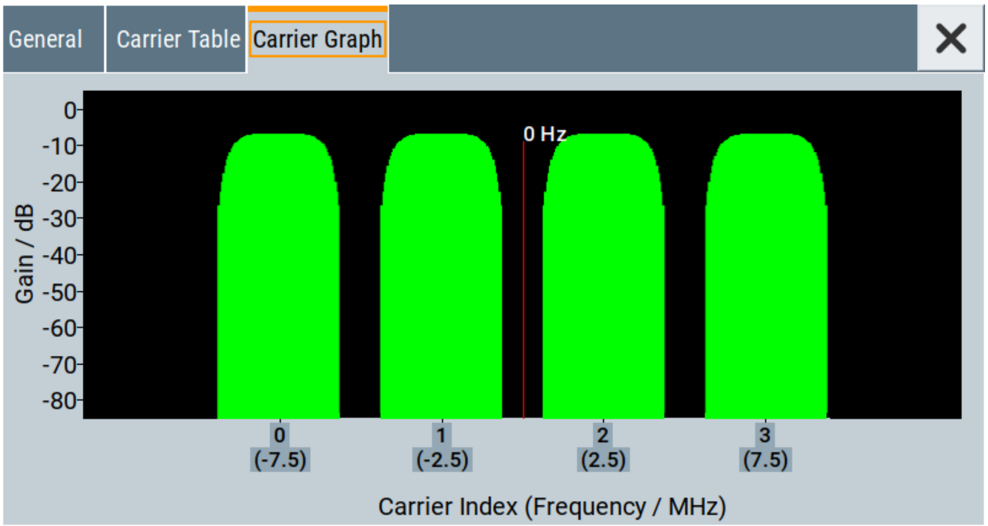
Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute` on page 650

4.9.3.4 Carrier Graph

Access:

1. Select "Baseband > ARB > General > Multi Carrier".

2. Select "ARB: Multi Carrier > Carrier Graph"



The carrier graph is a graphical representation of the current multi-carrier 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.

4.9.4 How to Use the Multi-Carrier Function

This section provides step-by-step instructions on how to configure and use the multi-carrier settings.

To create a multi-carrier waveform file (general workflow)

Perform the following general steps:

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 multi-carrier waveform, select "ARB > Multi Carrier > Output File"
4. To save and load multi-carrier waveform, select "ARB > Multi Carrier > Create or Create and Load")

To generate a multi-carrier signal for standard transmitter test

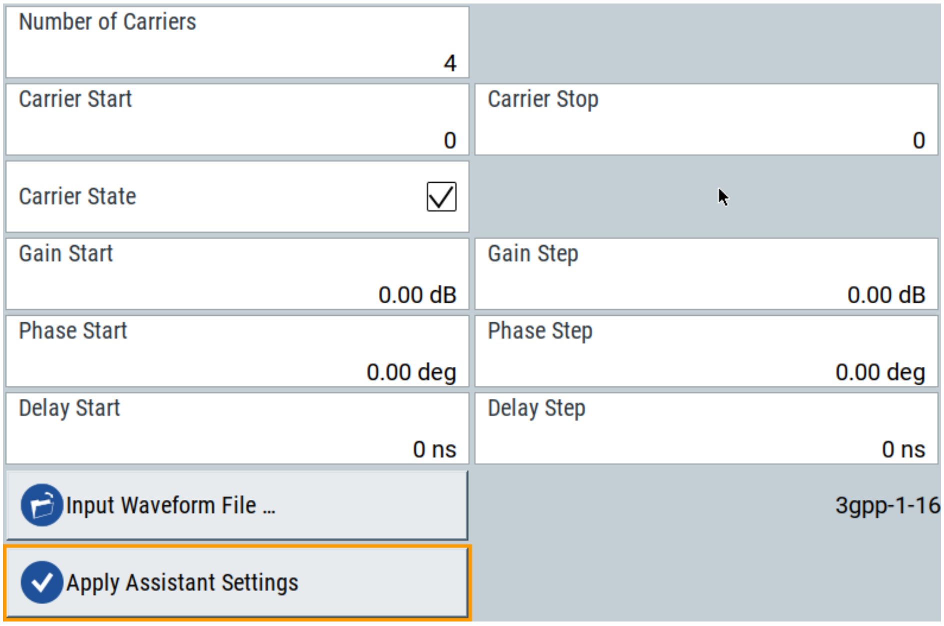
High power amplifiers of multi-carrier base stations face increased requirements in terms of linearity and acceptable intermodulation performance.

To set up a standard transmitter test, proceed as follows:

1. Open the "Baseband > 3GPP FDD" dialog. Perform the following:
   a) select "3GPP FDD > Basestations > Test Setups/Models"
   b) select "3GPP FDD: Downlink/Test Model > Test_Model_1_16channels".

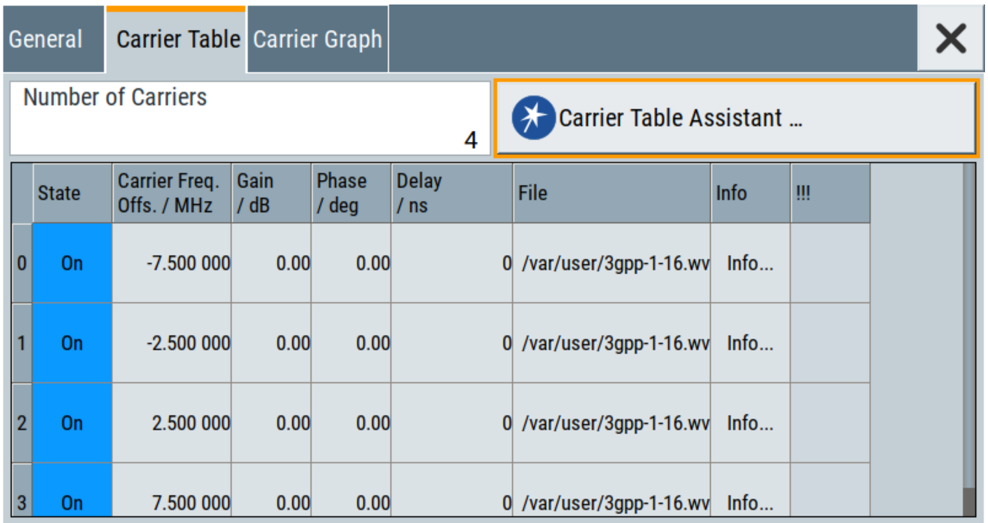
c) Confirm with "Select".

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 file to be generated, for example `3gpp_1_16`.
4. Confirm with "Save"
5. To set up a multi-carrier scenario with 4 carriers and a carrier spacing of 5 MHz, select "Baseband > ARB > 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". Select "Carrier Start = 0" and "Carrier Stop = 3".
   c) To load the generated waveform file to all 4 carriers, select "ARB Multi Carrier Table > Input Waveform File". Navigate to the generated waveform file `3gpp_1_16` and select it.
   d) Select "ARB Multi Carrier Table > Carrier State > On".

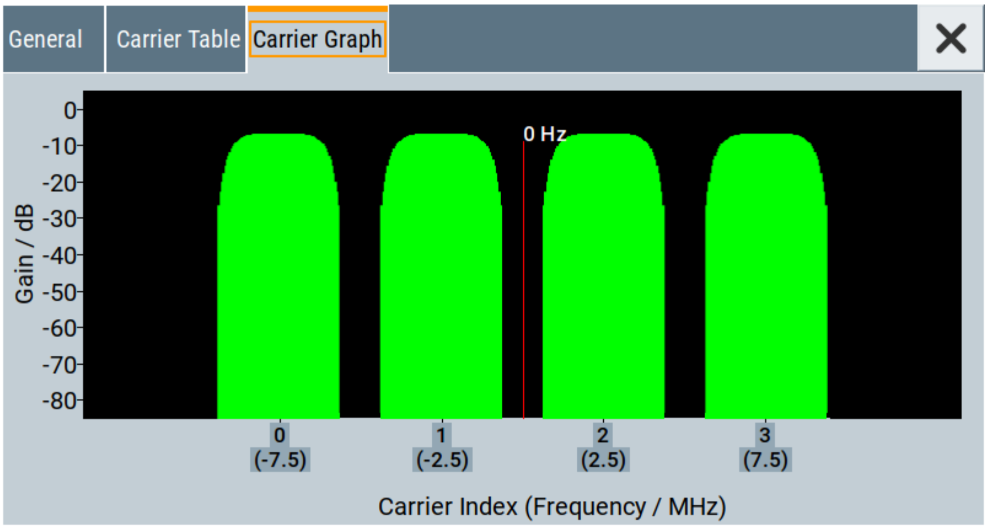


   e) Select "ARB Multi Carrier Table > Apply Assistant Settings". Close the dialog.

   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" and enter the name of the output file, for example `4x5MHz_3gpp_1_16`.
8. To trigger signal calculation and to load the waveform in the ARB generator, select "ARB: Multi Carrier > General > Create/Create and Load" function.
9. Select "ARB > General > Load Waveform".
   Confirm that the generated multi-carrier waveform is used.
10. Select "ARB > State > On" to enable the ARB generator.

4.10 Generating FM/PhiM/AM/Pulse Modulation Signals

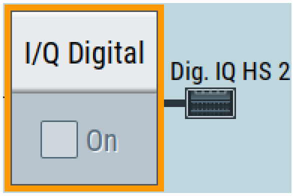
Required options

Additional to the minimum configuration, generating FM/Phi(Φ)M/AM/Pulse modulation signals at the R&S SMCV100B requires additional options:

- Option Basic AM/FM/PhiM (R&S SMCVB-K197)
- Option Pulse Modulation (R&S SMCVB-K198)

Signal routing to the instrument output

You can output "FM/ΦM/AM/Pulse Modulation" signals at the RF output connector. Routing to these signals to the digital I/Q output interface is not possible, the "I/Q Digital" block is not configurable.



Settings

4.10.1 FM/PhiM/AM Configuration and Settings

Option: R&S SMCVB-K197

Access:

► Select "Baseband > FM/ΦM/AM".

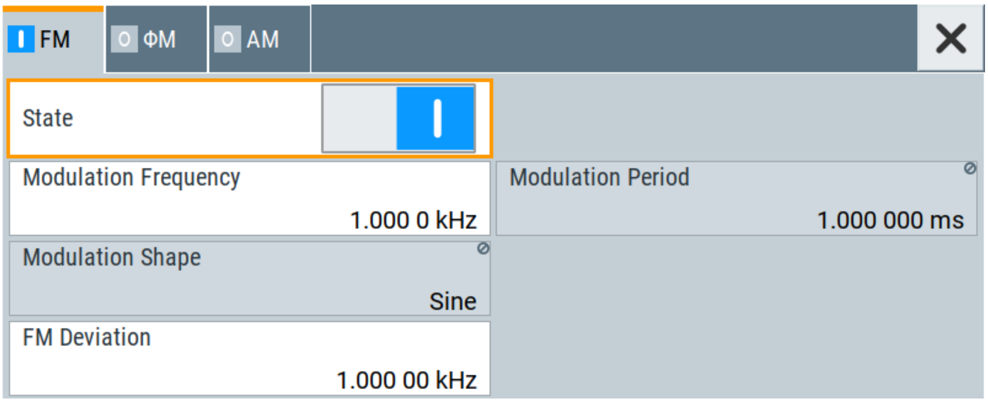
The dialog provides settings to generate digital baseband signals for frequency modulation (FM), phase modulation (PhiM/ΦM) and amplitude modulation (AM). You can generate FM and AM signals and ΦM and AM signals in parallel. FM and ΦM cannot be generated at the same time. Activating the FM state deactivates the ΦM state and vice versa.

Settings:

4.10.1.1 FM Settings

Access:

1. Select "Baseband > FM/ΦM/AM > FM".
2. If enabled, the baseband block displays "FM > On".



The tab provides settings necessary to configure basic frequency modulation.

The remote commands required to define these settings are described in "FM Commands" on page 658.

Settings:

State

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Remote command:

`[:SOURce<hw>]:BB:GENeral:FM[:STATe]` on page 659

Modulation Frequency

Sets the frequency of modulation signal.

Remote command:

`[:SOURce<hw>]:BB:GENeral:FM:FREQuency` on page 658

Modulation Period

Displays the period of the modulation signal.

Remote command:

`[:SOURce<hw>]:BB:GENeral:FM:PERiod` on page 658

Modulation Shape

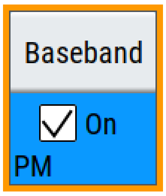
Displays the shape of the modulation signal.

Remote command:
[:SOURce<hw>]:BB:GENeral:FM:SHAPe on page 659

FM Deviation
Sets the frequency modulation deviation in kHz.

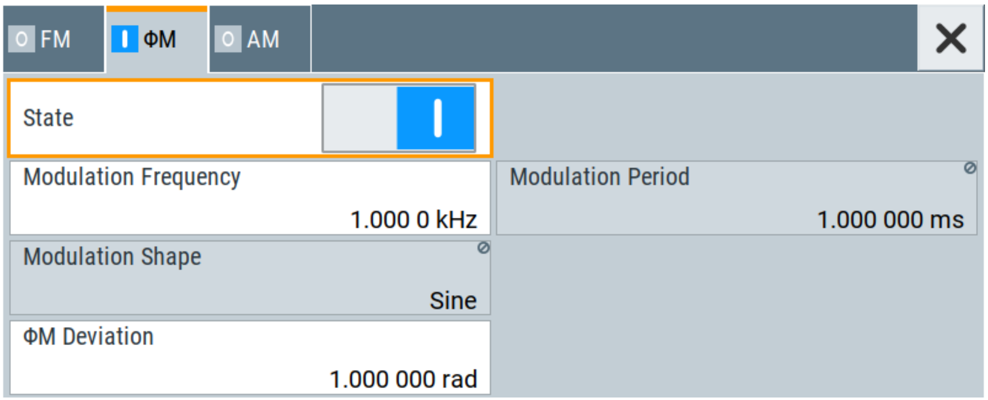
Remote command:
[:SOURce<hw>]:BB:GENeral:FM:DEViation on page 658

4.10.1.2 PhiM Settings



Access:

1. Select "Baseband > FM/ΦM/AM > ΦM".
2. If enabled, the baseband block displays "ΦM > On".



The tab provides settings necessary to configure basic phase modulation.

The remote commands required to define these settings are described in "PhiM Commands" on page 661.

Settings:

State
Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Remote command:
[:SOURce<hw>]:BB:GENeral:PM[:STATe] on page 662

Modulation Frequency
Sets the frequency of modulation signal.

Remote command:
[:SOURce<hw>]:BB:GENeral:PM:FREQuency on page 661

Modulation Period

Displays the period of the modulation signal.

Remote command:
[:SOURce<hw>]:BB:GENeral:PM:PERiod on page 661

Modulation Shape

Displays the shape of the modulation signal.

Remote command:
[:SOURce<hw>]:BB:GENeral:PM:SHAPe on page 662

PhiM Deviation

Sets the deviation of the phase modulation ΦM in radians or degrees.

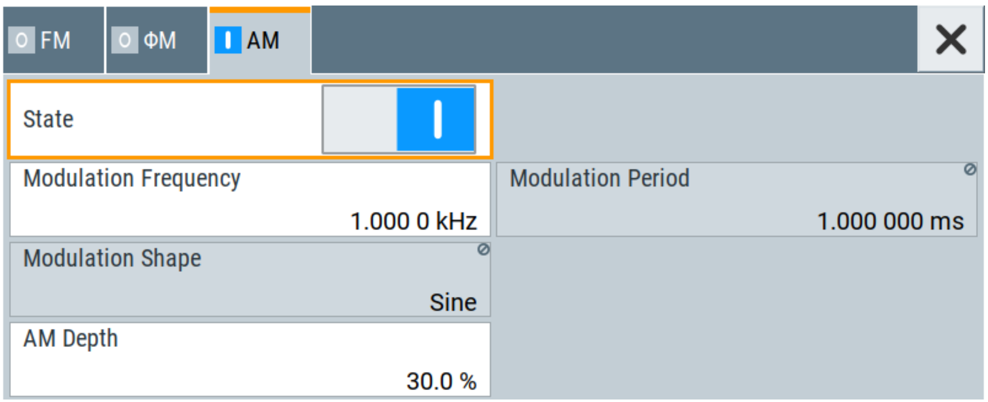
The maximal deviation depends on the RF frequency and the selected modulation mode. The value is clipped automatically, if the set is too high for the particular frequency.

Remote command:
[:SOURce<hw>]:BB:GENeral:PM:DEViation on page 661

4.10.1.3 AM Settings

Access:

1. Select "Baseband > FM/ΦM/AM > AM".
2. If enabled, the baseband block displays "AM > On".



The tab provides settings necessary to configure basic amplitude modulation.

The remote commands required to define these settings are described in "AM Commands" on page 659.

Settings:

State

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Remote command:

[:SOURce<hw>]:BB:GENeral:AM[:STATe] on page 661

Modulation Frequency

Sets the frequency of modulation signal.

Remote command:

[:SOURce<hw>]:BB:GENeral:AM:FREQuency on page 660

Modulation Period

Displays the period of the modulation signal.

Remote command:

[:SOURce<hw>]:BB:GENeral:AM:PERiod on page 660

Modulation Shape

Displays the shape of the modulation signal.

Remote command:

[:SOURce<hw>]:BB:GENeral:AM:SHAPe on page 660

AM Depth

Sets the depth of the modulation signal in percent.

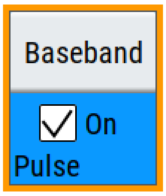
The depth is limited by the maximum peak envelope power (PEP).

Remote command:

[:SOURce<hw>]:BB:GENeral:AM:DEPTh on page 659

4.10.2 Pulse Modulation Configuration and Settings

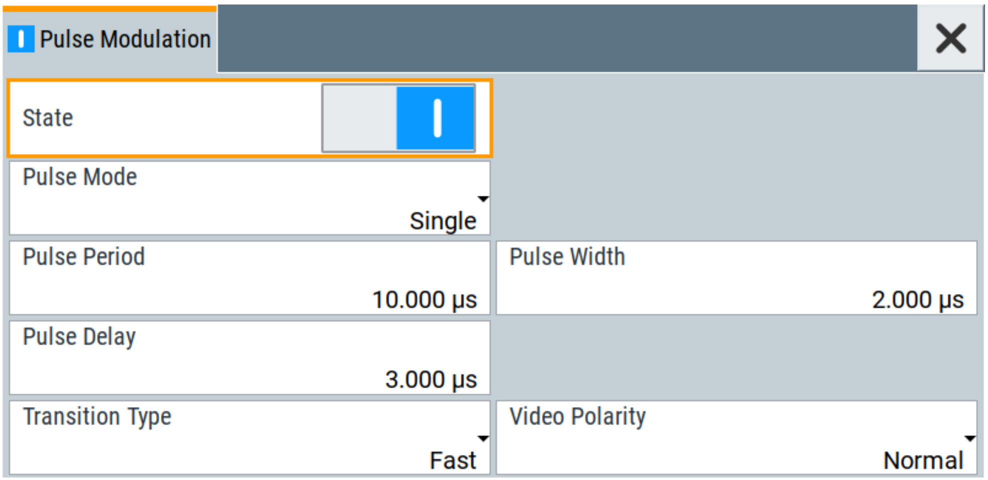
Option: R&S SMCVB-K198



Access:

1. Select "Baseband > Pulse Modulation".

2. If enabled, the baseband block displays "Pulse > On".



The tab provides settings necessary to configure pulse modulation.

The remote commands required to define these settings are described in "PULM Commands" on page 662.

Settings:

State

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM[:STATe]` on page 665

Pulse Mode

Sets the pulse mode.

"Double" The signal consists of a double pulse.

"Single" The signal consists of a single pulse.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:MODE` on page 663

Pulse Period

Sets the pulse period in microseconds.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:PERiod` on page 664

Pulse Width

Sets the pulse width in microseconds.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:WIDTh` on page 664

Pulse Delay

Requires "Pulse Mode > Single".

Sets the pulse delay in microseconds.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:DELay` on page 662

Double Pulse Delay

Requires "Pulse Mode > Double".

Sets the double pulse delay in microseconds.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:DELay` on page 663

Double Pulse Width

Requires "Pulse Mode > Double".

Sets the double pulse width in microseconds.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:WIDTh` on page 663

Transition Type

Sets the transition type of the pulse modulation signal, that is the slew rate (slope).

"Smooth" 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.

"Fast" Enables fast transitions with short rise and fall times.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:TRANsition:TYPE` on page 664

Video Polarity

Defines the video polarity.

"Normal" The pulse has normal video polarity.

"Inverse" The pulse has inverted video polarity.

Remote command:
`[:SOURce<hw>]:BB:GENeral:PULM:VIDeo:POLarity` on page 664

4.11 Shifting and Boosting the Baseband Signal

The R&S SMCV100B provides settings to frequency offset the internally generated and externally supplied baseband signal.

4.11.1 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.

4.11.1.1 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 Chapter 4.11.3, "How to Improve Signal Characteristics by Shifting the Baseband Signal", on page 237.

Limitations

The complex I/Q bandwidth of the shifted useful signal must not exceed the total available baseband bandwidth (see data sheet). 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

f_{use} is the complex useful bandwidth of the I/Q signal before the offset

f_{offset} is the frequency offset

The Figure 4-29 illustrates the setting range of the frequency offset.

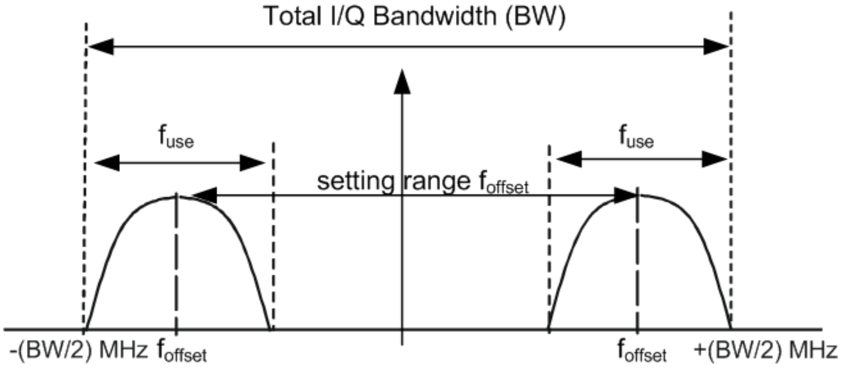


Figure 4-29: Setting range of frequency offset

Example: To calculate the maximum frequency offset

This example uses the following signal:

- Standard: "Baseband > Custom Digital Modulation"
- "Set according to Stanard > WCDMA-3GPP"
- "Symbol Rate = 3.84 Msym/s" (3.84 MHz)
- "Filter > Root Cosine"
- "Roll Off Factor = 0.22"

The complex useful bandwidth of filtered signal is calculated as follows (see "Impact of the Filter Parameters" on page 92):

- 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 ("System Configuration > Graphics > Power Spectrum") and observe the power spectrum of the signal with and without frequency offset:

- See Chapter 3.3.5, "Verifying the Generated Signal with the Graphics Display", on page 49.
- See "To set and verify a baseband frequency offset" on page 382.

4.11.1.2 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.

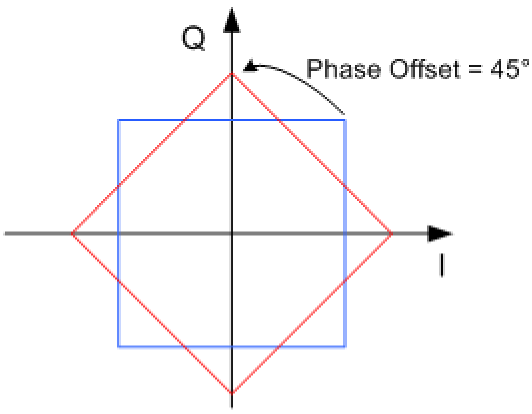


Figure 4-30: I/Q constellation diagram: Effect after offsetting the phase by an angle of 45 °

To observe the effect of offsetting the phase

Use the built-in real-time graphical display ("System Configuration > Graphics > Constellation") and observe that the points on the I/Q constellation diagram are turning counterclockwise.

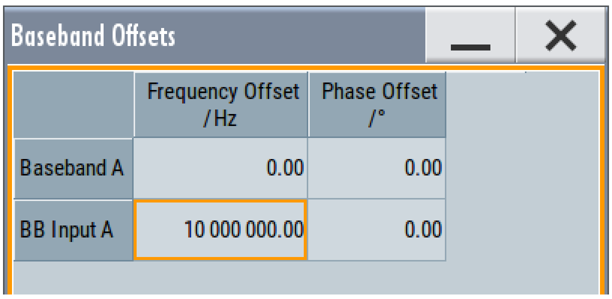
See Chapter 9.1, "Displaying Baseband Signal Characteristics in Real-Time", on page 368.

4.11.2 Baseband Offsets Settings

Access:

► Select "Baseband > Baseband Offsets" or "BB Input > Baseband Offsets".

The "Baseband Offsets" dialog provides the settings necessary to add frequency and/or phase offset.



The block diagram shows an icon Δf on the signal path to indicate an applied frequency offset.

Settings:

Frequency Offset

Enters the frequency offset for the internal or external baseband signal and shifts the useful baseband signal in the center frequency.

Use function, for example, to shift the baseband signal relative to the AWGN signal.

See:

- Chapter 4.11.1.1, "Impact of the Frequency Offset", on page 234 for detailed information on the calculation of the frequency offset value range
- Chapter 4.11.3, "How to Improve Signal Characteristics by Shifting the Baseband Signal", on page 237

Remote command:

`[:SOURce<hw>]:BB:FOFFset` on page 588

`[:SOURce<hw>]:BBIN:FOFFset` on page 588

Phase Offset

Enters the phase offset for the baseband signal (see Chapter 4.11.1.2, "Impact of the Phase Offset", on page 235).

The phase offset affects the signal on the "Baseband block" output.

Use this parameter, for example, to change the start phase of the baseband signal.

Remote command:

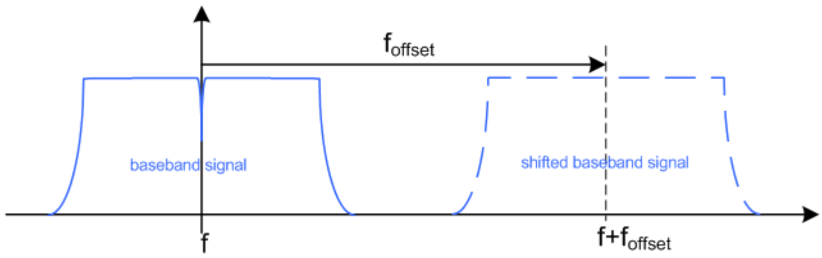
`[:SOURce<hw>]:BB:POFFset` on page 588

`[:SOURce<hw>]:BBIN:POFFset` on page 588

4.11.3 How to Improve 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.

In the following examples, we assume that:

- The R&S SMCV100B generates a baseband signal
- A spectrum analyzer is connected to the R&S SMCV100B, the analyzed is configured and measures the required signal characteristics.

To shift the generated baseband signal

► Select "Baseband > Baseband Offsets > Frequency Offset" and apply an offset to the generated baseband signal.

To verify characteristics of the generated signal

► Use the built-in real-time graphical display.
See Chapter 3.3.5, "Verifying the Generated Signal with the Graphics Display", on page 49.

To observe the effect of applied frequency offset and gain

► Use the built-in real-time graphical display.
See Chapter 3.3.5, "Verifying the Generated Signal with the Graphics Display", on page 49.

5 Configuring External Baseband Signals

R&S SMCV100B 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 would need time-aligned simultaneous signals between multiple instruments.
- etc.

R&S SMCV100B provides several settings that help fulfilling these requirements. This section explains main principles and gives an overview of the related settings and step-by-step instructions.

5.1 Overview of the Input and Output Signals and Interfaces

Designed as a signal generator with various application fields, the R&S SMCV100B 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 introduction to the topics. For an overview of the interfaces and their characteristics, refer to:

- Chapter 5.1.1, "Overview of the Baseband Signal Sources", on page 240
- Chapter 5.1.2, "Overview of the RF Output Signals", on page 240
- Chapter 5.1.4, "Important Signal Parameters and Interface's Characteristics", on page 241

5.1.1 Overview of the Baseband Signal Sources

The Table 5-1 gives an overview of the *possible* input signals and the connectors 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 5-1: Physical input signals

Input Signal	Input connector	GUI element	Refer to
Internal digital baseband signal	-	"Baseband"	Chapter 4, "Configuring Internal Baseband Signals", on page 71
External digital signal	"Dig. IQ HS 1"	"BB Input"	Chapter 5.3, "Digital Baseband Input Settings", on page 256

Input interface for the external digital baseband signal

The digital interface "Dig. IQ HS 1" can be used as input for digital signals. The interface provides direct communication with other Rohde & Schwarz instruments, like:

- Signal generators
- R&S FSW signal and spectrum analyzer

Application examples of the externally supplied 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 signals **instead of** the internally generated signal

5.1.2 Overview of the RF Output Signals

Usually, the generated baseband signal is modulated on the RF frequency and output at the RF connector. As shown in Table 5-2, the R&S SMCV100B 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); an RF envelope signal can be generated, too.

The Table 5-2 shows the possible output connectors with the corresponding kind of signal.

Table 5-2: Physical output signals

Type	Output Signal	Output connector	GUI element	Refer to
RF	RF signal	RF	"RF"	Chapter 8, "Configuring the RF Signal", on page 290
BB	Digital signal	"Dig. IQ HS 2"	"I/Q Digital" "Dig. IQ HS 2"	Chapter 5.4, "I/Q Digital Output Settings", on page 261

5.1.3 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")

5.1.4 Important Signal Parameters and Interface's Characteristics

The correct signal processing of the externally supplied input signals in the instrument and the correct processing of the output signal in the subsequently connected instrument require information of some signal parameters, like 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.

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 5-1).

The R&S SMCV100B 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 externally fed analog signal is important for the calculation of the RF output power.

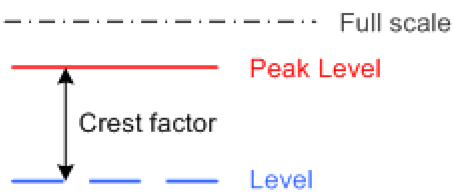


Figure 5-1: Relation between the level settings

Test setups often involve an up-converter connected to the analog or digital I/Q connectors of the generator or feeding of external signal to the digital input of the R&S SMCV100B. As a rule, whenever an I/Q signal is transferred between two instrument, *the crest factor and the peak levels of the two involved instruments have to be coordinated*. Proper signal settings and correct results are ensured if the peak level and crest factor values at the I/Q outputs of the "source" instrument (e.g. the R&S SMCV100B) and the I/Q inputs of the up-converter are equal.

In the R&S SMCV100B, level values are represented as relative to a full scale (see Figure 5-1).

Where to find the necessary values?

- Dialog "BB Input"
  Chapter 5.3, "Digital Baseband Input Settings", on page 256
- Dialog "Digital I/Q Out"
  Chapter 5.4, "I/Q Digital Output Settings", on page 261

Why the instrument monitors the signal internally and how to avoid overflow

The R&S SMCV100B 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 dB full scale) 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.

5.1.4.1 Specific Characteristics of the Digital I/Q Interface

What is a "digital channel" and how are the channels distributed to the basebands

The external digital signals supplied at the "Dig. IQ HS x" interfaces of the instrument may contain more than one, possibly even multiplexed, digital channels. The R&S SMCV100B processes each of these digital channels as a separate signal.

Fulfilling the prerequisites for a correct signal processing of the externally supplied digital baseband signal

The Chapter 5.1.4, "Important Signal Parameters and Interface's Characteristics", on page 241 emphasis why and which signal parameters are important for the correct internal signal processing of externally supplied signals in the R&S SMCV100B. This section focuses on the way 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, it is best to enter them directly
  - Estimated automatically by the internal measurement function
    Use the function Auto Level Set to trigger the R&S SMCV100B 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) perform 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 SMCV100B 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 SMCV100B to receive these values, enable the parameter "DIG IQ Auto Setting" on page 261.

In the second automatic way, the R&S SMCV100B 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 5-2.

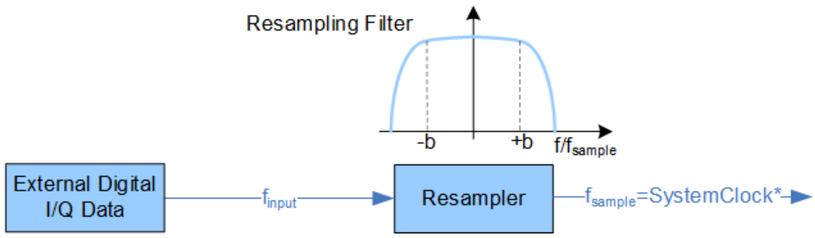


Figure 5-2: Resampling principle of external digital baseband signals

* = Max. sample rate depends on connected device
f_{input} = Max. sample rate

The R&S SMCV100B can process digital signals with sample rate f_{input} = 400 Hz to 100 MHz, where the maximum value ($f_{sample, max}$) depends on the capabilities of the connected transmitting/receiving device.

- **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 5-2. The resulting modulation bandwidth is calculated as *Sample Rate * 0.8*.
With a sample rate $f_{sample, max}$ of exactly 600 MSamples/s, the modulation bandwidth is 240 MHz.

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.

5.2 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:

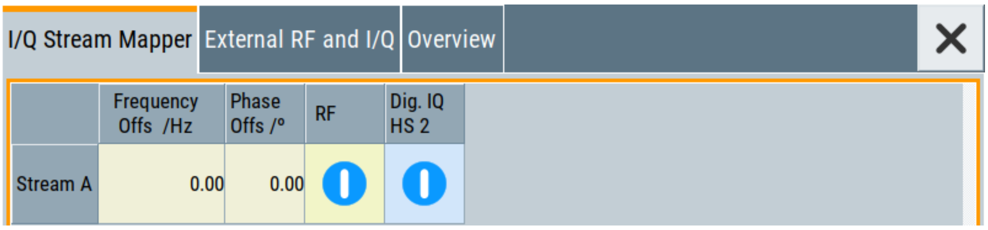
- Base unit
- Option wideband digital baseband outputs R&S SMCVB-K19
- Optional, option frequency R&S SMCVB-B103

This section described the following settings:

5.2.1 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

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.

Phase Offset

Sets the phase offset of the corresponding stream.

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:STReam<st>:STATe` on page 566

`:SCONfiguration:OUTPut:MAPPing:HSDigital:CHANnel<di>:STReam<st>:STATe` on page 566

5.2.2 External RF and I/Q Settings

With the settings in the "External RF and I/Q" tab, you can control external devices and instruments from the R&S SMCV100B, if all prerequisites are fulfilled. See "Prerequisites for control of external instruments from the R&S SMCV100B" on page 245.

Prerequisites for control of external instruments from the R&S SMCV100B

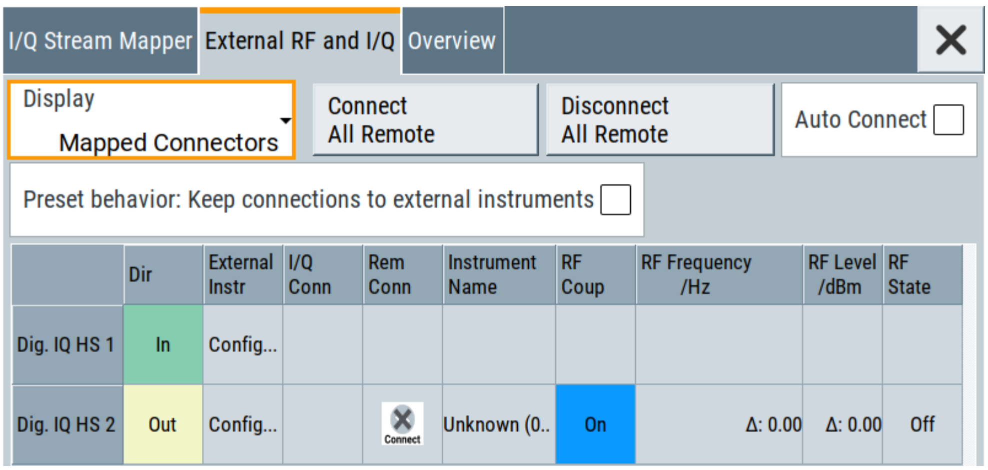
The following connections between the R&S SMCV100B and the external instruments are required:

- **Physical remote control connection** over LAN
  The remote control connection to the external instruments must be in status **connected**, see Remote Connection Status.
- **Physical signal connection** for the digital 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 SMCV100B.

Access:

► Select "Taskbar > 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 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:

5.2.2.1 Connections Configuration and Connection Status Overview Settings

Access:

▶ Select "Taskbar > System Config > System Configuration > External RF and I/Q".

Settings:

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 connector direction.

Remote command:
`:SCONfiguration:EXTernal:DISPlay` on page 567

Auto Connect

With enabled auto connect function, the instrument automatically detects connected external instruments and establishes the required connection.

If the "Auto Connect > Off", however, after a R&S SMCV100B startup you have to revise the test setup and perform the following:

- Check whether the necessary connections between the R&S SMCV100B and the external instruments are still existing.
- Prove that the remote control of the particular instruments is required.
- Trigger the Connect All Remote function.

Remote command:

`:SCONfiguration:EXTernal:ACONnect` on page 567

Connect/Disconnect All Remote

Triggers the instrument to:

- Establish the remote connections to all configured External Instruments.
- To terminate all existing remote connections.
  The external instruments are not removed from the list of external instruments. Only the remote connection status changes.

Remote connection status can be toggled with the parameter Remote Connection Status.

Note:

External instruments connected to the R&S SMCV100B 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 SMCV100B is preset ([Preset]).

To ensure that the remote connections to the external instruments will be automatically established after instrument's start-up or a reboot, set Auto Connect > "On".

Remote command:

`:SCONfiguration:EXTernal:REMote:CONNect[:ALL]` on page 568

`:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]` on page 568

Preset behavior: Keep connections to external instruments

Sets the effect of R&S SMCV100B preset ([Preset] or `*RST`) on the following:

- The connection status between the instrument and the connected external instruments.
- The R&S SMCV100B itself and the preset values.
- The connected instruments.

"Preset behavior..."	Off	On
R&S SMCV100B and preset values	Standard R&S SMCV100B preset See Table 10-1.	
Connection status	Terminated ("Disconnect All Remote")	Unchanged
Connected instruments	External instrument preset (`:DEVice:PRESet`)	External instrument preset

Remote command:
:SCONfiguration:EXTernal:PBEHaviour on page 568

Connector Name
Displays the connector name.

Remote command:
via keyword in the SCPI syntax, e.g. HSDigital<ch>

Direction
Displays the connector direction as a color coded field.

Connector	Direction/Color	Enabled in the "I/Q Stream Mapping"
"Dig. IQ HS 1"	In	-
"Dig. IQ HS 2"	Out	Yes

Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:DIRection? on page 569

External Instrument
Accesses a dialog with settings that help you to establish the connection to the external instruments.

Note:
Each external instrument must be connected via LAN the R&S SMCV100B.

In most test setups, all instruments must use a common reference frequency signal, either from an external common reference source or using the distributed reference frequency of the R&S SMCV100B.

I/Q Connection
Depends on the interface type.

- Digital I/Q interfaces:
  Indicates the status of the I/Q connection of the digital interfaces.
  The indication includes a status LED and an icon for the used connector ("Dig. IQ HS 1" and "Dig. IQ HS 2") used.

Indication	Designation
green LED and an icon	The "Dig. IQ HS 1" interface is used as an **input** connector.
yellow LED and an icon	The "Dig. IQ HS 2" interface is used as an **output** connector.
No icon displayed	No connection

Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:IQConnection:STATe?
on page 569

Remote Connection Status

Indicates the status of the remote connection. Click the status indicator to toggle the remote connection status.

To connect/disconnect all external instruments, use the functions Connect/Disconnect All Remote.

Note:

External instruments connected to the R&S SMCV100B 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 SMCV100B 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:HSDigital:REMote:DISConnect` on page 575
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?` on page 574

Instrument Name

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:HSDigital:INAMe?` on page 570
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?` on page 574

RF Couple

If enabled, this parameter couples all major RF setting (like the "RF Frequency", the "RF Level" and the "RF State") of the external instrument to the R&S SMCV100B.

The R&S SMCV100B acts as a "master", i.e the external instruments synchronize their settings and the RF output state to the R&S SMCV100B. You can apply delta frequency and level offset to the signal.

Remote command:
`:SCONfiguration:EXTernal:HSDigital:RF:COUPling` on page 570

(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:

$RF_{ExtInstr} = RF_{Instrument} + Delta_{Freq}$

Where both the RF frequency and the frequency offset are applied at the external instrument.

Remote command:
`:SCONfiguration:EXTernal:HSDigital<ch>:RF:FREQuency` on page 570
`:SCONfiguration:EXTernal:HSDigital:RF:FREQuency:OFFSet` on page 571

:SCONfiguration:EXTernal:HSDigital:RF:POWer on page 571
:SCONfiguration:EXTernal:HSDigital<ch>:RF:POWer:OFFSet on page 571

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 SMCV100B.

In uncoupled mode, enables/disables the RF output in the external instrument.

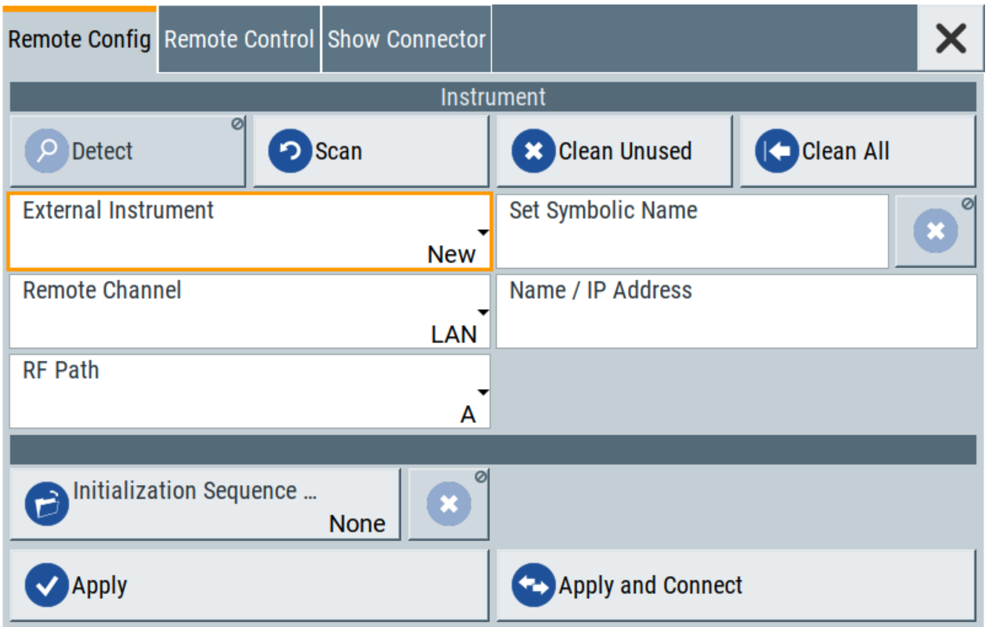
Remote command:
:SCONfiguration:EXTernal:HSDigital<ch>:RF:STATe on page 572

5.2.2.2 External Instrument Configuration Settings

Access:

1. Select "Taskbar > System Config > System Configuration > External RF and I/Q".
2. Navigate to the required connector.
   Select "External Instruments > Config ...".

   The "<Dig. Conn. Name>: External Instrument Configuration" dialog opens and displays the "External Instrument Configuration > Remote Config" settings.



Settings:

Remote Config Settings

Access:

► Select "Taskbar > System Config > System Configuration > External RF and I/Q > External Instruments > Config ...".

Settings:

Detect/Scan

If you connect an external instrument, you can fill in the required information in the "External Instrument Configuration" dialog manually or use one of the provided "Detect/Scan" functions. Both functions consider the connections via the supported interfaces, USB or LAN.

The parameter External Instrument lists the pool of available instruments.

Scans the network for connected supported instruments, like:

R&S SGS or R&S SGT.

Note: The scan function searches throughout the entire network and can last several minutes.

Note: The first initialization of an instrument connected to a network can last several minutes. During their initialization, instruments are not detected by the detect/scan function.

"Detect" Searches for external instruments connected to this particular digital interface of the R&S SMCV100B.

Remote command:
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DETect?` on page 574

"Scan" Scans the network for connected supported instruments, like:

Note: The scan function searches throughout the entire network and can last several minutes.

Remote command:
`:SCONfiguration:EXTernal:REMote:SCAN` on page 572
`:SCONfiguration:EXTernal:REMote:SCAN:STATe?` on page 572

Clean Unused/Clean All
Triggers the instrument to clean at once all unused LAN connections. This function allows you to retrieve a new pool of valid instruments.

The "Clean All" function removes all configured settings from the "External RF and I/Q". USB connections to external instruments are not affected.

Remote command:
`:SCONfiguration:EXTernal:REMote:PURGe` on page 575
`:SCONfiguration:EXTernal:REMote:CLEan` on page 576

External Instrument
Lists all available instruments, found by the Detect/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 572
`:SCONfiguration:EXTernal:REMote:ADD` on page 573
`:SCONfiguration:EXTernal:HSDigital:REMote:ISELect` on page 574

Set Symbolic Name
Sets the alias name of the instrument.

Remote command:
`:SCONfiguration:EXTernal:REMote:ADD` on page 573
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?` on page 574

Remote Channel
Selects the hardware channel (USB or LAN) used by the remote channel to the external instrument.

Remote command:
`:SCONfiguration:EXTernal:REMote:ADD` on page 573
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?` on page 574

Name / IP Address
Displays/sets the IP address or hostname of the connected external instrument.

Remote command:
`:SCONfiguration:EXTernal:REMote:ADD` on page 573
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?` on page 574

RF Path
In a two-path instrument, determines the RF output to be used.

Remote command:
`:SCONfiguration:EXTernal:REMote:ADD` on page 573
`:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?` on page 574

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, i.e. Remote Connection Status is active, the R&S SMCV100B 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 575
`:SCONfiguration:EXTernal:HSDigital:REMote:INITialization:FILE` on page 575

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:HSDigital:REMote:ISELect` on page 574

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.

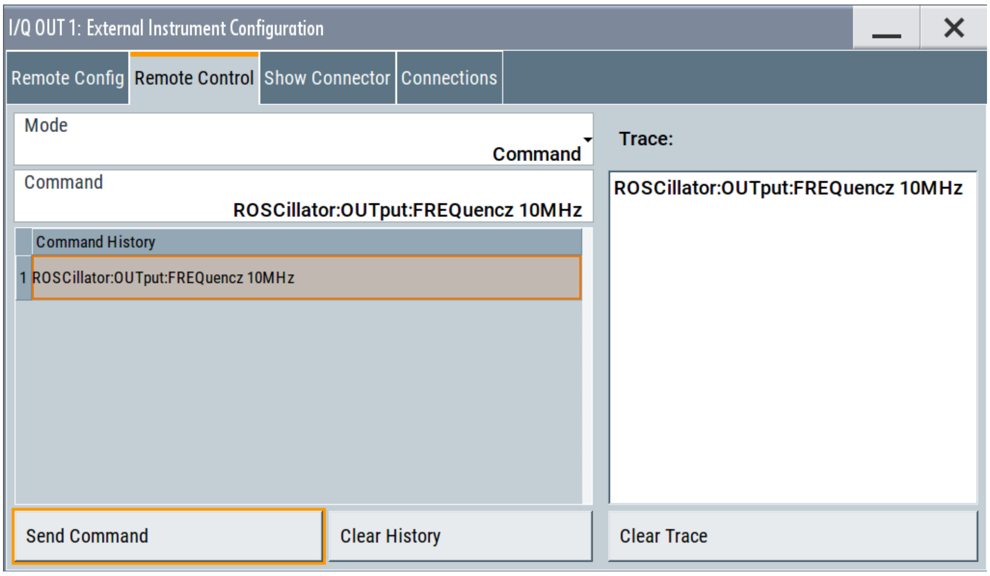
Remote command:
`:SCONfiguration:EXTernal:HSDigital:REMote:ISELect` on page 574
`:SCONfiguration:EXTernal:HSDigital:REMote:CONNect` on page 574

Remote Control Settings

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 "Remote Control".



In this dialog, you can send individual SCPI commands or a sequence of SCPI commands to the connected instruments.

The sent 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

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:HSDigital:REMote:SEND` on page 576

File, Sequence, Send Sequence
Accesses 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 253.

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.

Commands 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".

Show Connector

Access:

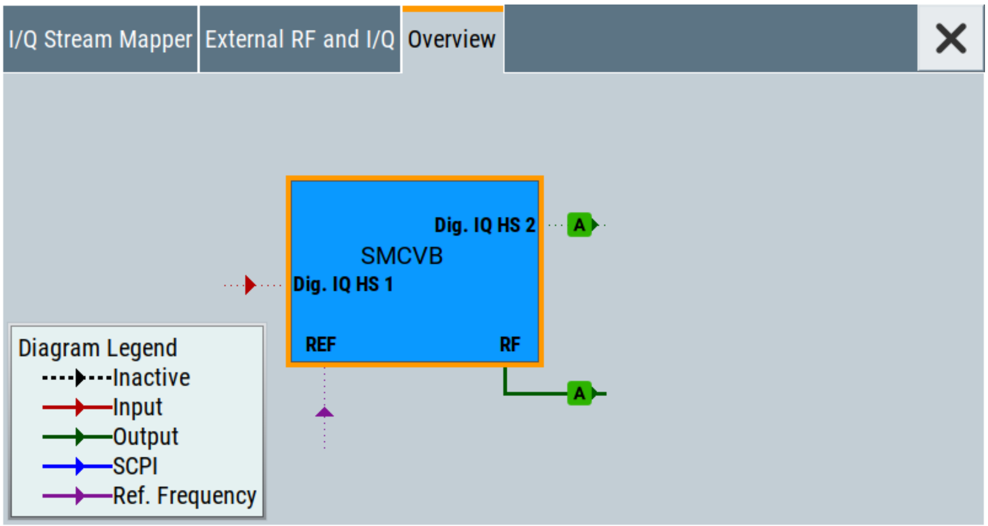
1. Select "Taskbar > System Config > System Configuration > External RF and I/Q".
2. Navigate to the required connector.
   Select "External Instruments > Config ...".
3. In the "<Dig. Conn. Name>: External Instrument Configuration" dialog, select "Show Connector".

   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.

5.2.3 Overview

Access:

► To display an *interactive* overview diagram of the current configuration, select "System Configuration > Overview".



The overview tab shows information on the following:

- Current stream mapping to the output interfaces
  See Chapter 5.2.1, "I/Q Stream Mapper Settings", on page 244.
- Connected controller (external PC).
  See Chapter 5.2.2, "External RF and I/Q Settings", on page 245.
- Connections for remote control of connected external I/Q and RF devices
- Input and output signals

Hotspots for fast access to the required settings

Several of the displayed elements are hotspots. Select an element to access the related dialog.

5.3 Digital Baseband Input Settings

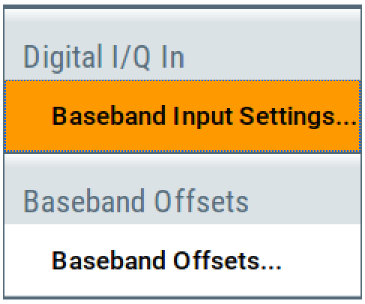
The R&S SMCV100B provide the "Dig. IQ HS 1" interface to feed an **external digital baseband signal** into the signal path.

Required options

The equipment layout for applying an external baseband signal includes:

- Base unit
- Option frequency R&S SMCVB-B103
- Option digital baseband input/output R&S SMCVB-K19
  (incl. the digital interface "Dig. IQ HS 1" used as input)

For more information, see data sheet.



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. IQ HS 1"** is located on the R&S SMCV100B rear panel, see Chapter 5.1, "Overview of the Input and Output Signals and Interfaces", on page 239.

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 ""Dig. IQ HS x" In".

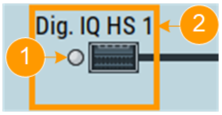
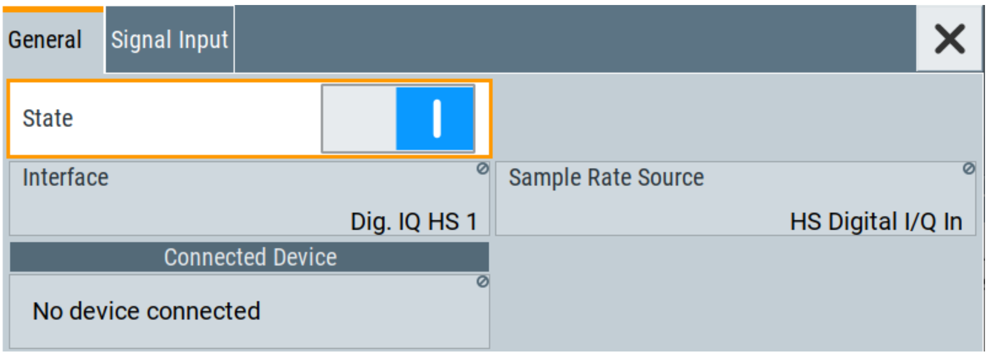
   

   Figure 5-3: Representation of the digital baseband input interface Dig. IQ HS 1

   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 Chapter 4.11, "Shifting and Boosting the Baseband Signal", on page 234.
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. IQ HS 1" connector**..
4. To set the input connector, select "BB Input > General > Interface > "Dig. IQ HS x""
5. To enable the input signal, try one of the following:
   - Select "BB Input > On".
   - Select "BB Input > Baseband Input Settings > State > On".

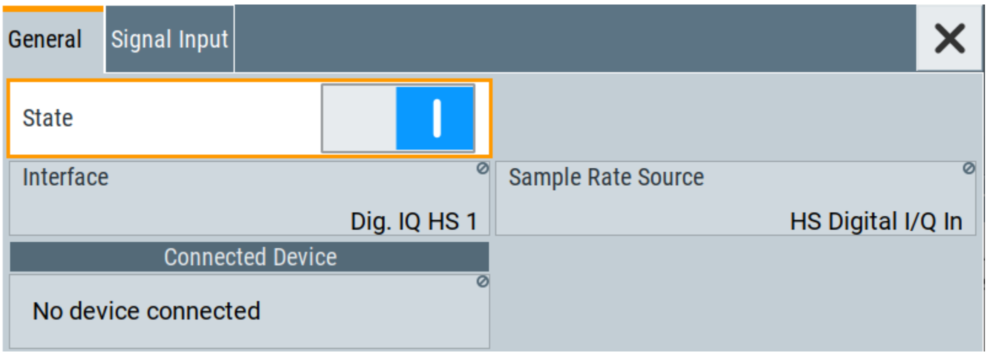
The remote commands required to define these settings are described in Chapter 13.15.2, "SOURce:BBIN Subsystem", on page 580.

Settings:

5.3.1 General Settings

Access:

► Select "BB Input > Digital I/Q In > Baseband Input Settings".



Settings:

State

Enables the feeding of the selected external digital signals into the baseband.

Remote command:

`[:SOURce<hw>]:BBIN:STATe` on page 581

Interface

Displays the digital interface for input, that is "Dig. IQ HS 1".

Remote command:

`[:SOURce<hw>]:BBIN:DIGital:INTerface` on page 582

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 584

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. IQ HS 1" interface:

- Name and serial number of the connected instrument
- The transmitter sample rate, if supported by the transmitter

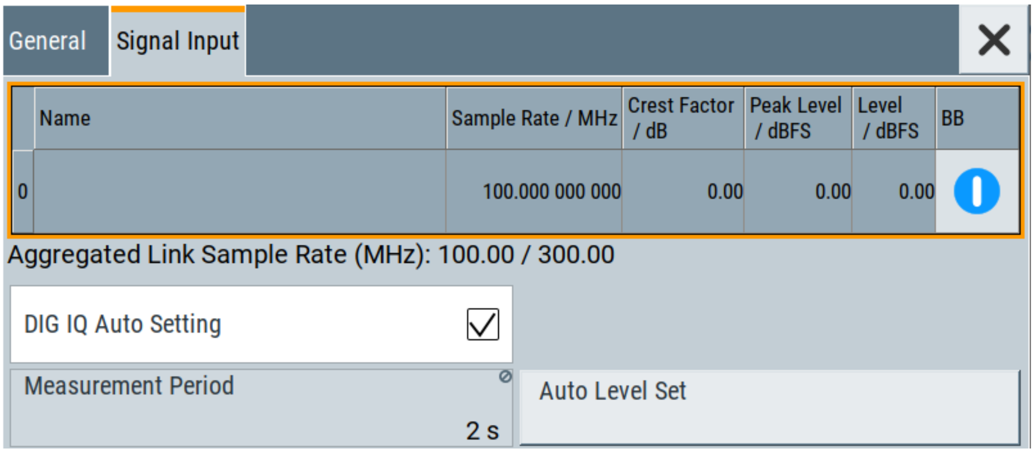
"None" indicates that no device is connected.

Remote command:
[:SOURce<hw>]:BBIN:CDEVice? on page 582

5.3.2 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
Displays information on the up to 8 digital channels at the "Dig. IQ HS 1" 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 582

Sample Rate ← Channel Table
Indicates the used sample rate per channel.

For information on the max. sample rate and the aggregated sample rate, depending on the number of active channels, observe the indication Aggregated Link Sample Rate.

Remote command:
[:SOURce<hw>]:BBIN:CHANnel<ch0>:SRATe on page 584

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 583

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 583

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 583

BB ← Channel Table
Activates the channel. Only one channel can be activated at a time. Toggle the state of the channel to test all of them subsequently.

Remote command:
[:SOURce<hw>]:BBIN:CHANnel<ch0>:BB:STATe on page 582

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 can not exceed the maximum sample rate.
- The R&S SMCV100B 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, see data sheet.

Remote command:
[:SOURce<hw>]:BBIN:SRATe:SUM? on page 584
[:SOURce<hw>]:BBIN:SRATe:MAX? on page 585

DIG IQ Auto Setting
Activates an automatic adjustment of the baseband input signal.

The R&S SMCV100B 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 585

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 586

Auto Level Set
Starts measuring the input signal for estimating the crest factor, the peak level, and the Revel of the input signal.

Remote command:
[:SOURce<hw>]:BBIN:ALEVel:EXECute on page 586

5.4 I/Q Digital Output Settings

Required options

The equipment layout for output of a baseband signal includes:

- Base unit
- Option digital baseband input/output R&S SMCVB-K19
  (incl. the digital interface "Dig. IQ HS 2" used as output)

The current firmware does not support output of baseband signal at the "Dig. IQ HS 2" interface.

For more information, see data sheet.

To access and configure the "I/Q Digital Output" settings

The connector is located on the rear panel.

In the default instrument state, the block diagram displays the "Dig. IQ HS 2" connector in a folded state. The digital output interface is inactive (gray LEDs).

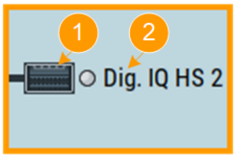


Figure 5-4: Representation of the digital output interface Dig. IQ HS 2

1 = Digital output interface state: gray = inactive; blue = active
2 = Digital output connector name

1. Select the "Dig. IQ HS 2" symbol to unfold the "I/Q Digital" block.

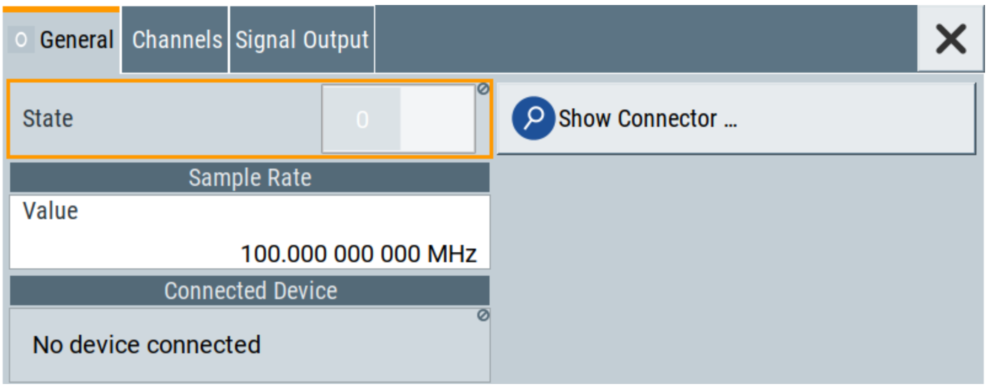
   You access the settings of the **"Dig. IQ HS 2" connector**.
2. To access the dialog box for configuring the digital output signal, select "I/Q Digital > I/Q Digital Out".

   The remote commands required to define these settings are described in Chapter 13.15.8.1, "SOURce:IQ:OUTPut:DIGital Commands", on page 693.

5.4.1 General Settings

Access:

► Select "I/Q Digital > I/Q Digital Out".



Settings:

State

Displays the digital I/Q output state, that is deactivated.

Remote command:

`[:SOURce<hw>]:IQ:OUTPut:DIGital:STATe` on page 694

Show Connector

Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Chapter 11.2.2.3, "Status Indicators", on page 422).

Value

Sets/displays the sample rate of the digital I/Q output signal. The maximal sample rate depends on the connected receiving device.

Remote command:

`[:SOURce<hw>]:IQ:OUTPut:DIGital:SRATe` on page 695

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. IQ HS 1" interface:

- Name and serial number of the connected instrument
- The transmitter sample rate, if supported by the transmitter

"None" indicates that no device is connected.

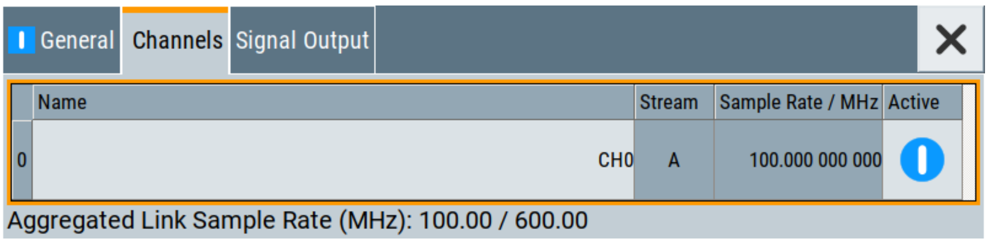
Remote command:

`[:SOURce<hw>]:IQ:OUTPut:DIGital:CDEVice?` on page 695

5.4.2 Channels Settings

Access:

► Select "I/Q Digital > I/Q Digital Settings > Channels".



The channels are displayed in table form, where the number of rows corresponds to the number of channels.

Settings:

Number
Subsequent number.

Name
Channel indication.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:NAME` on page 697

Stream
Indicates the streams routed routed to the channel.

Sample Rate
Sets the sample rate per channel.

For information on the max. sample rate and the aggregated sample rate, depending on the number of active channels, observe the indication Aggregated Link Sample Rate.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:SRATe` on page 697

Active
Activates the channel.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:STATe` on page 698

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 can not exceed the maximum sample rate.
- The R&S SMCV100B 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.

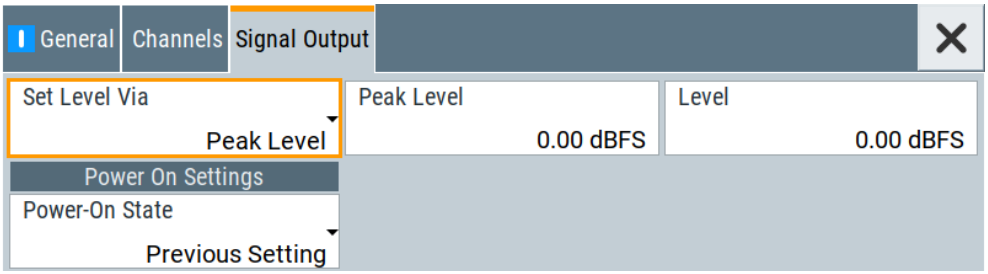
For more information, see data sheet.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:SRATe:SUM?` on page 698
`[:SOURce]:IQ:OUTPut:DIGital:SRATe:MAX?` on page 698

5.4.3 Signal Output Settings

Access:

► Select "I/Q Digital > I/Q Digital Settings > Signal Output".



The tab comprises settings necessary to configure the I/Q digital signal output parameters.

Settings:

Signal Output

Comprises the level settings of the output signal. The signal level is expressed as a peak or RMS level value.

Note: The "Level" display always refers to both signal components, i.e. *SQR(*I^2*+*Q^2*)*.

"Set Level Via" Selects whether the signal level is expressed as a peak or as RMS level value.

Remote command:
`[:SOURce]:IQ:OUTPut:DIGital:POWer:VIA` on page 695

"Peak Level" Enters the peak level of the output signal relative to full scale of 0.5 V (in terms of dB full scale).

Remote command:
`[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:PEP` on page 695

"Level" Enters the RMS level of the output signal.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:LEVel` on page 696

Power-On State

Selects the state which the I/Q digital output connector "Dig. IQ HS 2" is to resume after the instrument is switched on.

"I/Q Out Off" On power-on, the output is deactivated.

"Previous Setting"
Resumes the state that was active before the last switch off.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut:DIGital:PON` on page 697

5.5 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 master-slave **mode**.

This section explains how to use the provided settings to define the signal generation start in the basebands of **multiple instruments**.

5.5.1 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 common trigger signal:

- Let one R&S SMCV100B generate a dedicated signal that triggers all R&S SMCV100B instruments.
  See Example "Triggering several R&S SMCV100B instruments simultaneously" on page 266.
- Connect all instruments to a common external trigger source.

See Chapter 3.3.4, "Enabling and Configuring a Marker Signal", on page 47.

Example: Triggering several R&S SMCV100B instruments simultaneously

This example shows you how to connect several R&S SMCV100B, distribute the trigger signal generated by the first one (R&S SMCV100B#1) and trigger the instruments simultaneously.

Required cabling and connections:

- Connect the instruments in a star network, concerning the trigger signal.
- Always use cables of the same length.
  Use as short as possible cables.

Required configurations:

- In **all** R&S SMCV100B:
  - Use the default settings "User 3 > Direction = Input" and "Signal = Global Trigger 1".
  - Select "Baseband > ... > Trigger In > Trigger Source > Ext. Global Trigger 1".

To trigger the signal generation form R&S SMCV100B#1, select "Global Connectors > Execute Trigger".

R&S SMCV100B#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 SMCV100B and all basebands.

6 Adding Noise to and Impairing the Signal

The test case scenarios in accordance with the specifications often require a not "clean" signal but rather a signal that is impaired or interfered. To fulfill such requirements, the R&S SMCV100B is equipped with a noise generator and provides the possibility to impair the digital I/Q signal.

This section describes the following functions:

6.1 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.

6.1.1 Required Options

The equipment layout for generating an AWGN signal includes:

- Base unit
- Option Noise Generator (R&S SMCVB-K62)

6.1.2 About the AWGN Generator

Provided the required options are installed, the R&S SMCV100B 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 Gaussian distribution of the noise power density and uniform frequency distribution.

Generation of the AWGN signal

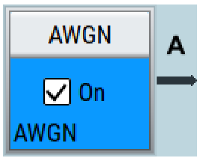
The Gaussian noise is generated with a feedback shift register with subsequent probability transformation. The switching configuration is such that ideal statistical characteristics are achieved:

- 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 signal in one of the following different modes:

- **"Additive Noise":** the generated noise signal superimposes the interference-free useful signal



- **"Noise Only":** a pure noise signal is generated and modulated to the carrier; the connection to the baseband is interrupted.

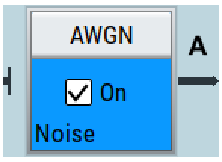
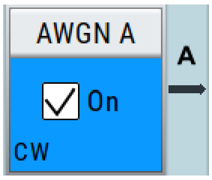


Figure 6-1: Representation of an AWGN > Mode > Noise Only in the block diagram

- **"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 6-2 illustrates the relation between the signal and noise parameters.

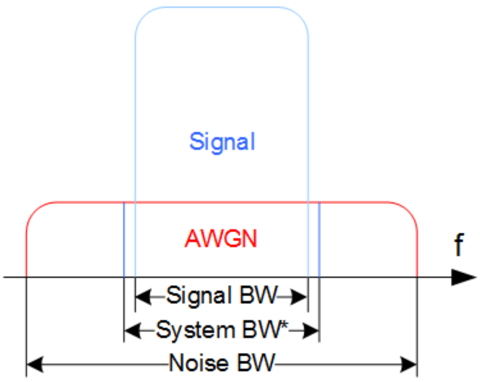


Figure 6-2: Graphical representation of the relation between system bandwidth and noise bandwidth (Minimum Noise/System BW = 2)

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 6-3).

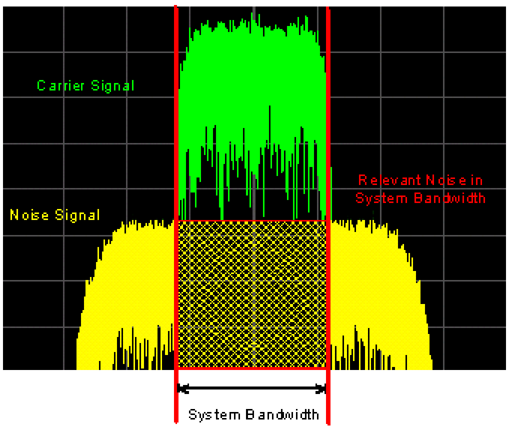
To ensure flat noise within the selected system bandwidth, the **noise bandwidth** has to be larger than the system bandwidth. The minimum noise bandwidth is sometimes part of the specifications and is calculated as follows:

"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, as specified in the data sheet.

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 6-3).

The noise power of digitally modulated signal is characterized by the parameter $\mathbf{E_b/N_0}$ 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 "AWGN > Noise Power / Output Results > 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 signals generated by the "Custom Digital Mod", the bit rate is determined by the selected standard
  (see parameter "Custom Dig Mod > General" > "Symbol Rate" and "Custom Dig Mod > 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 6-3 for an example of an AWGN generation with the following configuration:

- "Baseband"
  - "Custom Digital Modulation > Set acc. 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 Results for Output > RF"
  - "Noise Power / Output Results > Reference Mode > Carrier"
  - "Noise Power / Output Results > Carrier/Noise Ratio = 10 dB"
- "RF > On"

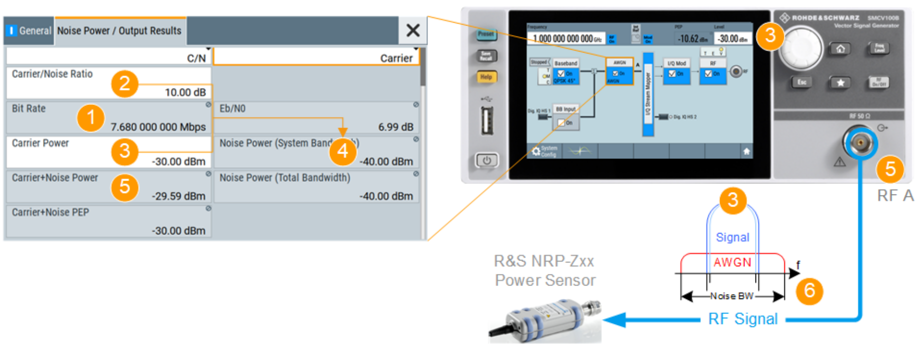


Figure 6-3: AWGN: Understanding the displayed information

1 = Bit Rate derived from the selected "Symbol Rate = 3.840 Msym/s"
2 = Selected Carrier/Noise Ratio
3 = Carrier Power = Status bar > Level = -30 dBm
4 = Noise Power calculated from the "Carrier Power" and the "Carrier/Noise Ratio" = -30 dBm - 10 dB = -40 dBm
5 = Carrier+Noise Power = power at the "RF 50 Ω" output; i.e. the power a connected power meter would measure
6 = Noise Bandwidth = System Bandwidth*Minimum Noise/System Bandwidth Ratio = 3.840 MHz*3 = 11.520 MHz

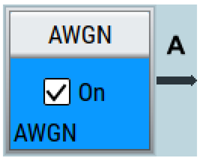
Use the built-in graphical signal monitoring function of the instrument to display the signal characteristics in real-time, see "To observe the effect of enabled additive noise (AWGN)" on page 384.

Application fields

Typically, the noise generator is required for the following tests:

- In receiver sensibility tests with predefined SNR of the receiver, see "To configure the AWGN for receiver sensibility tests with predefined SNR of the receiver" on page 280
- In bit-error or block-error measurements, depending on the set signal-to-noise ratio (SNR)
- Whenever a pure noise signal is required

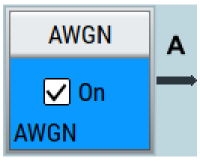
6.1.3 AWGN Block



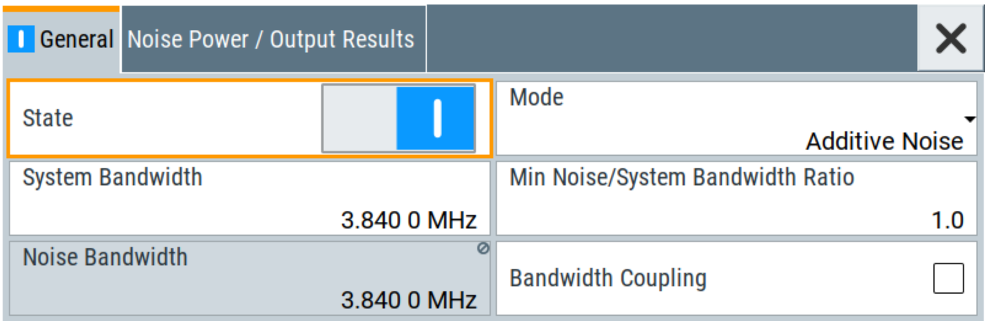
The "AWGN" block provides access to the settings for the **AWGN generator**, see Chapter 6.1.4, "AWGN Settings", on page 273. The label in the AWGN block indicates the AWGN mode that is activated. The quickest way to activate or deactivate the AWGN generator is the "On/Off" switch in the AWGN block.

6.1.4 AWGN Settings

Access:



1. Select "Block Diagram > AWGN".



   The dialog contains the settings for noise level configuration and CW interfering parameters.

2. To activate the AWGN generator, select "Block Diagram > AWGN > On".

   The remote commands required to define these settings are described in Chapter 13.15.3.5, "SOURce:AWGN Subsystem", on page 665.

Settings:

6.1.4.1 General Settings

Access:

► Select "Block Diagram > AWGN".

Settings:

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 667

Mode

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.

"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 667

System Bandwidth

For "Additive Noise" and "Noise Only" modes, 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 6-2.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth` on page 668

Minimum Noise/System Bandwidth Ratio

For "Additive Noise" and "Noise Only" modes, sets the ratio of minimum noise bandwidth to system bandwidth, as required by some standards.

"Noise Bandwidth" = "System BW" x "Minimum 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 C/N or S/N ratio in relation to system bandwidth is not influenced.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:RATio` on page 669

Bandwidth Coupling

Requires "Mode > Additive Noise/Noise Only". Activating bandwidth coupling requires an activated digital broadcast baseband signal, e.g. "Baseband > ATSC-M/H > ATSC-M/H > On".

Activates bandwidth coupling. If activated, the AWGN "System Bandwidth" couples to the digital broadcast baseband signal bandwidth. The baseband signal bandwidth is derived from the "Used Bandwidth" or "Symbol Rate" of the active coder of the digital broadcast standard.

Also the "Minimum Noise/System Bandwidth Ratio" is updated corresponding to the coupled "System Bandwidth".

"Bandwidth Coupling" is deactivated for "Audio AM", "Audio FM" and all other baseband signals, e.g. custom digital modulated signals.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:COUPling[:STATe]` on page 668

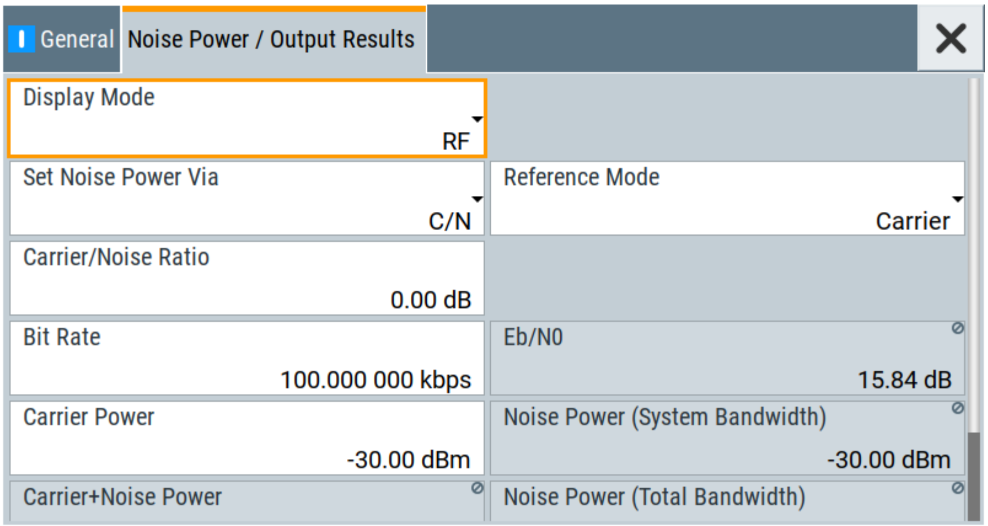
Target CW Frequency Offset
In "CW Interferer" mode, sets the desired frequency of the sine wave.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:TARGet` on page 672

6.1.4.2 Noise Power/Output Results Settings

Access:

► Select "AWGN > Noise Power/Output Results".



The available settings depend on the selected Mode.

Settings:

Display Mode

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 669

Set Noise Power Via

In "Additive Noise" mode, selects the way the noise power is determined.

The following correlation applies:

"C/N or S/N"= ("E_b/N_0")(f_{bit}/B_{sys})*, where:

- "C/N or S/N" is the carrier/noise ratio
- "E_b/N_0" 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 Chapter 6.1.2, "About the AWGN Generator", on page 268.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:MODE` on page 669

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 670

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 Chapter 6.1.2, "About the AWGN Generator", on page 268.

Remote command:
[:SOURce<hw>]:AWGN:BRATe on page 670

Carrier/Noise Ratio, Signal/Noise Ratio
In "Additive Noise" and "CW Interferer" mode, 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 Display Mode.

- In "Reference Mode > Carrier": sets the noise power. It does not affect the power of the useful 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 useful 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 useful signal.
- The power of the useful 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 6-3.

Remote command:
[:SOURce<hw>]:AWGN:CNRatio on page 670

E_b/N_0
In "Additive Noise" mode, sets the ratio of bit energy to noise power density.

- In "Reference Mode > Carrier": sets the *noise power* and hence the power of the output signal, i.e. the carrier + noise signal.
  It does not affect the power of the useful signal, i.e. the carrier power is kept constant.
- In "Reference Mode > Noise": sets the *power of the useful signal*, i.e. 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 useful signal.
- The power of the useful 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 6-3.

Remote command:
[:SOURce<hw>]:AWGN:ENRatio on page 670

Carrier Power, Signal Power
("Additive Noise" and "CW Interferer")

The name of this parameter depends on the selected output Display Mode.

- 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 useful 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 6-3.

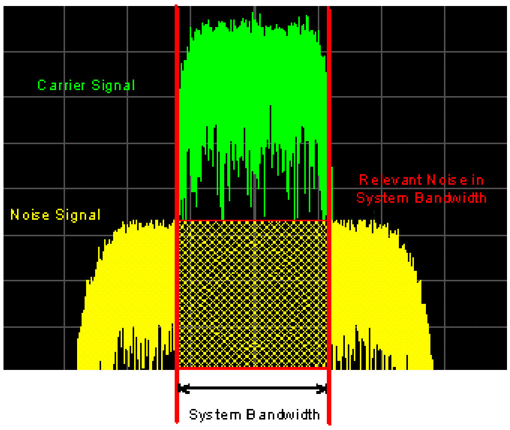
Remote command:
`[:SOURce<hw>]:AWGN:POWer:CARRier` on page 671

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 interfering signal. The power of the carrier is derived from the entered C/I value.
  - "Reference Mode > Carrier"
    Displays the power of the interfering signal. The power of the interfering 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 6-3.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:NOISe` on page 671

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 6-3.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal?` on page 671

Carrier + Noise Power, Signal + Noise Power (System Bandwidth), Carrier + Interferer Power, Signal + Interferer Power
In "Additive Noise" and "CW Interferer" mode, displays the overall power of the noise/ interferer signal plus useful signal.

The output selected with the parameter Display Mode determines:
- The name of this parameter
- The units the overall power is measured in, dBm or dB (full scale)

See also Figure 6-3.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:SUM?` on page 672

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 useful signal.

The output selected with the parameter Display Mode 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 672

Noise Bandwidth
For "Additive Noise" and "Noise Only" modes and with activated AWGN generator, indicates the real noise bandwidth.

See also Figure 6-2.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:NOISe?` on page 669

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 673

6.1.5 How to Configure the Noise Generator 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 SMCV100B generates an uplink EUTRA/LTE signal with 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"
- "Status bar > Frequency = 1.95 GHz" and "Level = -69.9 dBm"
- "RF State > On"

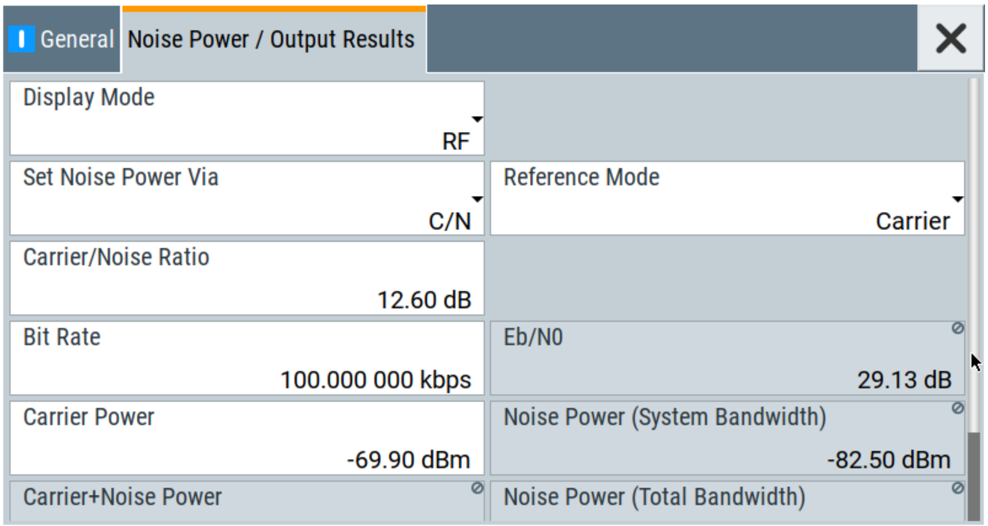
To configure the AWGN for receiver sensibility tests with predefined SNR of the receiver

We assume that an AWGN interfering signal with the following characteristics is required:

The mean power of the interfering signal is -82.5 dBm/BW and C/N = 12.6 dB.

1. Select "AWGN" and enable:
   - "Mode > Additive Noise"
   - "System Bandwidth = 4.5 MHz"
     The definition of the interfering 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 6-2.
   - "Min Noise/System Bandwidth Ratio = 1.5"
2. Select "Noise Power/Output Results" and enable:
   - "Set Noise Power Via = C/N"

- "Reference Mode = Carrier"
- "Carrier/Noise Ratio = 12.6 dB"



The dialog confirms the required mean power of the interfering signal "Noise Power (System Bandwidth) = -82.5 dBm".

3. Select "AWGN > General > State > On".

To generate a CW interfering signal

For the following example, we assume that two interfering 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) Select "Status bar > Frequency = 1.96 GHz" and "Level = -52 dBm"
2. Enable the required interfering 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 > State > On"

6.2 Impairing the Signal

In the R&S SMCV100B, *digital linear impairments* such as I/Q imbalance and quadrature error can be added to the generated signal.

6.2.1 Required Options

The base unit is sufficient. Additional options are not required.

6.2.2 About the Linear I/Q Impairments

Signal impairments (**I/Q Impairments**) are well-defined arithmetic modifications of the data. Every data sample is modified in the same way.

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)

The R&S SMCV100B offers functions to impair the internally generated signal.

6.2.2.1 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 6-4.

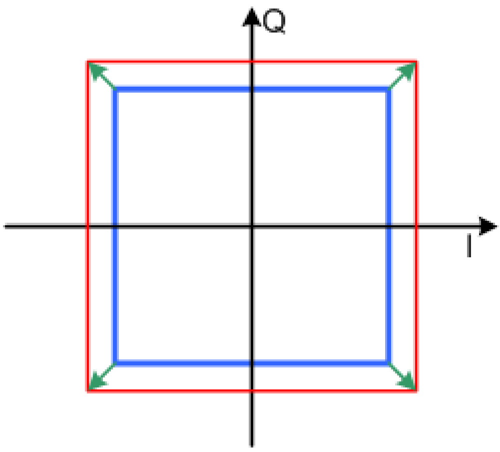


Figure 6-4: Effect of an increased amplitude in the I/Q constellation diagram

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 imbalance, 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 6-5.

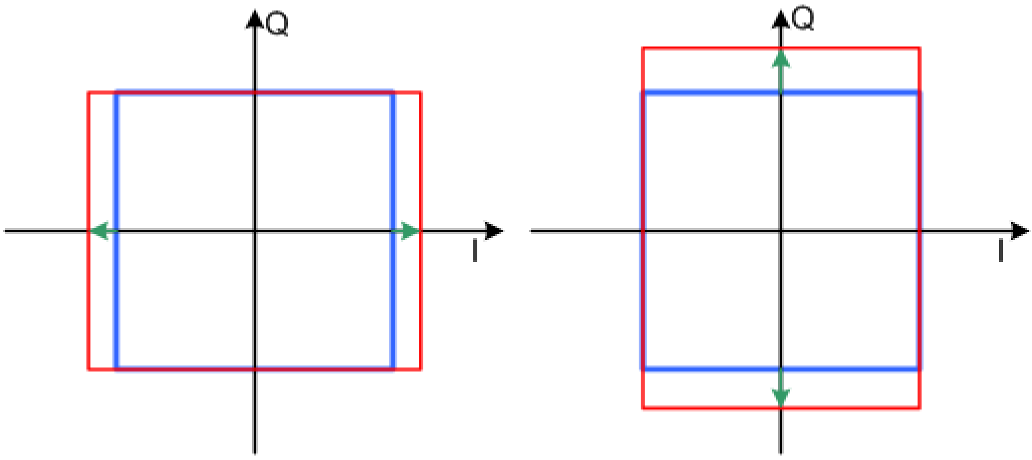


Figure 6-5: Negative gain imbalance (left) and positive gain imbalance (right) in the I/Q constellation diagram

6.2.2.2 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 6-6.

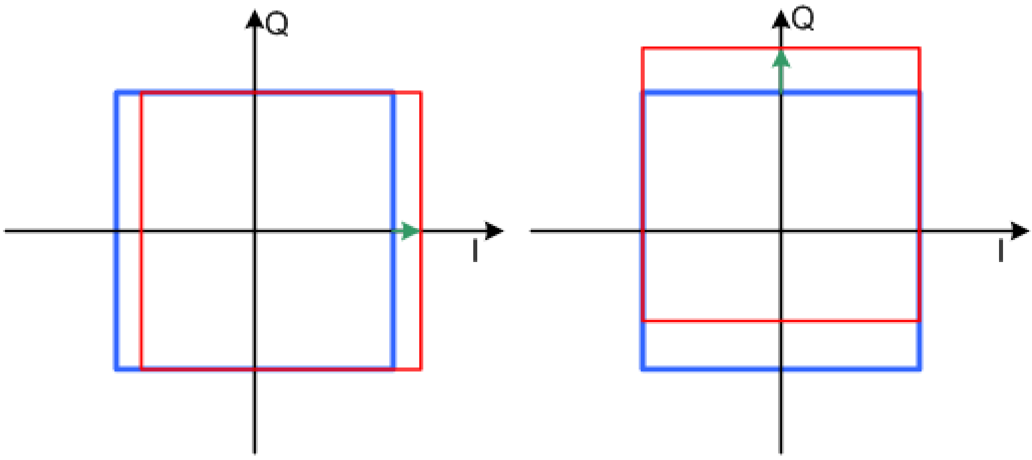


Figure 6-6: I offset (left) and Q offset (right) in the I/Q constellation diagram

6.2.2.3 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 6-7.

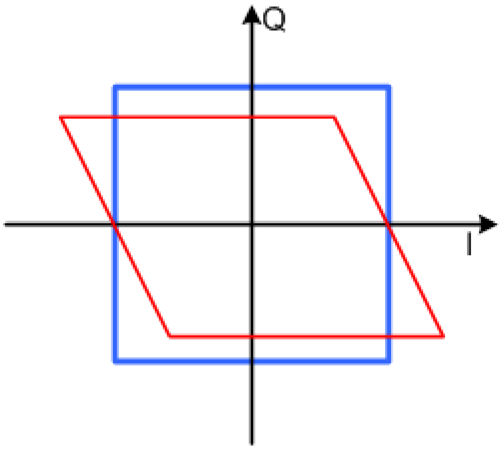


Figure 6-7: Positive quadrature offset in the I/Q constellation diagram

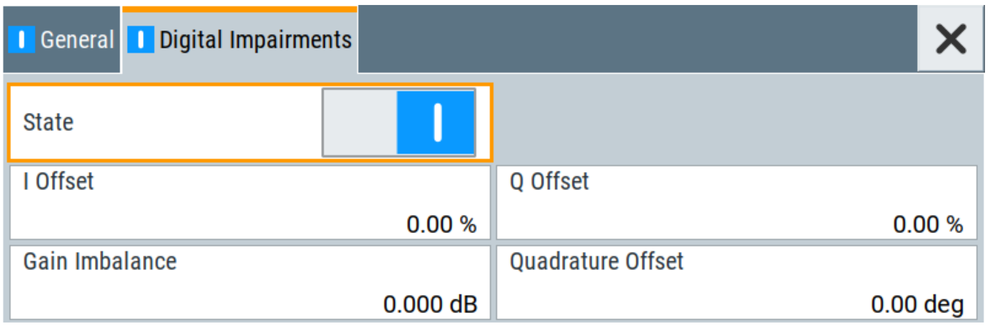
6.2.3 Digital Impairments Settings

You can add digital impairments to each internal generated I/Q stream.

See also Chapter 6.2.2, "About the Linear I/Q Impairments", on page 282.

Access:

► Select "I/Q Mod > Digital Impairments".



The dialog covers the settings for I/Q impairment, like leakage, imbalance and offset.

The remote commands required to define these settings are described in Chapter 13.15.3.6, "SOURce:BB:IMPairment Subsystem", on page 673.

Settings:

State
Activates the impairment of the I/Q signal.

If activated, the settings for I/Q offset, I/Q imbalance, and quadrature offset become effective.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:STATe` on page 674

I/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 Chapter 6.2.2.2, "I and Q Offset", on page 283.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:LEAKage:I` on page 673
`[:SOURce<hw>]:BB:IMPairment:LEAKage:Q` on page 673

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 Chapter 6.2.2.1, "Gain and Gain Imbalance", on page 282.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude]` on page 673

Quadrature Offset
Sets the quadrature offset.

For more information, see Chapter 6.2.2.3, "Quadrature Offset", on page 283.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:QUADrature[:ANGLe]` on page 674

7 Applying I/Q Vector Modulation

The R&S SMCV100B offers I/Q modulation with an external digital signals or an internally generated digital signal.

For a description on the signal impairment functionality and settings for applying non-linear effects, see:

- Chapter 6.2, "Impairing the Signal", on page 282

7.1 Required Options

The equipment layout for I/Q modulation includes:

- Base unit
- One of the Frequency options (R&S SMCVB-B103/-KB106)
  Sufficient for I/Q modulation with internal signal.

7.2 About the I/Q Modulator

The R&S SMCV100B offers I/Q modulation with internally generated digital signals.

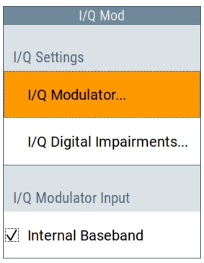
Defining the input signal of the I/Q modulator

The Table 7-1 gives an overview of the possible input signals and the connectors they are supplied at. Any of the specified input signals is processed by the I/Q modulator and output at the RF output.

Table 7-1: Physical input signals of the I/Q modulator

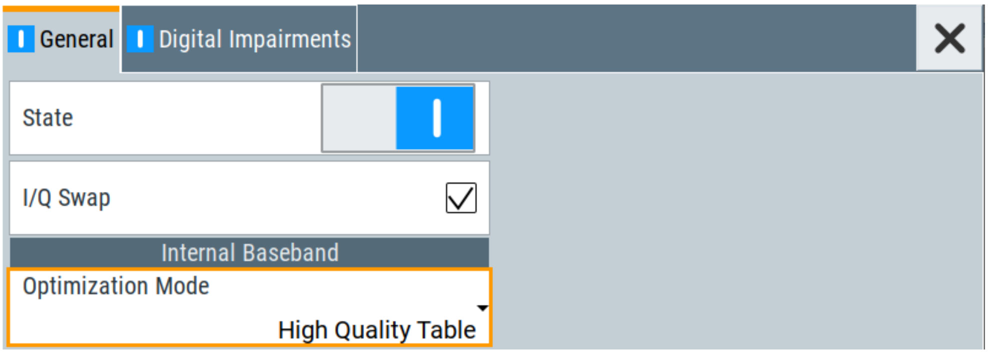
Input signal	Input connector	GUI parameter
Internal digital baseband signal	-	"I/Q Mod. > I/Q Mod. In > Internal Baseband I/Q In" and "Baseband > On"
External digital signal	"Dig. IQ HS 1"	"I/Q Mod. > I/Q Modulator Input > Internal Baseband" and "BB Input > On"

7.3 I/Q Modulator Settings



Access:

► Select "I/Q Mod > I/Q Settings > I/Q Modulator".



The dialog comprises the I/Q modulator settings and settings for enabling digital impairments.
The remote commands required to define these settings are described in Chapter 13.15.7, "SOURce:IQ Subsystem", on page 692.

For a description on the signal impairment functionality and settings for applying non-linear effects, see:

- Chapter 6.2, "Impairing the Signal", on page 282

Settings:

State

Activates/deactivates I/Q modulation.

Remote command:
`[:SOURce<hw>]:IQ:STATe` on page 693

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 IQ signal is modulated to the desired RF in a different way in the I/Q modulator:

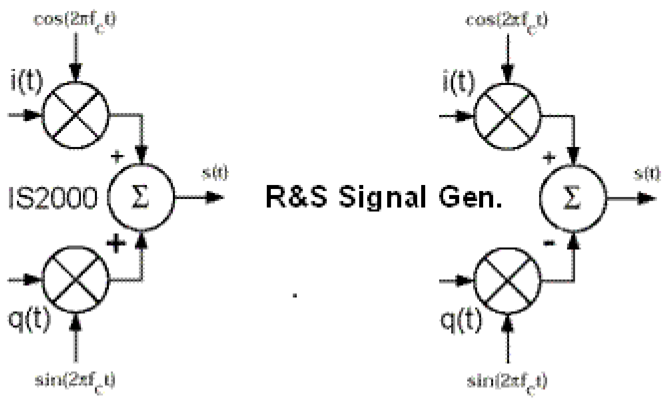


Figure 7-1: Definition of I/Q modulator in IS2000 and the R&S SMCV100B

IS2000 = the RF signal s(t) is derived from the baseband I/Q signal as s(t)=i(t)cos(2*pi*f_ct) + q(t)sin(2*pi*f_ct)
R&S SMCVB = the RF signal s(t) is based on the definition s(t)=i(t)cos(2*pi*f_ct) - q(t)sin(2*pi*f_ct)

"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 CDMA200 and 1xEV-DO standards.
An I/Q modulator defined according to these standards can cope with the RF signal generated by the R&S SMCV100B.

Remote command:
`[:SOURce<hw>]:IQ:SWAP[:STATe]` on page 693

Optimization Mode
Selects the optimization mode.

For information on the I/Q modulation performance in any of the modes, see the data sheet.

"Fast" Fast optimization by compensation for I/Q skew.
This mode is suitable in time sensitive environments and narrowband signal.

"High Quality Table"
Requires R&S SMCVB-K544.
This mode provides improved optimization while maintaining setting time.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE` on page 674

7.4 How to Adjust the I/Q Modulator to Optimize Performance

With its default settings, the I/Q Modulator provides vector modulated signal that is optimized for time sensitive measurements and lower noise.

Adjusting the settings helps to improve signal quality to improve the flatness of the RF signal.

In the following examples, we assume that:

- The R&S SMCV100B generates a baseband signal
- A spectrum analyzer is connected to the R&S SMCV100B, the analyzed is configured, and measures the required signal characteristics.

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 flat signal but requires longer settling time and leads to signal interruption.

2. Select "Optimization Mode > High Quality"

   Note:
   Do not use the mode "I/Q Modulator > Optimization Mode > High Quality" in combination with the modes "RF Level > Setting Characteristics > Uninterrupted/Strictly Monotone".

   The high quality I/Q optimization leads to RF signal interruption. The requirements of the RF level modes "Uninterrupted" and "Strictly Monotone" can not be fulfilled.

3. On a connected signal analyzer, monitor the signal characteristics.

8 Configuring the RF Signal

The vector signal generator R&S SMCV100B generates RF signals with outstanding spectral purity within the frequency range from 8 kHz up to 7.125 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 SMCV100B 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 SMCV100B 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 on how to configure a simple CW signal, see:
  - Chapter 8.5, "RF Frequency Settings", on page 293
  - Chapter 8.6, "RF Level Settings", on page 296
  - Chapter 3.3.1, "Generating an Unmodulated Carrier", on page 39
- Vector modulated signal
  Generates an I/Q vector modulated signal
  See Chapter 7, "Applying I/Q Vector Modulation", on page 286.

The R&S SMCV100B 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 Chapter 8.9, "Varying the RF Signal in List or Sweep Mode", on page 304.

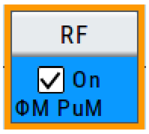
8.1 Required Options

The equipment layout for generating the RF signal includes:

- Base unit
- Option frequency (R&S SMCVB-B103/-KB106)
- Optional, option bandwidth extension from 60 MHz to 120 MHz RF bandwidth (R&S SMCVB-K521)
- Optional, option bandwidth extension to 160 MHz RF bandwidth (R&S SMCVB-K522)
(requires R&S SMCVB-K521)
- Optional, option bandwidth extension to 240 MHz RF bandwidth (R&S SMCVB-K523)
(requires R&S SMCVB-K522)

For more information, see data sheet.

8.2 How to Access the RF Settings



Access:

1. In the block diagram, select the block "RF > RF".
2. Select the required function form the list.

   The RF block comprises all functions and settings concerning the RF signal. These include the RF frequency and level settings with all enhanced functions for improving the signal characteristics, the analog modulations, list and sweep mode settings as well as connector assignments and measurement functions of the RF signal.

8.3 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) Select "Level > RF ON > On"
b) Press the [RF on/off] key at the front panel.

3. In the block diagram, observe the color of the "RF On" icon.

   The blue color indicates that the RF output is activated.

RF State/RF ON
Activates or deactivates the RF output.

Acts as the [RF on/off] key.

Remote command:
`:OUTPut<hw>[:STATe]` on page 547

RF output impedance
You can query the impedance of the RF output.

Remote command:
`:OUTPut<hw>:IMPedance?` on page 548

8.4 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.

► Use one of the following:
- "Status Bar > Frequency and Level"
- "RF > RF Frequency > Frequency > Frequency"
- "RF > RF Level > Level > Level"
- "RF > RF Frequency > Phase"

Current frequency and level values are indicated on 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.

See "RF frequency and level display with a downstream instrument" on page 292.

RF frequency and level display with a downstream instrument

If your test setup includes a downstream instrument, you can enter the parameter of the downstream instrument in the frequency or level settings dialog of the R&S SMCV100B. Examples of downstream instruments are mixers, frequency multipliers, amplifiers or attenuators and of their corresponding major parameters offset, multiplier, amplitude. The R&S SMCV100B generates the signal without the downstream parameters, but considers all additional parameters concerning the frequency and level.

Example parameters that affect the frequency and level:

- Frequency offset
- Multiplication factor
- User correction
- Digital attenuation

Any of these cases are indicated by a dedicated icon in the status bar, depending on the affected parameter.

Figure 8-1 illustrates the calculation of the "Frequency" and "Level" values, displayed in the status bar.

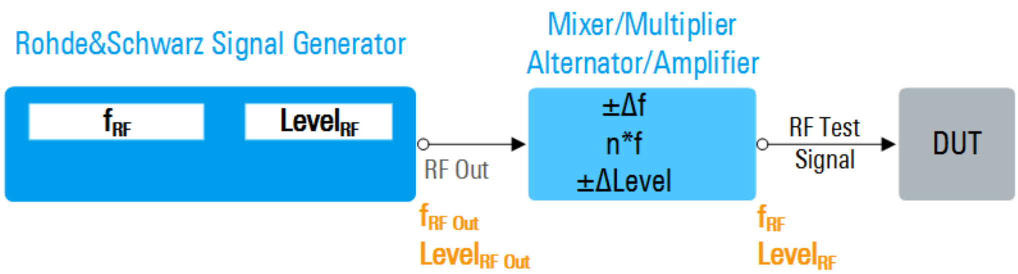


Figure 8-1: Frequency and Level display vs frequency and level at the RF output

f_{RF}, $Level_{RF}$	= Frequency and level ("Status bar > Frequency and Level") at the output of the downstream instrument, see also Calculation of f_{RF} and $Level_{RF}$)
$f_{RF\ Out}$, $Level_{RF\ Out}$	= Frequency and level at the output connector ["RF 50 Ω"] ("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")

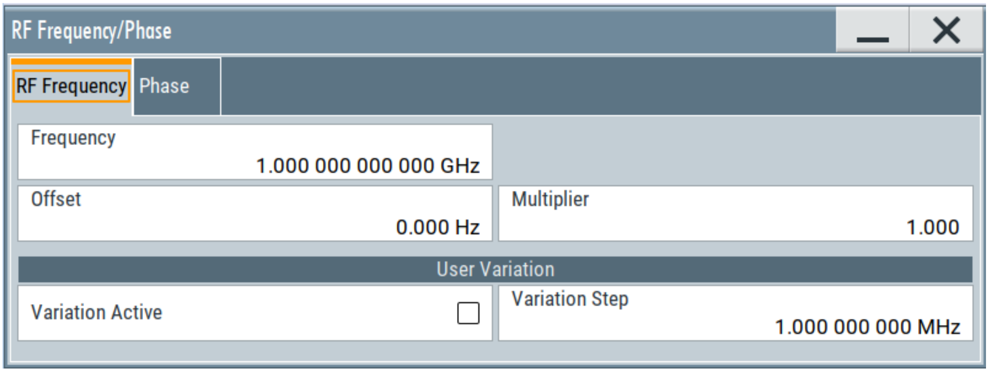
Calculation of f_{RF} and $Level_{RF}$

- $f_{RF} = n*f_{RF\ Out} + \Delta f$
- $Level_{RF} = Level_{RF\ Out} + \Delta Level + Level_{DigAtt}$
  ($Level_{DigAtt}$ for active internal I/Q modulation, "RF > RF Level > Digital Attenuation")

8.5 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 Chapter 13.15.5, "SOURce:FREQuency Subsystem", on page 686.

Settings

Frequency

Sets the RF frequency.

This frequency is output at the "RF 50 Ω" connector. It does not consider an Offset or multiplication factor (Multiplier).

See "RF frequency and level display with a downstream instrument" on page 292.

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 Chapter 8.9, "Varying the RF Signal in List or Sweep Mode", on page 304.

Remote command:
`[:SOURce<hw>]:FREQuency[:CW|FIXed]` on page 688

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 SMCV100B RF output is not changed.

See "RF frequency and level display with a downstream instrument" on page 292.

Remote command:

`[:SOURce<hw>]:FREQuency:OFFSet` on page 689

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 SMCV100B RF output is not changed.

See "RF frequency and level display with a downstream instrument" on page 292.

Remote command:

`[:SOURce<hw>]:FREQuency:MULTiplier` on page 689

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 691

`[:SOURce<hw>]:POWer:STEP:MODE` on page 718

Variation Step ← User Variation

Sets the user-defined step width.

Remote command:

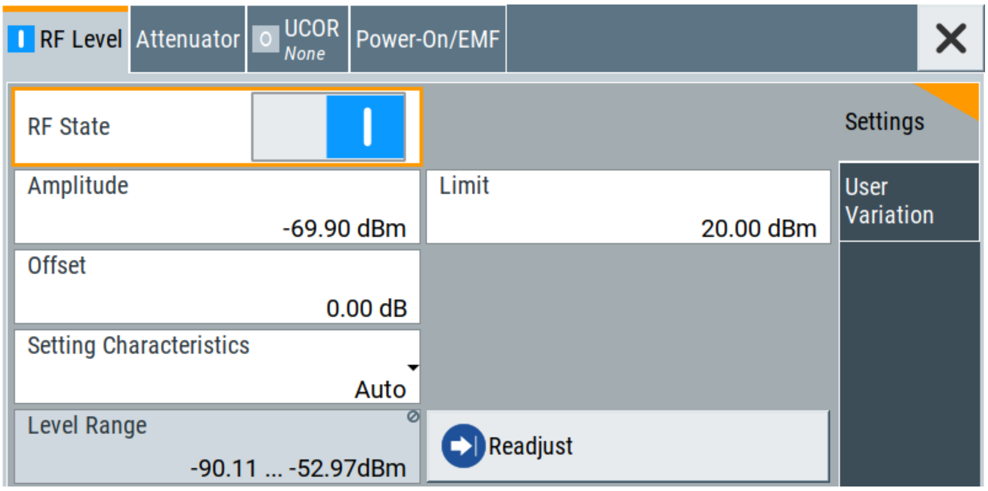
`[:SOURce<hw>]:FREQuency:STEP[:INCRement]` on page 692

`[:SOURce<hw>]:POWer:STEP[:INCRement]` on page 718

8.6 RF Level Settings

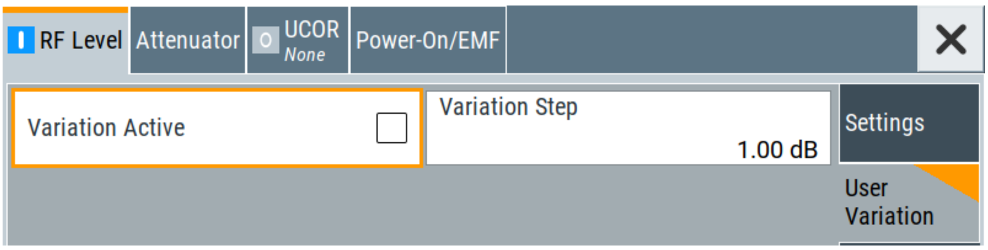
Access:

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 Chapter 13.15.11, "SOURce:POWer Subsystem", on page 713.

Settings

Amplitude
Sets the level of the RF signal.

The value is offset-free and corresponds to the level at the "RF 50 Ω" connector.

See "RF frequency and level display with a downstream instrument" on page 292.

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 Chapter 8.9, "Varying the RF Signal in List or Sweep Mode", on page 304.

Remote command:
`[:SOURce<hw>]:POWer:POWer` on page 717
Note: The SCPI command `[:SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude]` sets the level of the "Level" display.
This means, the level containing offset.

Limit
Sets an upper limit for the RF output power.

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 715

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 SMCV100B RF output is not changed.

See "RF frequency and level display with a downstream instrument" on page 292.

Remote command:
[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet on page 718

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, as specified in the data sheet.
The RF signal is shortly blanked when the step attenuator is switching.

"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.

Remote command:
[:SOURce<hw>]:POWer:LBEHaviour on page 715

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 720
[:SOURce<hw>]:POWer:RANGe:UPPer? on page 720

Readjust

Recalculates and adjusts the internal switch positions of the RF chain according to the current level.

Remote command:
[:SOURce<hw>]:POWer:ALC:SONCe on page 714

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 691
[:SOURce<hw>]:POWer:STEP:MODE on page 718

Variation Step ← User Variation

Sets the user-defined step width.

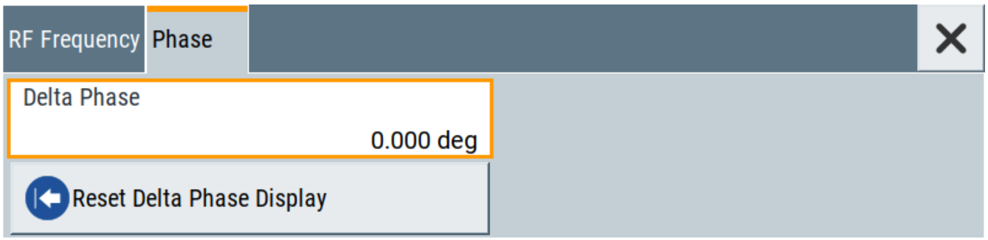
Remote command:
[:SOURce<hw>]:FREQuency:STEP[:INCRement] on page 692
[:SOURce<hw>]:POWer:STEP[:INCRement] on page 718

8.7 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 Chapter 13.15.10, "SOURce:PHASe Subsystem", on page 712.

Settings

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 712

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 713

8.8 Reference Oscillator

The R&S SMCV100B 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 a external reference signal with fixed reference frequency of 10 MHz.

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 factory preset.

8.8.1 Required Options

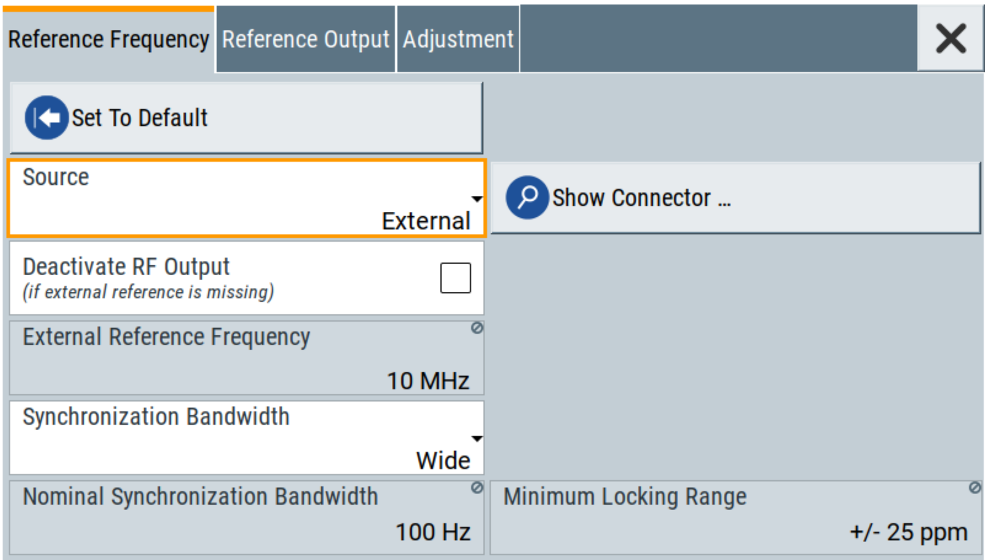
R&S SMCV100B base unit

For more information, see data sheet.

8.8.2 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 Chapter 13.15.12, "SOURce:ROSCillator Subsystem", on page 720.

Settings:

Set to Default

Calls the default settings.

Remote command:
`[:SOURce]:ROSCillator:PRESet` on page 721

Source

Selects the reference frequency source.

"Internal" Uses the internal reference oscillator, either with calibrated or a user-defined Adjustment Value.

"External" Uses an external reference signal.

Note: If the external reference is missing, the R&S SMCV100B issues a warning message and indicates the icon (external reference missing).

To set the frequency of the external reference, see "External Reference Frequency" on page 302.

Remote command:
`[:SOURce]:ROSCillator:SOURce` on page 721

Show Connector

Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Chapter 11.2.2.3, "Status Indicators", on page 422).

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 722

External Reference Frequency
Displays the frequency of the external reference signal.

"10 MHz" Selects 10 MHz for the external reference frequency signal.

Remote command:
[:SOURce]:ROSCillator:EXTernal:FREQuency on page 722

Synchronization Bandwidth
Selects the synchronization bandwidth for an external reference signal.

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 SMCV100B issues an error message.

For more information, see data sheet.

Remote command:
[:SOURce]:ROSCillator:EXTernal:SBANdwidth on page 722

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 723

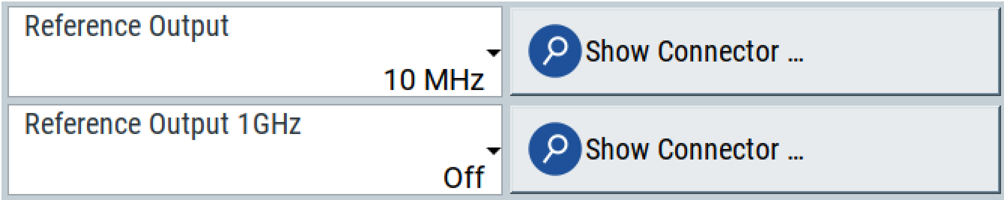
Minimum Locking Range
Indicates the minimum locking range for the selected External Reference Frequency and the Synchronization Bandwidth.

Remote command:
[:SOURce]:ROSCillator:EXTernal:MLRange? on page 723

8.8.3 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 Chapter 13.15.12, "SOURce:ROSCillator Subsystem", on page 720.

Settings:

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.

"Input Signal (loop through)"
Passes the external reference frequency to the output directly.

Remote command:
`[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE` on page 723

Show Connector

Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

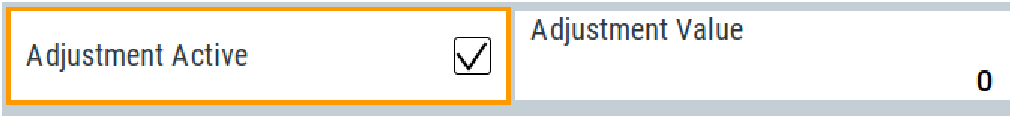
A blinking LED on the front/rear panel indicates the selected connector, too (see Chapter 11.2.2.3, "Status Indicators", on page 422).

8.8.4 Adjustment Settings

Access:

1. Select "RF" > "RF Frequency" > "Reference Frequency".

2. Select "Adjustment".



Settings:

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 724

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 724

8.9 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 SMCV100B 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.

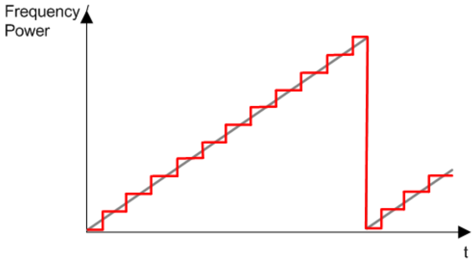


Figure 8-2: Schematic representation of a signal generated in sweep mode

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 8-3 represents the frequency and power value pairs, in this case with the dwell time set the same for all steps (global dwell time).

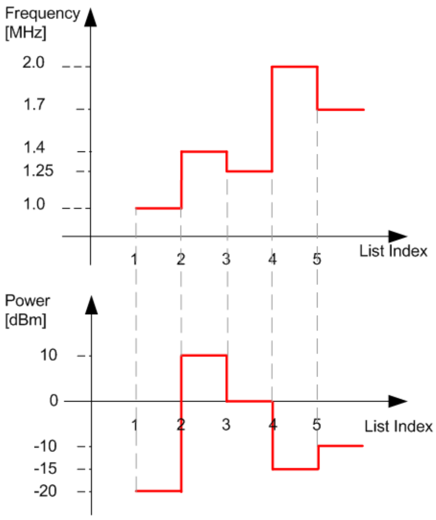


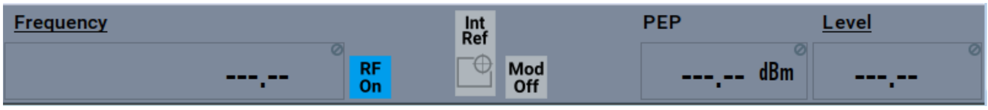
Figure 8-3: Schematic representation of a signal generated in list mode (global dwell time)

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 Chapter 11.1.2, "Display Update Settings", on page 418.

8.9.1 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).

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 SMCV100B 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 "Setup an RF frequency or power sweep" on page 725
- Example "Create an RF list and activate the list mode" on page 699

Auto mode (Sweep/List)

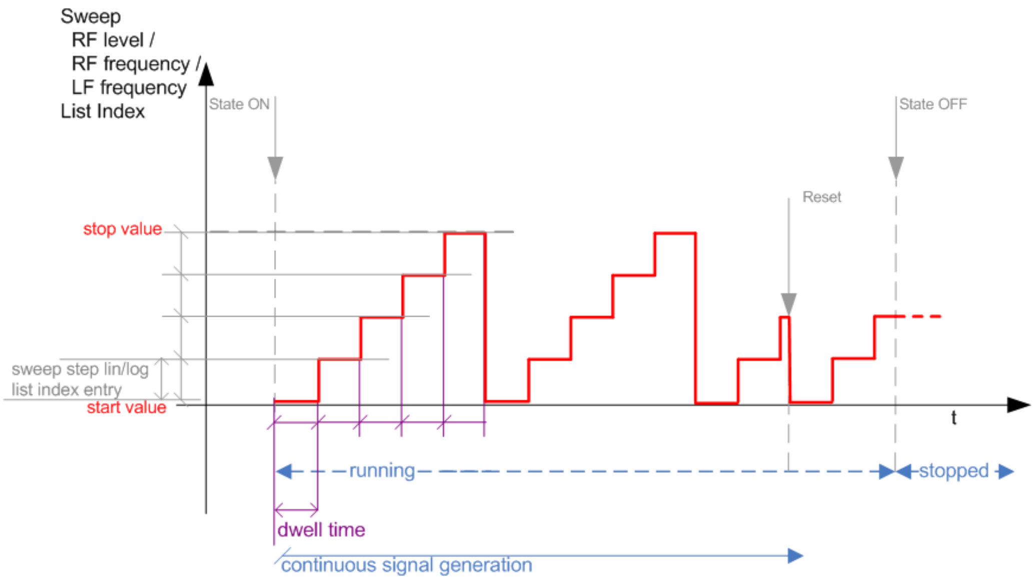


Figure 8-4: Auto mode (Sweep/List)

- 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 8-1: 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`
List	`:SOURce<hw>:LIST:MODE AUTO` `:SOURce<hw>:LIST:TRIGger:SOURce AUTO`

Single / Extern Single mode (Sweep/List)

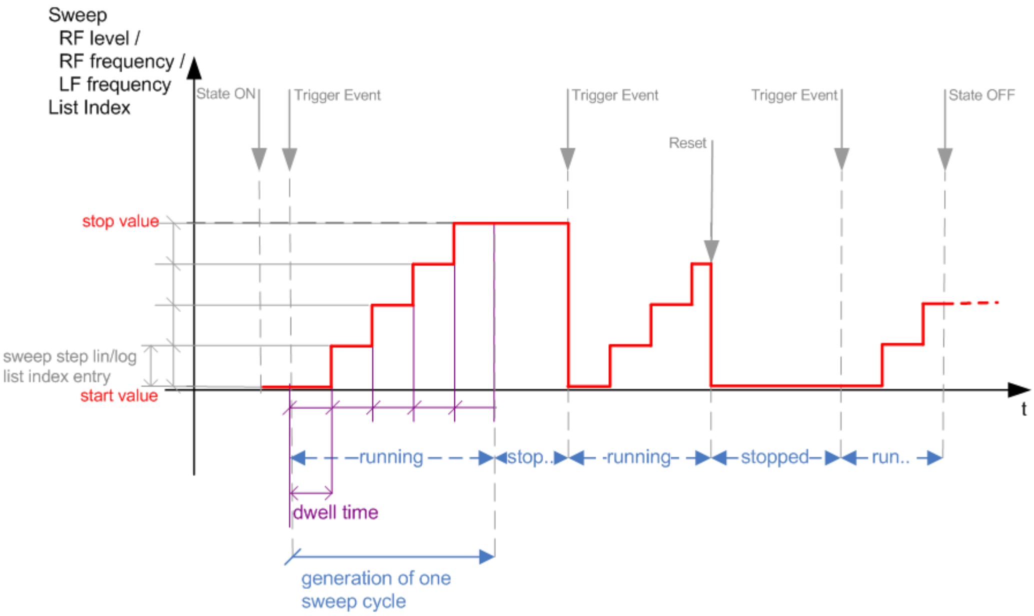


Figure 8-5: Single / Extern Single mode (sweep / list)

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 313 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 8-2: 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`
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)

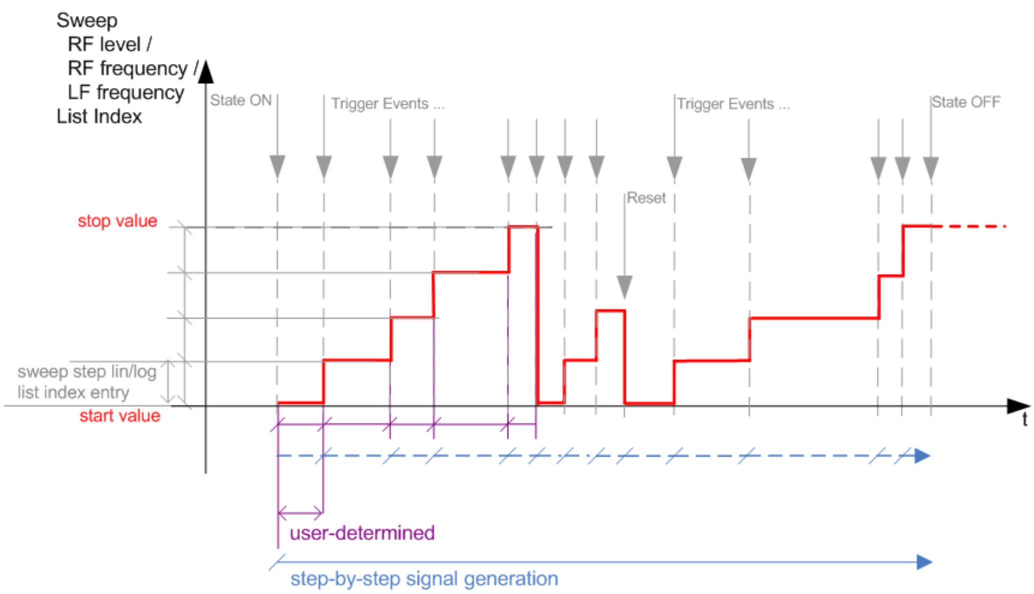


Figure 8-6: Step / Extern Step mode (sweep / list)

- 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 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
- 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 8-3: 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`
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)

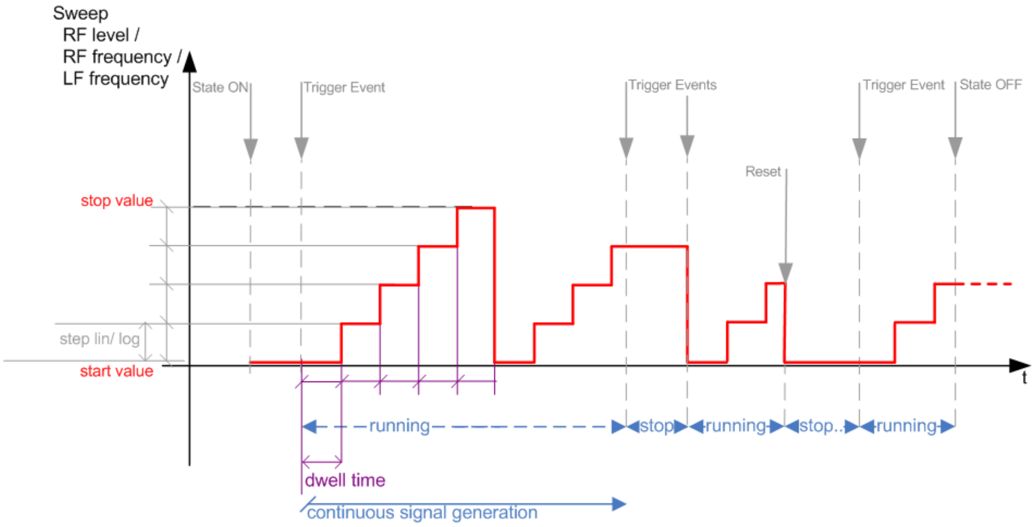


Figure 8-7: Extern Start/Stop mode (sweep)

- 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 8-4: 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`

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.

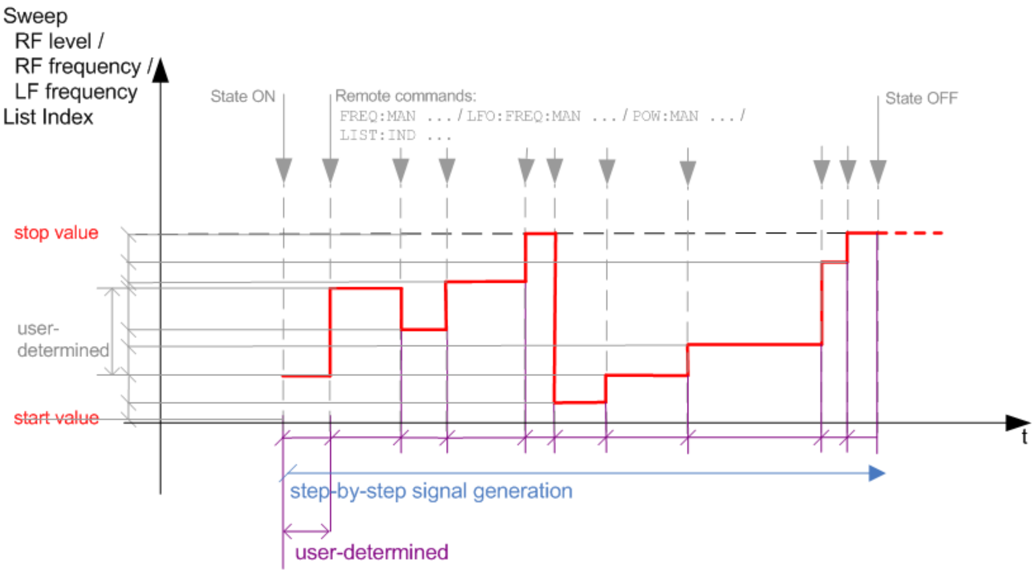


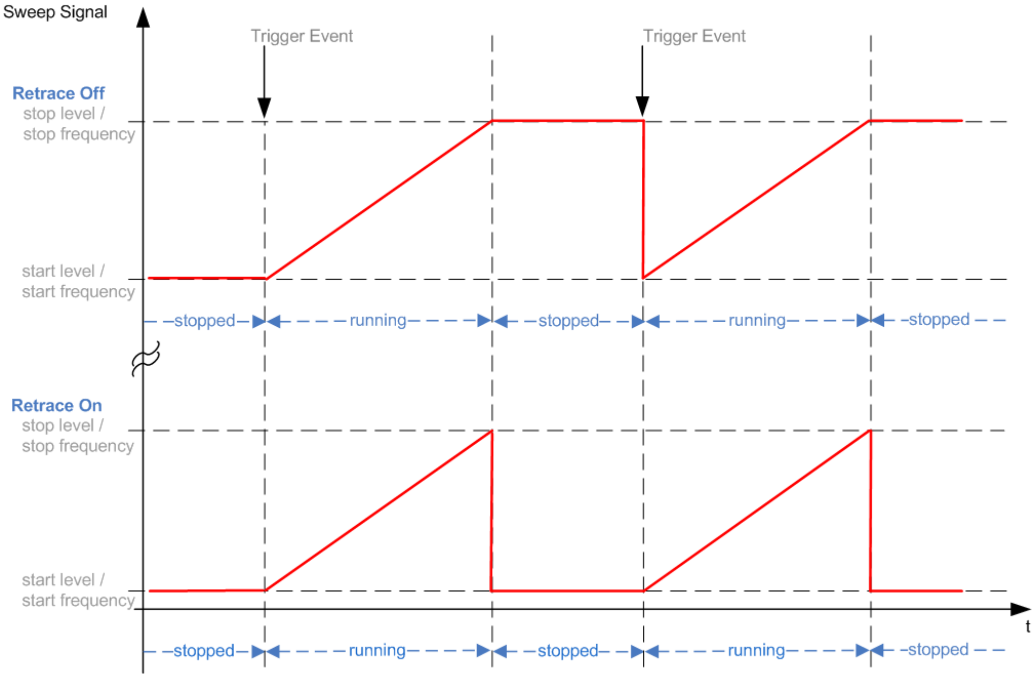
Figure 8-8: Manual mode in remote control (sweep / list)

- 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 8-5: 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>`
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 323
- "Mode" on page 322

8.9.2 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 Chapter 8.9.2.2, "Sweep Signal Shapes", on page 316.

Configuration and operation of sweep mode signals

- The R&S SMCV100B generates a sweep signal by varying the following parameters: either the *RF frequency*, the *RF level* or both, the *RF frequency*and the *RF level* in combined RF sweep mode, 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.

Combined RF frequency / level sweep processing mode

The combined RF sweep functionality processes the signal similar to the Live list mode. The R&S SMCV100B sets the frequency and level values simultaneously in the hardware. The difference to the list mode is that the values are not taken from a previously created list, but are calculated using the selected frequency and level ranges, the dwell time and the number of steps.

8.9.2.1 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 SMCV100B 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 8-6: 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
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

Variable	Description
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.

8.9.2.2 Sweep Signal Shapes

The R&S SMCV100B 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.

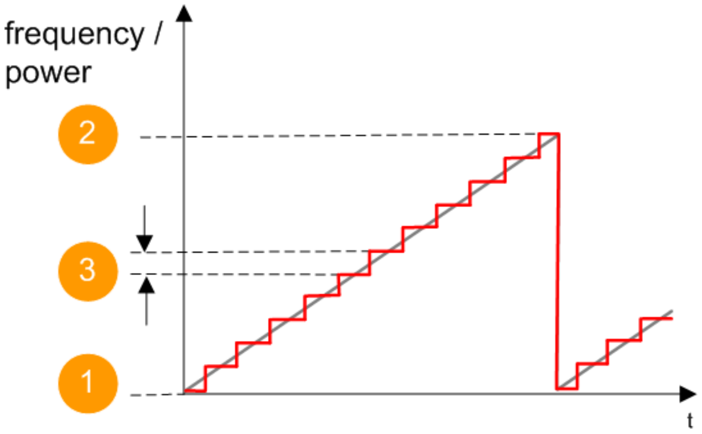


Figure 8-9: Sweep signal sawtooth shape

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.

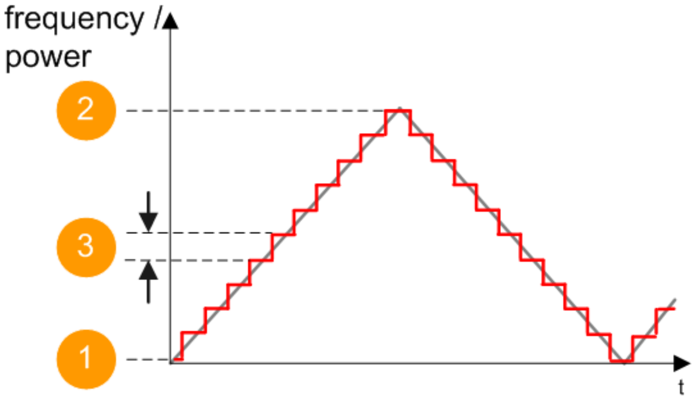


Figure 8-10: Sweep signal triangle shape

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.

8.9.3 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 Chapter 8.9.7, "List Editor", on page 335)

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 Chapter 10.7, "Using the File Manager", on page 402)

- 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 Edit List Mode Data
- "Global"
  This mode processes the list with a fixed time interval you can set with Global Dwell Time.

List processing mode

8.9.4 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.

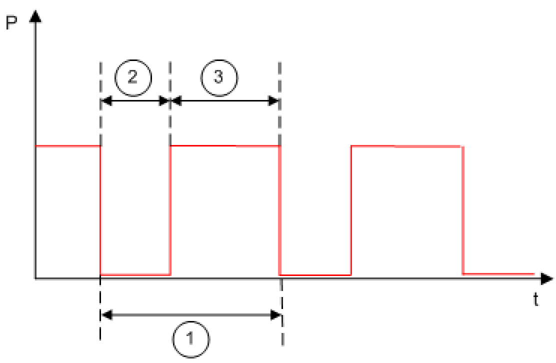


Figure 8-11: Dwell Time vs. settling time

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 SMCV100B 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 SMCV100B 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 SMCV100B 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 SMCV100B 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.

8.9.5 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"

   The sweep modes use the similar parameters to be configured. Thus, the description comprises the settings of the three dialogs, "RF Frequency Sweep", "RF Level Sweep" and "LF Frequency Sweep". If parameters relate to only particular modes, they are pointed out.

The remote commands required to define these settings are described in:

- Chapter 13.15.5, "SOURce:FREQuency Subsystem", on page 686

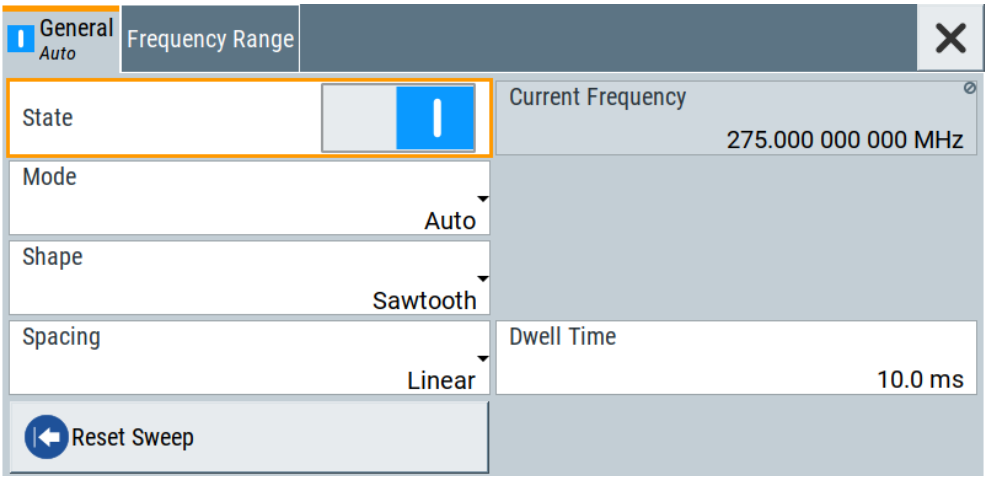
- Chapter 13.15.11, "SOURce:POWer Subsystem", on page 713
- Chapter 13.15.13, "SOURce:SWEep Subsystem", on page 724

Settings

8.9.5.1 General Sweep Settings

Access:

► Select, for example, "RF" > "Sweep/List" > "RF Frequency Sweep".



Settings

State (RF frequency sweep)
Activates RF frequency sweep signal generation.

Note: Active sweep mode deactivates other sweeps or lists and vice versa.

Remote command:
[:SOURce<hw>]:FREQuency:MODE on page 687

State (RF level sweep)
Activates RF level sweep signal generation.

Note: Active sweep mode deactivates other sweeps or lists and vice versa.

Remote command:
[:SOURce<hw>]:POWer:MODE on page 716

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 689

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 716

Mode
Selects the sweep mode.

See Chapter 8.9.1, "Signal Generation and Triggering in the Sweep and List Modes", on page 306.

"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 729
:TRIGger<hw>:FSWeep:SOURce on page 759
RF level sweep:

[:SOURce<hw>]:SWEep:POWer:MODE on page 727
:TRIGger<hw>:PSWeep:SOURce on page 759

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 731
RF level sweep:
[:SOURce<hw>]:SWEep:POWer:RETRace on page 731

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.

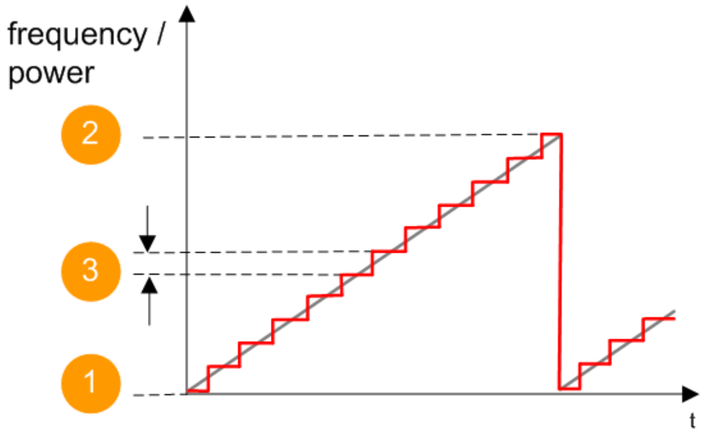


Figure 8-12: Sweep signal sawtooth shape

1 = Start value
2 = Stop value
3 = Step width

"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.

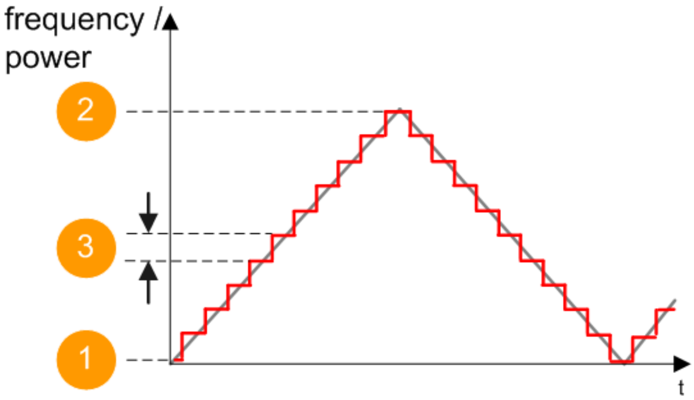


Figure 8-13: Sweep signal triangle shape

1 = Start value
2 = Stop value
3 = Step width

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:SWEep[:FREQuency]:SHAPe` on page 730
RF level sweep:
`[:SOURce<hw>]:SWEep:POWer:SHAPe` on page 730

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 729

Dwell Time
Defines the duration of the individual sweep steps.

Note: In case of considerable overrun conditions, the R&S SMCV100B turns off the sweep mode.

See also Chapter 8.9.4, "Significant Parameters and Functions", on page 318.

Remote command:
`[:SOURce<hw>]:SWEep[:FREQuency]:DWELl` on page 728
`[:SOURce<hw>]:SWEep:POWer:DWELl` on page 727

Trigger Slope

For "Mode = Extern Step/Single", selects the polarity of the active slope of an applied instrument trigger.

Trigger signal is expected at one of the "User x" connectors.

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

"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]:INPut:TRIGger:SLOPe` on page 692

Execute Single Sweep

In "Mode = Single", starts a sweep manually.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:SWEep[:FREQuency]:EXECute` on page 730
`:TRIGger<hw>:FSWeep[:IMMediate]` on page 760
RF level sweep:
`[:SOURce<hw>]:SWEep:POWer:EXECute` on page 730
`:TRIGger<hw>:PSWeep[:IMMediate]` on page 760
General:
`:TRIGger<hw>[:SWEep][:IMMediate]` on page 760

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 732

8.9.5.2 Global Connector Settings

The "Input Signal" dialog, the "Trigger/Marker/Clock" dialog and "Trigger In", "Marker" and "Clock" tabs in "Baseband > ARB/Custom Digital Mod" configuration dialogs provide quick access to the related connector settings. Click the "Global Connectors" button to access the settings.

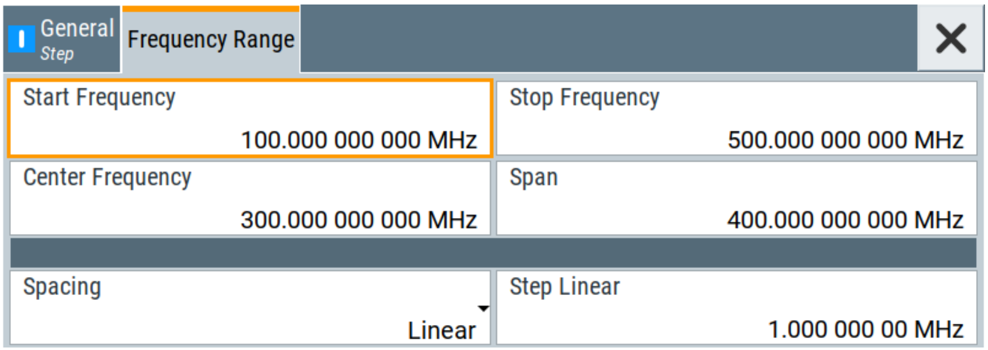
See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

8.9.5.3 Frequency Range Settings

Access:

1. Select for example "RF" > "Sweep/List" > "RF Frequency Sweep"

2. Select "Frequency Range".



Settings

Start Frequency/Stop Frequency

Defines the frequency sweep range by setting the start and end values.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Remote command:
RF frequency sweep:
`[:SOURce<hw>]:FREQuency:STARt` on page 691
`[:SOURce<hw>]:FREQuency:STOP` on page 691

Center Frequency

In "RF Frequency Sweep" mode, sets the RF center frequency.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Remote command:
`[:SOURce<hw>]:FREQuency:CENTer` on page 690

Span

In "RF Frequency Sweep" mode, sets the span of the frequency sweep range.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Remote command:
`[:SOURce<hw>]:FREQuency:SPAN` on page 690

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 729

Step Linear/Step Logarithmic
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, you can enter either an absolute or logarithmic step width.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

"Step Linear" The step width is a constant value in Hz.

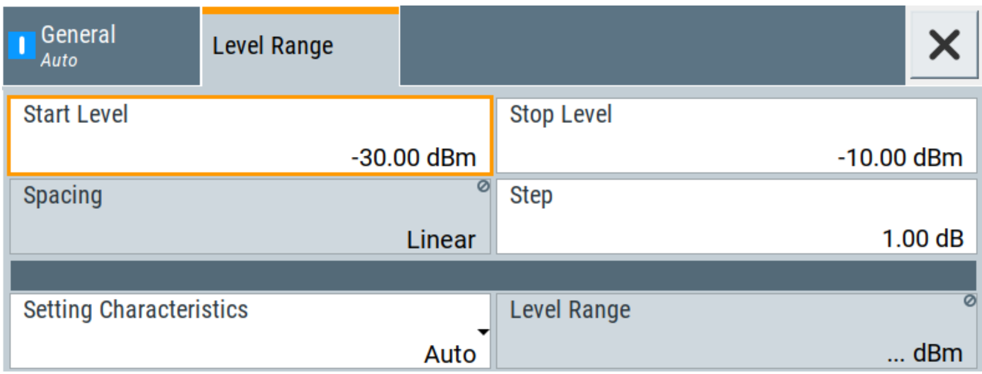
"Step Logarithmic"
The step width is determined logarithmically in %, i.e. as a constant fraction of the current frequency.

Remote command:
`[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear]` on page 731
`[:SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic` on page 731

8.9.5.4 Level Range Settings

Access:

1. Select "RF" > "Sweep/List" > "RF Level Sweep"
2. Select for example "Level Range".



Settings

Start Level / Stop Level
Defines the RF level sweep range by setting the start and end values.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Remote command:
RF level sweep:
`[:SOURce<hw>]:POWer:STARt` on page 717
`[:SOURce<hw>]:POWer:STOP` on page 717

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 728

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, as specified in the data sheet.
The RF signal is shortly blanked when the step attenuator is switching.

"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.

Remote command:
`[:SOURce<hw>]:POWer:LBEHaviour` on page 715

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 720
`[:SOURce<hw>]:POWer:RANGe:UPPer?` on page 720

8.9.6 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:

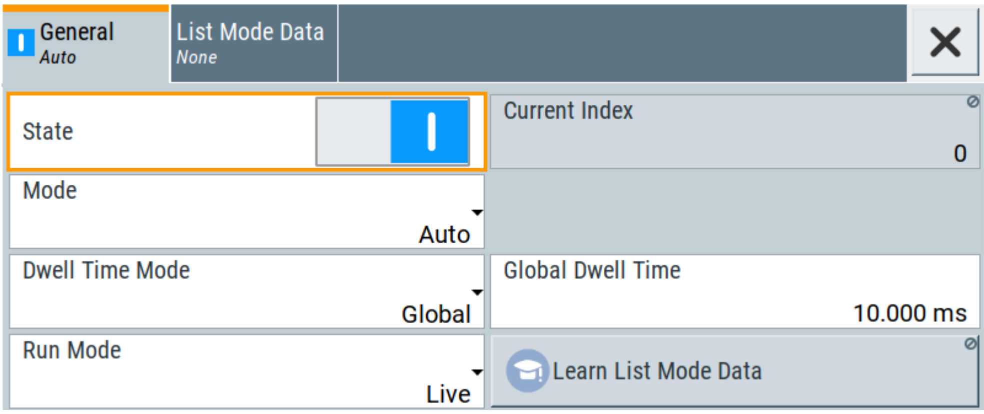
▶ Select "RF" > "Sweep/List" > "List mode".

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 Chapter 13.15.9, "SOURce:LIST Subsystem", on page 698.

8.9.6.1 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

Activates the list mode and processes the currently selected list.

Note: Active sweep mode deactivates other sweeps or lists and vice versa.

Remote command:
`[:SOURce<hw>]:FREQuency:MODE` on page 687

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 704

Mode

Selects the mode for list processing.

See Chapter 8.9.1, "Signal Generation and Triggering in the Sweep and List Modes", on page 306.

"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 706
`[:SOURce<hw>]:LIST:MODE` on page 705

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 Chapter 8.9.7, "List Editor", on page 335.

Remote command:
[:SOURce<hw>]:LIST:DWELl:MODE on page 702

Global Dwell Time
Sets the dwell time for Dwell Time Mode > "Global".

Note: In case of considerable overrun conditions, the R&S SMCV100B turns off the list mode.

See also "Dwell time" on page 318.

Remote command:
[:SOURce<hw>]:LIST:DWELl on page 702

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 320.

Remote command:
[:SOURce<hw>]:LIST:RMODe on page 705

Learn List Mode Data
See also "When to use the "Learn List Mode Data" function" on page 320.

Remote command:
[:SOURce<hw>]:LIST:LEARn on page 705

Trigger Slope
For "Mode = Extern Step/Single", selects the polarity of the active slope of an applied instrument trigger.

Trigger signal is expected at one of the "User x" connectors.

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

"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]:INPut:TRIGger:SLOPe on page 692

Show Connector
Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Chapter 11.2.2.3, "Status Indicators", on page 422).

Reset
Resets the list to the starting point.

Remote command:
`[:SOURce<hw>]:LIST:RESet` on page 709

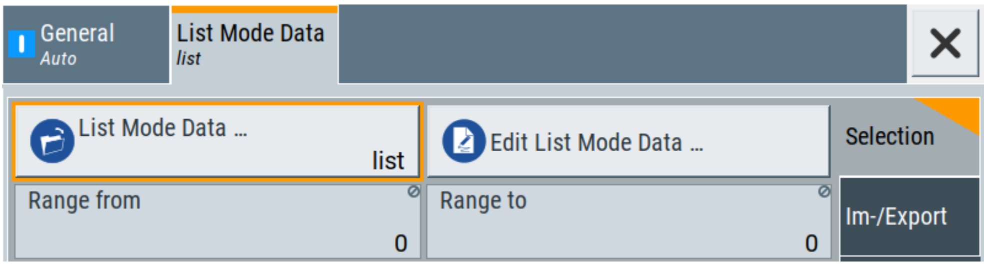
Execute Single
Manually starts list processing in "Single" mode.

Remote command:
`[:SOURce<hw>]:LIST:TRIGger:EXECute` on page 706

8.9.6.2 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
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 317.

Remote command:
`[:SOURce<hw>]:LIST:CATalog?` on page 708
`[:SOURce<hw>]:LIST:SELect` on page 709
`[:SOURce<hw>]:LIST:DELete` on page 708
`[:SOURce<hw>]:LIST:DELete:ALL` on page 708

Edit List Mode Data
Opens the editor to insert and save data lists with RF frequency, power and dwell time values, see Chapter 8.9.7, "List Editor", on page 335.

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.

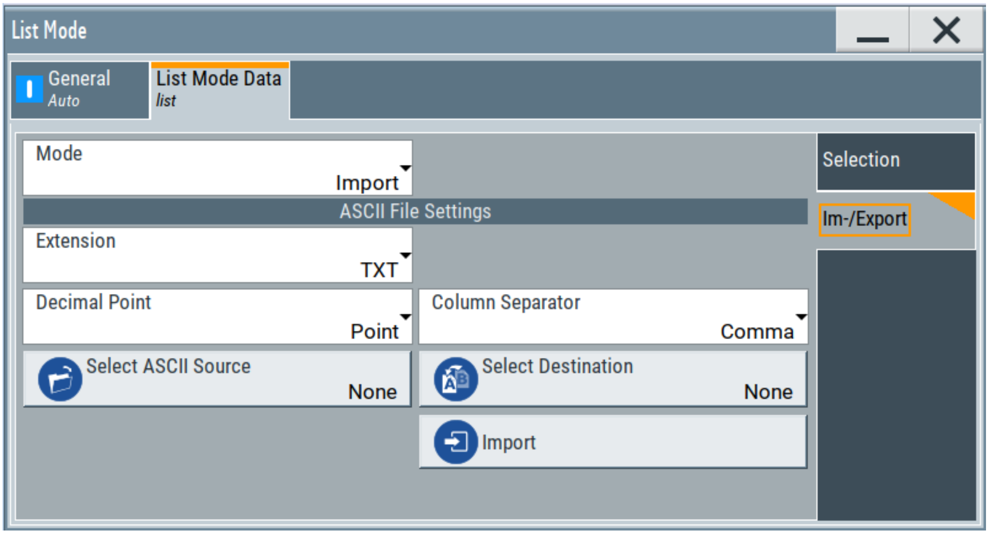
The instrument generates the signal with the values of the selected index range and ignores all other list entries.

Remote command:
`[:SOURce<hw>]:LIST:INDex:STARt` on page 704
`[:SOURce<hw>]:LIST:INDex:STOP` on page 704

8.9.6.3 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
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 712
`[:SOURce<hw>]:CORRection:DEXChange:MODE` on page 686

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 711
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal` on page 711
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn` on page 711
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension` on page 684
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal`
on page 685
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn`
on page 685

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 710
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect` on page 711
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog?` on page 684
`[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect` on page 685

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 712

[:SOURce<hw>]:CORRection:DEXChange:SELect on page 686

Import / Export

Imports or exports the selected data list file, depending on the current mode.

Remote command:

[:SOURce<hw>]:LIST:DEXChange:EXECute on page 710

[:SOURce<hw>]:CORRection:DEXChange:EXECute on page 685

8.9.7 List Editor

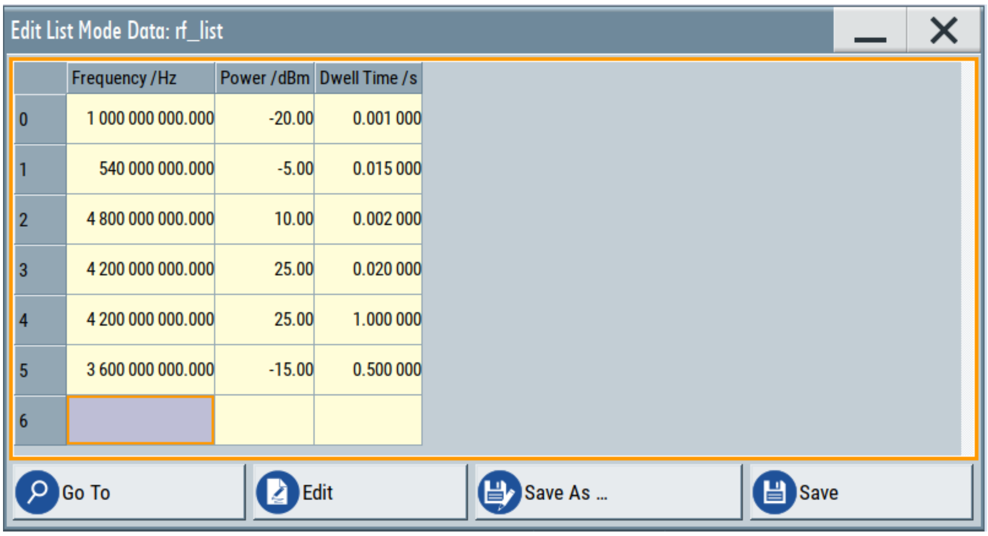
The "User Correction" and "List Mode" dialogs provide a build-in list editor for defining the corresponding value pairs.

The table and navigation functions of the UCOR and list mode editors have the same structure and are therefore summarized below. The access is specified for both modes, the fields and functions are explained using the example of the list mode.

Access to "Edit List Mode Data":

► "RF" > "Sweep/List" > "List Mode" > "List Mode Data" > "Edit List Mode Data"

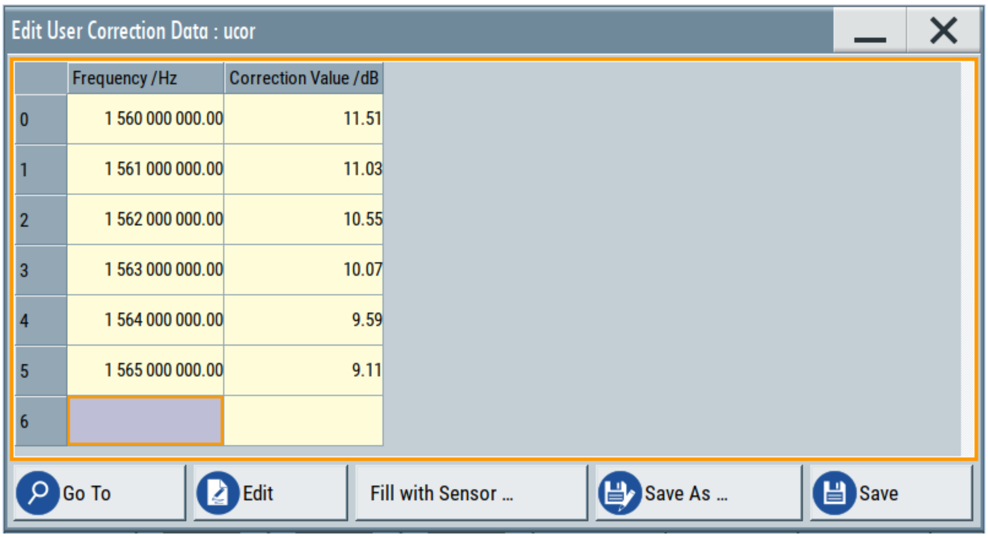
The editor for list mode provides a table with RF frequency and power values, an extra column for defining variable dwell times, and standard navigation functions.



The remote commands required to define the list mode data are described in Chapter 13.15.9, "SOURce:LIST Subsystem", on page 698.

Access to "Edit User Correction Data":

► "RF" > "RF Level" > "User Correction" > "Edit User Cor. Data"



The editor for user correction data provides a table with RF frequency and power values and standard navigation functions.

The remote commands required to define the user correction data are described in Chapter 13.15.4, "SOURce:CORRection Subsystem", on page 678.

All columns in a row must contain values. Cells with missing values are therefore filled automatically, using the value of the previous row.

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, shown by the example of the "Edit List Mdoe Data" dialog. If a function relates to a particular dialog, it is explicitly stated.

Settings

Edit List Mode Data

Table with values for list or user correction processing.

Note: 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.

"Frequency /Hz"

Sets the frequency values.

Remote command:
[:SOURce<hw>]:LIST:FREQuency on page 703
[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency on page 681

"Power /dBm" (list mode data table)

Sets the level values.

Remote command:
[:SOURce<hw>]:LIST:POWer on page 706

"Correction Value /dBm" (user correction data table)

Sets the level values.

Remote command:
[:SOURce<hw>]:CORRection:CSET:DATA:POWer on page 681

"Dwell /s"

In list mode, sets the dwell time values.

Remote command:
[:SOURce<hw>]:LIST:DWELl:LIST on page 702

Data handling keys

Standard functions for file and data handling.

Go To ← Data handling keys

Selects a row for editing.

Edit ← Data handling keys

Enables you to insert, or delete a row or ranges within a list, and provides access to a dialog for automatic filling, see " Fill... " on page 337.

Fill with Sensor ← Data handling keys

Opens a dialog to configure the automatic filling of user correction data with an R&S NRP power sensor. Available in UCOR mode only.

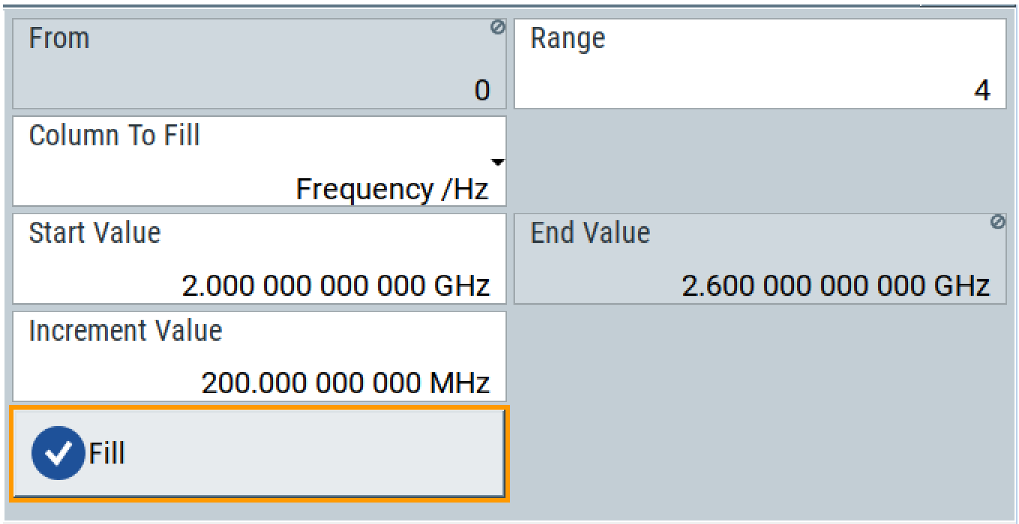
See Chapter 8.10.2.3, "Fill with Sensor", on page 350

Save As/Save ← Data handling keys

Stores the list 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".

8.9.8 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 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. Switch state to "On".

4. 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?`

8.10 Improving Level Performance

To adjust the RF output signal to specific needs in your application optimally, the R&S SMCV100B provides different functions:

- **Attenuator**
  The R&S SMCV100B 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 Chapter 8.10.1, "Attenuator", on page 341.
- **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 Chapter 8.10.2, "User Correction", on page 343.
- **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 SMCV100B 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 SMCV100B and monitor its readings, including calibration.

  See:
  – Chapter 8.10.3, "Using Power Sensors", on page 353
  – Chapter 8.10.4, "How to Calibrate the Power Level with an R&S NRP Power Sensor", on page 364
  – Chapter 8.10.3.2, "NRP Sensor Mapping", on page 355
  – Chapter 8.10.3.3, "NRP Power Viewer", on page 358

8.10.1 Attenuator

About the attenuator

According to the requirements of your application, you can select different attenuator characteristics.

The following are examples of test requirements and the corresponding configuration:

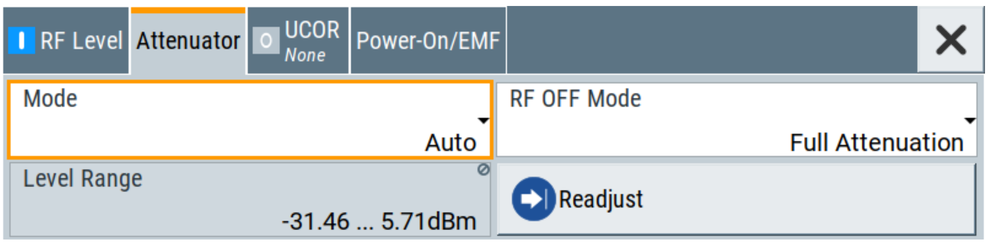
- Automatic configuration
  Select standard operation mode ("Auto"), in which the generator adjusts the attenuation of the RF output signal automatically.
- DUT tests under low signal to noise conditions
  Low output power is suitable to test the behavior of a DUT under low signal to noise conditions.
- 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.
- Noise sensitive applications
  The parameter "RF OFF Mode > Full Attenuation" sets maximum attenuation and thus suppresses noise when you turn off the RF signal.

8.10.1.1 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 Chapter 13.12, "OUTPut Subsystem", on page 546 and Chapter 13.15.11, "SOURce:POWer Subsystem", on page 713.

Settings

Mode

Determines the operating mode of the step attenuator.

"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 342.

Remote command:
:OUTPut<hw>:AMODe on page 548

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 548
:OUTPut<hw>:AFIXed:RANGe:UPPer? on page 548

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.

Remote command:
[:SOURce<hw>]:POWer:ATTenuation:RFOFf:MODE on page 714

8.10.1.2 Reverse Power Protection

The R&S SMCV100B 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 549
:OUTPut<hw>:PROTection:CLEar on page 549

8.10.2 User Correction

The R&S SMCV100B 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 SMCV100B 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.

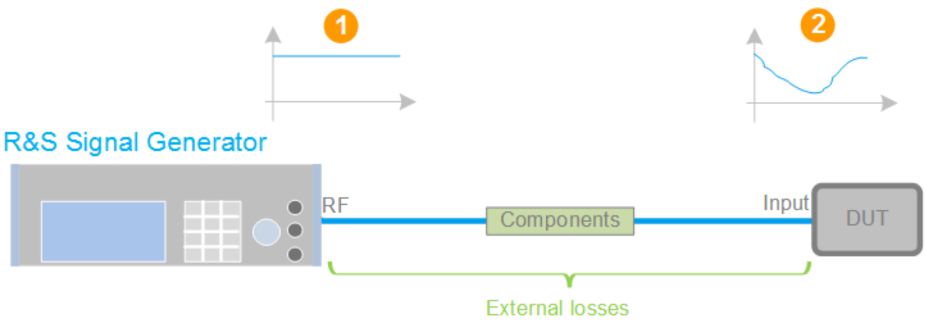


Figure 8-14: Effect of external losses on the signal flatness at the DUT input

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 SMCV100B
2	=	Signal received at the DUT, incl. the external losses

About UCOR

User correction (UCOR) is a method that determines the external level loss over a frequency range in advance, see Figure 8-15.

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 data sheet.

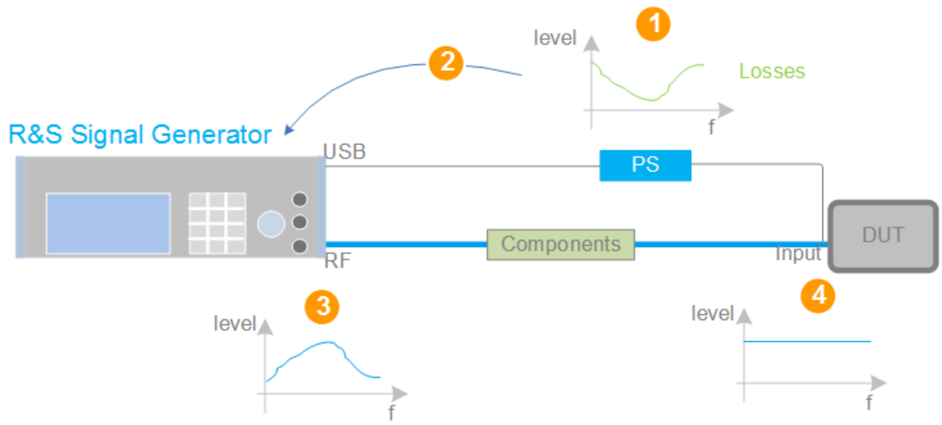


Figure 8-15: Understanding the principle of user correction

DUT	=	Device under test
Compo-nents	=	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 SMCV100B
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 SMCV100B and the DUT
2	=	Obtain the correction data by inverting the collected data; load the correction parameters in the R&S SMCV100B
3	=	In the R&S SMCV100B, 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 Chapter 10.7, "Using the File Manager", on page 402.

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.

Interactions and characteristics

Activated user correction is effective in all operating modes.

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"

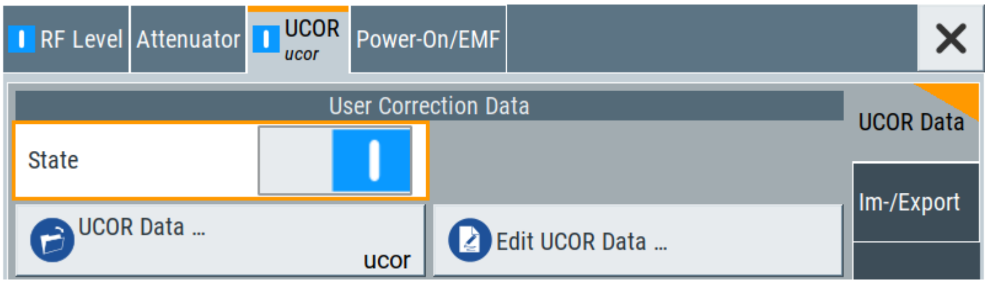
8.10.2.1 User Correction Settings

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 Chapter 8.10.2, "User Correction", on page 343.

4. Select block diagram > RF > "On".
5. Select "State > 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 Chapter 13.15.4, "SOURce:CORRection Subsystem", on page 678.

Settings

State

Activates user correction.

Remote command:
`[:SOURce<hw>]:CORRection[:STATe]` on page 683

User Correction

Indicates the corrected level value for a specific frequency point.

Remote command:
`[:SOURce<hw>]:CORRection:VALue?` on page 682

UCOR Data

Accesses 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`. When a file is selected, 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 the file *.uco > Select"

- Use the general editor function to create internally new 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 683
`[:SOURce<hw>]:CORRection:CSET[:SELect]` on page 682
`[:SOURce]:CORRection:CSET:DELete` on page 684

Edit UCOR Data
Opens the build-in table editor to define a new correction table or edit an existing one.

See also:
- Chapter 8.9.7, "List Editor", on page 335
- " Fill... " on page 337
- Chapter 8.10.2.3, "Fill with Sensor", on page 350

8.10.2.2 List Editor

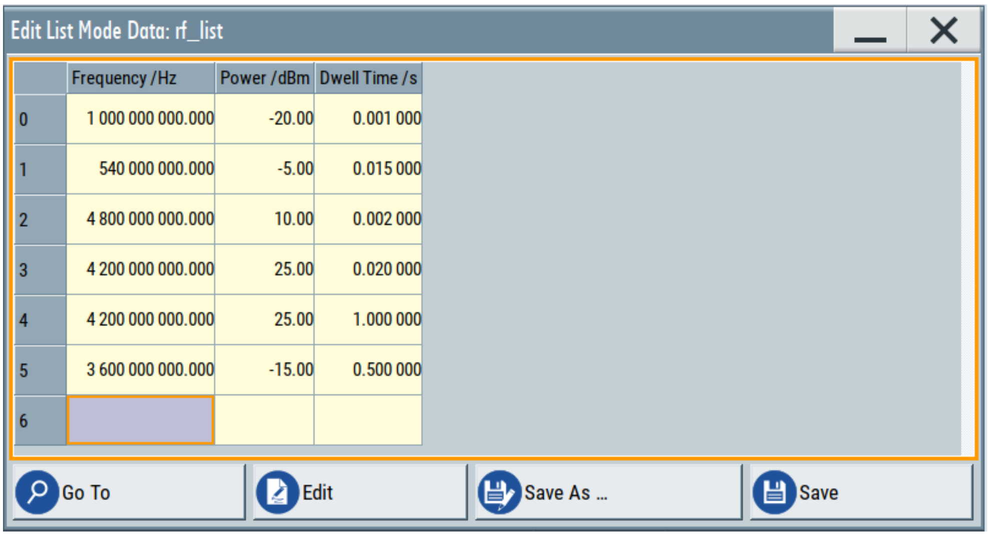
The "User Correction" and "List Mode" dialogs provide a build-in list editor for defining the corresponding value pairs.

The table and navigation functions of the UCOR and list mode editors have the same structure and are therefore summarized below. The access is specified for both modes, the fields and functions are explained using the example of the list mode.

Access to "Edit List Mode Data":

► "RF" > "Sweep/List" > "List Mode" > "List Mode Data" > "Edit List Mode Data"

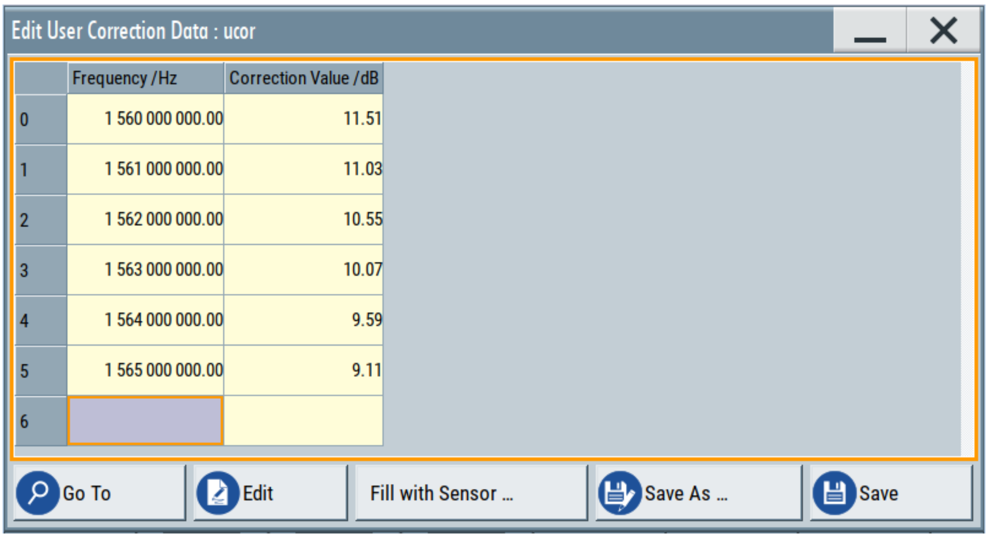
The editor for list mode provides a table with RF frequency and power values, an extra column for defining variable dwell times, and standard navigation functions.



The remote commands required to define the list mode data are described in Chapter 13.15.9, "SOURce:LIST Subsystem", on page 698.

Access to "Edit User Correction Data":

► "RF" > "RF Level" > "User Correction" > "Edit User Cor. Data"



The editor for user correction data provides a table with RF frequency and power values and standard navigation functions.
The remote commands required to define the user correction data are described in Chapter 13.15.4, "SOURce:CORRection Subsystem", on page 678.

All columns in a row must contain values. Cells with missing values are therefore filled automatically, using the value of the previous row.

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, shown by the example of the "Edit List Mdoe Data" dialog. If a function relates to a particular dialog, it is explicitly stated.

Settings

Edit List Mode Data

Table with values for list or user correction processing.

Note: 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.

"Frequency /Hz"

Sets the frequency values.

Remote command:
[:SOURce<hw>]:LIST:FREQuency on page 703
[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency on page 681

"Power /dBm" (list mode data table)

Sets the level values.

Remote command:
[:SOURce<hw>]:LIST:POWer on page 706

"Correction Value /dBm" (user correction data table)

Sets the level values.

Remote command:
[:SOURce<hw>]:CORRection:CSET:DATA:POWer on page 681

"Dwell /s"

In list mode, sets the dwell time values.

Remote command:
[:SOURce<hw>]:LIST:DWELl:LIST on page 702

Data handling keys

Standard functions for file and data handling.

Go To ← Data handling keys

Selects a row for editing.

Edit ← Data handling keys

Enables you to insert, or delete a row or ranges within a list, and provides access to a dialog for automatic filling, see " Fill... " on page 337.

Fill with Sensor ← Data handling keys

Opens a dialog to configure the automatic filling of user correction data with an R&S NRP power sensor. Available in UCOR mode only.

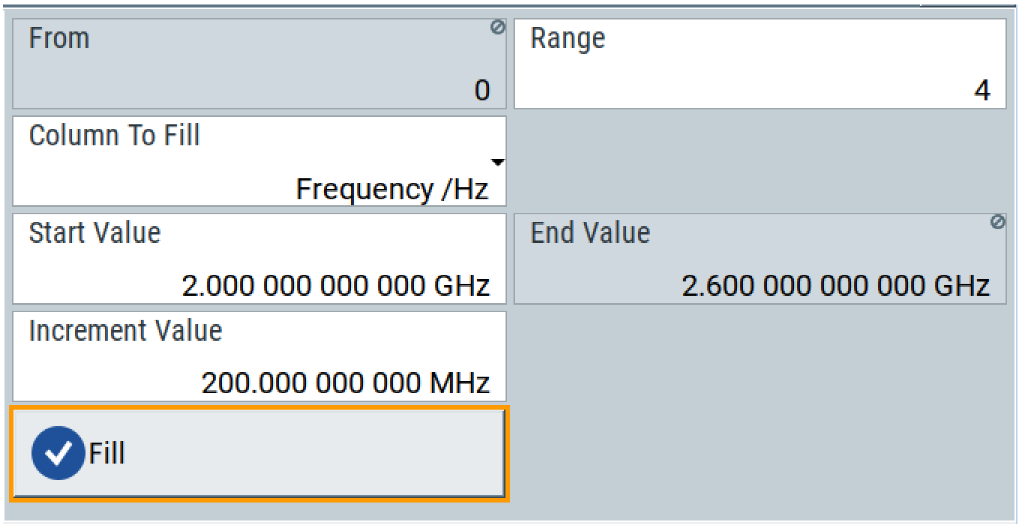
See Chapter 8.10.2.3, "Fill with Sensor", on page 350

Save As/Save ← Data handling keys

Stores the list 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".

8.10.2.3 Fill with Sensor

Access:

► Select "RF" > "RF Level" > "User Correction".

This dialog contains parameters for filling a table automatically with sensor readings.

To fill the table, select "Execute".

For information on power sensors an how to use them, see Chapter 8.10.4, "How to Calibrate the Power Level with an R&S NRP Power Sensor", on page 364.

Settings

Fill User Correction Data with Sensor

- "Sensor"
  Displays connected sensors for selection.
- "List To Fill"
  Indicates the used list.
- "Use SParameter"
  Indicates whether SParameter correction in the R&S NRP power sensor is used.
- "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 might be blanked shortly. This setting is useful if blanking of RF is undesirable or the absence of power at the sensor cannot be guaranteed.
- "Execute"

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:ZERoing:STATe` on page 683
`[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe`
on page 682

Used SMCV100B Settings For Measurement

Displays the settings relevant for the measurement.

"Modulation"	Indicates the modulation state
"Amplitude"	Shows the currently set level.

Remote command:
n.a.

8.10.2.4 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".

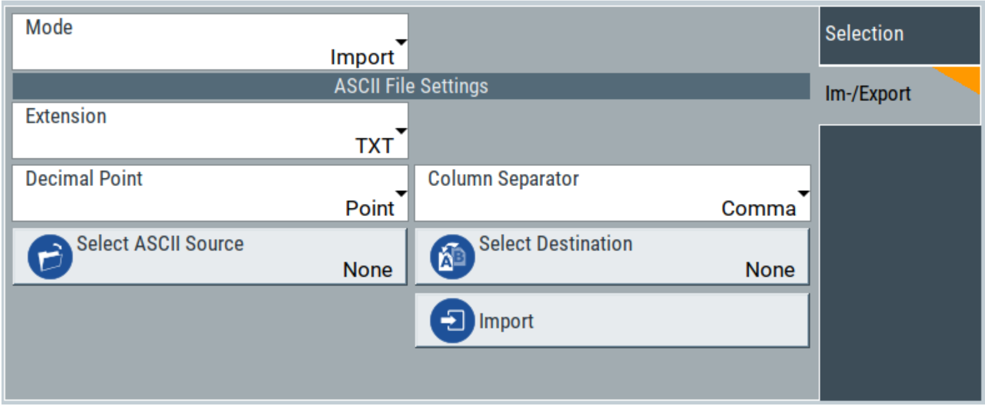


Figure 8-16: Im-/Export dialog (example with UCOR settings)

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

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 712
`[:SOURce<hw>]:CORRection:DEXChange:MODE` on page 686

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 711
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal` on page 711
`[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn` on page 711

[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension on page 684
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal on page 685
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn on page 685

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 710
[:SOURce<hw>]:LIST:DEXChange:AFILe:SELect on page 711
[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog? on page 684
[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect on page 685

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 712
[:SOURce<hw>]:CORRection:DEXChange:SELect on page 686

Import / Export

Imports or exports the selected data list file, depending on the current mode.

Remote command:

[:SOURce<hw>]:LIST:DEXChange:EXECute on page 710
[:SOURce<hw>]:CORRection:DEXChange:EXECute on page 685

8.10.3 Using Power Sensors

The R&S SMCV100B works with most 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.

R&S NRP sensors are highly accurate standalone measuring devices, suitable for a wide range of applications. The devices 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 SMCV100B works with any sensor of the R&S NRP series and can perform 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 http://www.rohde-schwarz.com in section "Power Meters & Voltmeters".

For more information about working with power sensors, see the following topics:

- Chapter 8.10.3.1, "Connecting R&S NRP Power Sensors to the R&S SMCV100B", on page 354
  Overview on the supported connectors, connection options and the required accessories.
- Chapter 8.10.3.2, "NRP Sensor Mapping", on page 355
  Shows all R&S NRP sensors connected to the instrument, or in the LAN.
- Chapter 8.10.3.3, "NRP Power Viewer", on page 358
  A function for measuring and monitoring the RF output power or a user-defined signal source.

8.10.3.1 Connecting R&S NRP Power Sensors to the R&S SMCV100B

Connection	Sensor Type (incl. USB Hub)	Cables/Acessories	Characteristics
"USB" type A	R&S NRPxx	R&S NRP-ZKU	USB interface cable
	R&S NRP-Zxx	R&S NRP-Z3 R&S NRP-Z4	USB adapter cables
	R&S NRP-Z5 USB sensor hub (high-speed USB 2.0)	Standard USB cable (USB type A to USB type B)	This connection does not support external triggering.
	Standard USB hub with external power supply unit R&S NRPxx	R&S NRP-ZKU	USB interface cable
	Standard USB hub with external power supply unit R&S NRP-Zxx	R&S NRP-Z3 R&S NRP-Z4	USB adapter cables
LAN	R&S NRPxxxSN/xxxTN/xxxAN	• 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.	Using the Ethernet interface requires PoE (Power over Ethernet) to provide the electrical power.

R&S NRP sensors are connected to the R&S SMCV100B in the following ways:

- 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. It provides simultaneous internal and external triggering of all connected 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 SMCV100B. 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®Series Power Sensors Getting Started.

Detection and mapping

The R&S SMCV100B automatically detects a connected R&S NRP power sensor and indicates it in the "NRP Power Viewer" and "NRP Sensor Mapping" dialogs.

You can change the default mapping in the NRP Sensor Mapping dialog.

On connection, the R&S SMCV100B immediately starts the measurement of a detected R&S NRP power sensor. If you perform an instrument preset ([Preset] key or `*RST`), the R&S SMCV100B stops the measurements. The connection and the mapping of the power sensors remain, the measurements must be restarted.

8.10.3.2 NRP Sensor Mapping

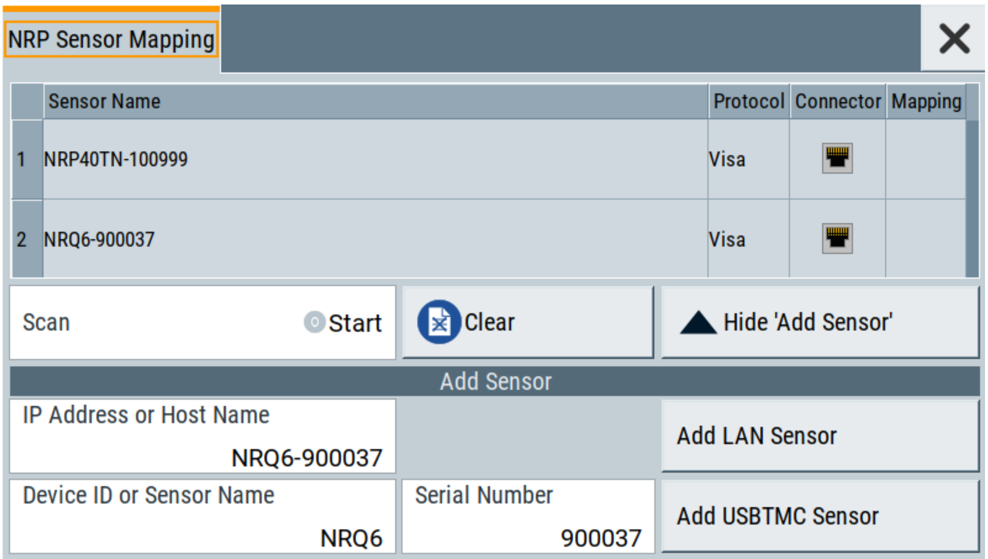
The "NRP Sensor Mapping" lists all R&S NRP sensors detected by the instrument.

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. Vice versa, the R&S SMCV100B removes a sensor from the list, when it is disconnected.

R&S NRP sensors that are connected via LAN or use the USBTMC protocol are not automatically detected. They are 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 detected sensors are characterized by the used protocol and the corresponding connector icon. In the "Mapping" column, you can assign the sensor to one of the available sensor channels. The list can contain several entries but the R&S SMCV100B can only use up to four sensors simultaneously.
The remote commands required to define these settings are described in Chapter 13.13, "SENSe, READ, INITiate and SLISt Subsystems", on page 549.

Settings

Sensor Mapping List

Displays a list of all sensor entries with information on the sensor name, the used protocol, the connector and the assigned mapping.

If a sensor is connected via LAN or uses the USBTMC protocol, its protocol is indicated as "Visa".

Remote command:
:SLISt[:LIST]? on page 553
:SLISt:ELEMent<ch>:MAPPing on page 555
:SLISt:SENSor:MAP on page 555

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 553

Clear
Adds the ID parameter of a detected sensor to the list of sensors.

Add Sensor/Hide 'Add Sensor'
Shows or hides the "Add Sensor" settings.

Add Sensor settings
Configures settings to add sensors connected to the R&S SMCV100B via USB or LAN.

Add LAN Sensor settings ← Add Sensor settings
Configures settings to add sensors connected to the R&S SMCV100B via 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 SMCV100B 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 553

Add USB Sensor settings ← Add Sensor settings
Configures settings to add sensors connected to the R&S SMCV100B via USB.

"Device ID or Sensor Name"	Displays the device identifier or the name of the R&S NRP power sensor. If the R&S SMCV100B does not detect a connected R&S NRP sensor, you can assign the ID or name manually.
"Serial Number"	Displays the serial number of the R&S NRP power sensor. If the R&S SMCV100B does not detect a connected R&S NRPsensor, 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 554

8.10.3.3 NRP Power Viewer

The R&S SMCV100B features the power viewer function for measuring or monitoring signals with R&S NRP power sensors.

The R&S SMCV100B can perform up to four power measurements simultaneously. The measured signals can be the RF output power or other selected signal sources.

About

The R&S SMCV100B 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 to much noise in your setup, by a bad supression 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.

Depending on the R&S NRP power sensor type, the manual setting of the filter length varies in resolution:

- Resolution = 1 for the R&S NRPxx power sensor family
- Resolution = 2^n for R&S NRP-Zxx power sensors, with n = 1 to 16

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.
- Different sensor types achieve the same filtering result with different filter and time window lengths.

  The time window length depends on the sensor type:
  - For most sensors, it is fixed to 20 ms.
  - For the R&S NRP-Z81 sensor, it is 10 μs.
    The R&S NRP-Z81 uses filter length that is 1000 times larger than the filter length for other sensors.

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:
- Software version of the connected power sensor:
  `:SENSe<ch>[:POWer]:TYPE?` on page 563
- Acquisition of level correction data:

Additional information

See Rohde & Schwarz website http://www.rohde-schwarz.com in 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 "Overview" tab shows the list of detected sensors, and provides a separate tab per sensor.

A sensor tab contains all parameters for configuring the sensor settings, like average or peak display, reference source, filter and level offset.
The remote commands required to define these settings are described in Chapter 13.13, "SENSe, READ, INITiate and SLISt Subsystems", on page 549, including the triggering of the measurement and the retrieval of measurement results.

Settings:

Sensor type and serial number

Indicates the type and the serial number of the selected R&S NRP power sensor, and the channel the sensor is assigned to.

The displayed Level (Peak) / Level (Average) values correspond to the particular sensor.

Remote command:
`:SENSe<ch>[:POWer]:TYPE?` on page 563
`:SENSe<ch>[:POWer]:SNUMber?` on page 562

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 556
`:SENSe<ch>:UNIT[:POWer]` on page 556

Sensor Mapping
Accesses the NRP Sensor Mapping dialog.

Sensor Settings
One tab per sensor provides the corresponding setting parameters.

State ← Sensor Settings
Activates level measurement.

Remote command:
`:INITiate<hw>[:POWer]:CONTinuous` on page 555
To query the availability of a sensor at a given connector, use the command `:SENSe<ch>[:POWer]:STATus[:DEVice]?` on page 563.

Zero ← Sensor Settings
Activates the auto zeroing.

For details, see "About zeroing" on page 359.

Remote command:
`:SENSe<ch>[:POWer]:ZERO` on page 563

Use Frequency Of ← Sensor Settings
Selects the source for measurement.

"RF" The R&S SMCV100B 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 SMCV100B. 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 562

Frequency ← Sensor Settings
Defines the frequency value if "Source > User" is used.

Remote command:
`:SENSe<ch>[:POWer]:FREQuency` on page 561

Level Offset State,Level Offset ← Sensor Settings
Activates and defines a level offset which is considered in the power meassurement 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 562
`:SENSe<ch>[:POWer]:OFFSet:STATe` on page 562

Filter ← Sensor Settings
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 358.

"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 560

Filter Length ← Sensor Settings
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 558
`:SENSe<ch>[:POWer]:FILTer:LENGth[:USER]` on page 559

Auto Once ← Sensor Settings
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 358.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:SONCe` on page 560

Noise/Signal Ratio ← Sensor Settings
For Filter > Fixed Noise, sets the noise content.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:NSRatio` on page 559

Timeout ← Sensor Settings
For "Filter > Fixed Noise", sets a time limit for the averaging process.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe` on page 559

Default Aperture Time ← Sensor Settings
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 557

Aperture Time ← Sensor Settings
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 557

S-Parameter ← Sensor Settings
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 558
`:SENSe<ch>[:POWer]:CORRection:SPDevice:LIST?` on page 558
`:SENSe<ch>[:POWer]:CORRection:SPDevice:SELect` on page 557

Enable Logging ← Sensor Settings
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 561

8.10.4 How to Calibrate the Power Level with an R&S NRP Power Sensor

Using a R&S NRP power sensor and the user correction function of the instrument, you can compensate external frequency responses. The R&S SMCV100B 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 SMCV100B

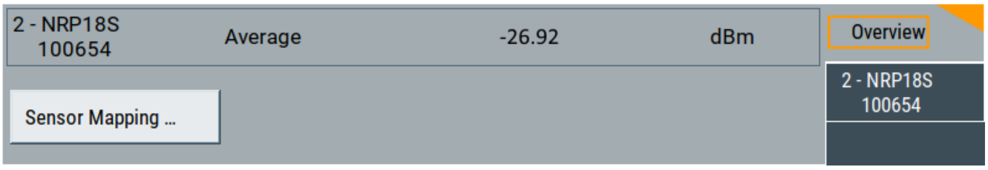
1. Connect the power sensor.
   See Chapter 8.10.3.1, "Connecting R&S NRP Power Sensors to the R&S SMCV100B", on page 354.
2. Select "RF" > "RF Measurement" > "NRP Sensor Mapping".
3. If the sensor is not detected automatically, select "Scan > Start".

   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 Chapter 8.10.3.2, "NRP Sensor Mapping", on page 355.
5. Close the dialog.

To configure and calibrate the R&S NRP in the R&S SMCV100B

Provided the power sensor is connected to the R&S SMCV100B and is assigned to a sensor channel, we recommend that you calibrate and configure the power sensor in the "NRP Power Viewer" dialog.

1. In the block diagram > RF, turn off the RF output signal.
2. Select "RF" > "RF Measurement" > "NRP Power Viewer".

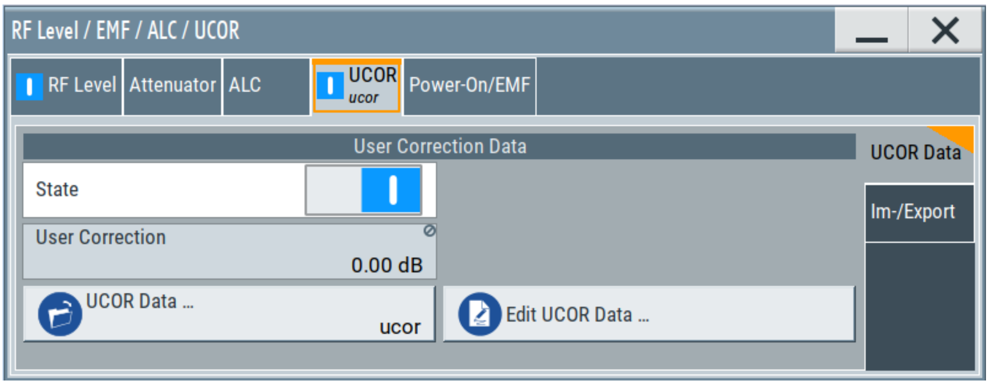


3. If the R&S SMCV100B has detected several connected power sensors, select the tab of the sensor you want to use.
4. Select "Zero" to start zeroing of the sensor.
   Note: Always turn the RF power off or disconnect the sensor from RF before zeroing, since the function calibrates the power sensor at 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.

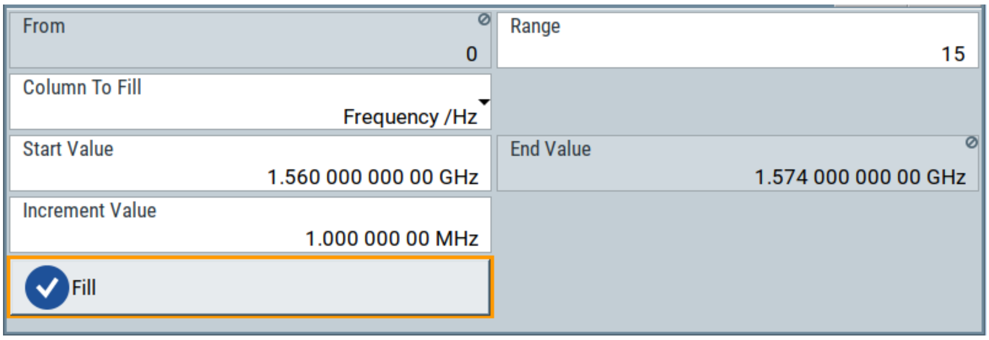
To create user correction data with an R&S NRP and the R&S SMCV100B

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 SMCV100B 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 perform power leveling calibration with user correction data

We assume that a user correction file is available in the user directory of the R&S SMCV100B 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 SMCV100B considers the user correction data and adjusts the signal level accordingly to compensate external frequency responses.

9 Monitoring Signal Characteristics

The R&S SMCV100B is a highly configurable signal generator with level settings distributed over several dialogs. To optimize the signal generation process and to help monitoring the variation of the signal parameters through the instrument, the R&S SMCV100B is equipped with a real time graphical signal display. This section explains the provided functions for monitoring of the signal characteristics in real time. Here you can also find out how to visualize the generated signal with measurement diagrams.

9.1 Displaying Baseband Signal Characteristics in Real-Time

In test setups, you usually use signal and spectrum analyzers or an oscilloscope to display and analyze the characteristics of the generated signal. In the R&S SMCV100B, you can also use the built-in graphical signal display function and visualize a subset of signal characteristics.

9.1.1 Required Options

The minimum equipment layout for using this function includes the base unit.

9.1.2 About the Graphical Signal Display

To ease the setting and routing of baseband signals, R&S SMCV100B 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 diagrams.

9.1.2.1 Available Diagrams

This section focuses on graphical signal displays, their content and application. See Table 9-1 for an overview of the signal characteristics you can monitor.

Table 9-1: Graphics modes overview

Graphics modes	Domain	Measurement is known from this instrument
I/Q Diagram	Time	Oscilloscope (standard mode)
Vector Diagram	Time	Oscilloscope (XY mode)

Graphics modes	**Domain**	**Measurement is known from this instrument**
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

I/Q Diagram

The I/Q diagram displays the inphase component (i[t]) and quadrature component (q[t]) of the I/Q signal over time.

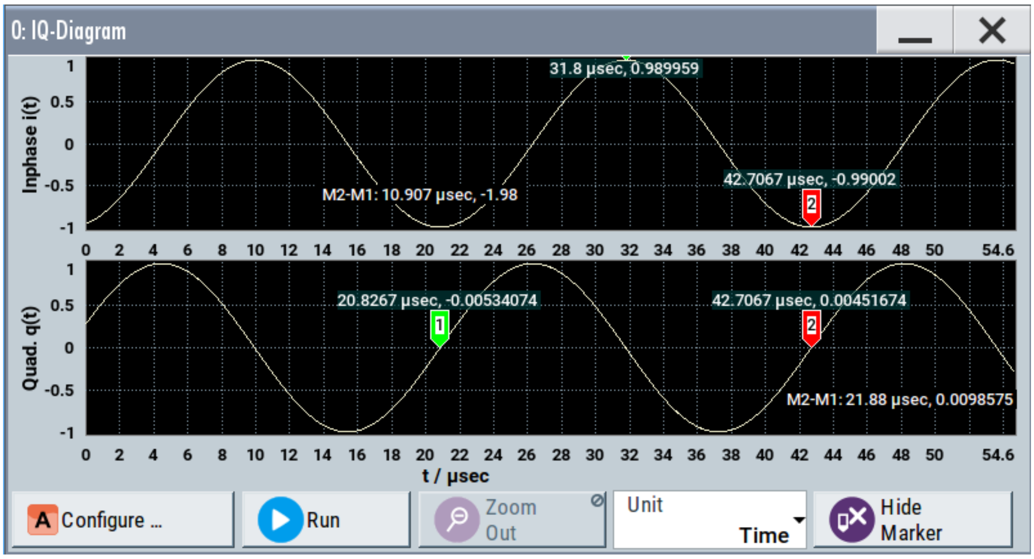


Figure 9-1: I/Q diagram with markers

= window with two separate coordinate systems with identical X and Y axes
X-axis = time represented as number of symbols, chips, or samples 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 9-2.

Vector Diagram

The vector diagram displays the Q component over the I component. All points in the complex domain are connected by lines.

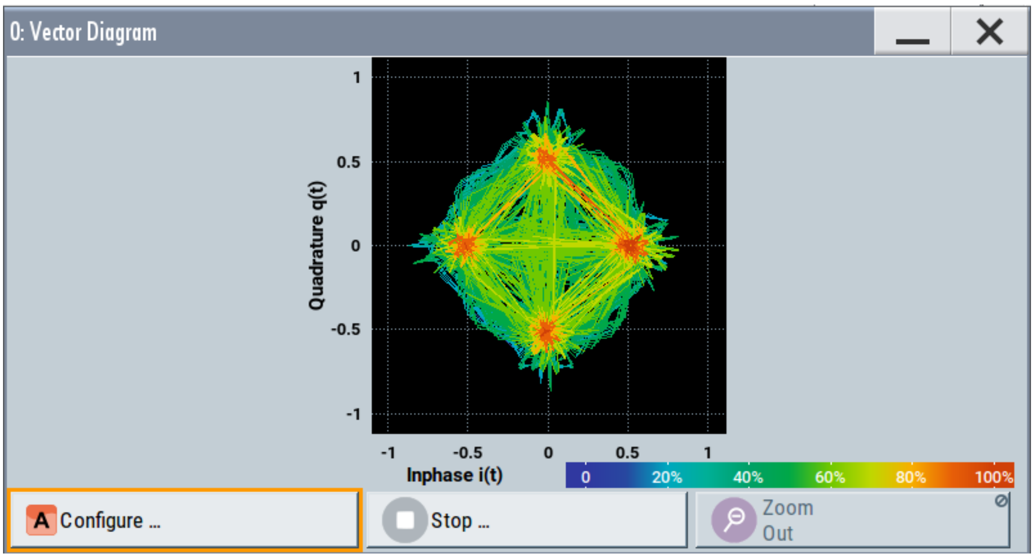


Figure 9-2: Vector diagram (64 QAM)

X-axis, Y-axis = amplitudes of the signal components, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +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 9-2.

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 "Custom Digital Modulation > Modulation" dialog.

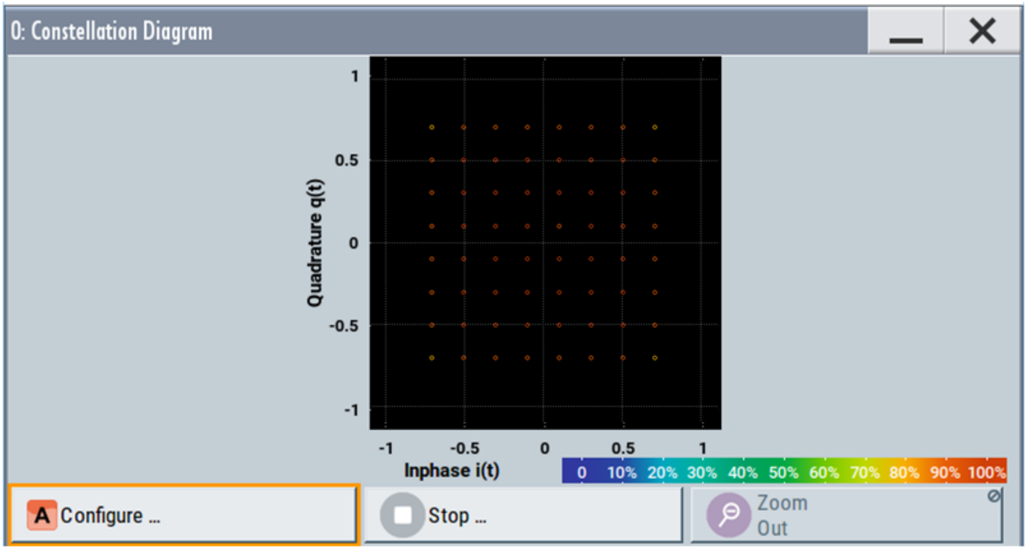


Figure 9-3: Constellation diagram (64 QAM)

X-axis, Y-axis = amplitudes of the signal components, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

Application: To classify modulation.

Signal acquisition points: See Table 9-2.

Eye Diagram

The eye diagram displays synchronized and superimposed sections of either the in-phase or the quadrature components of the signal.

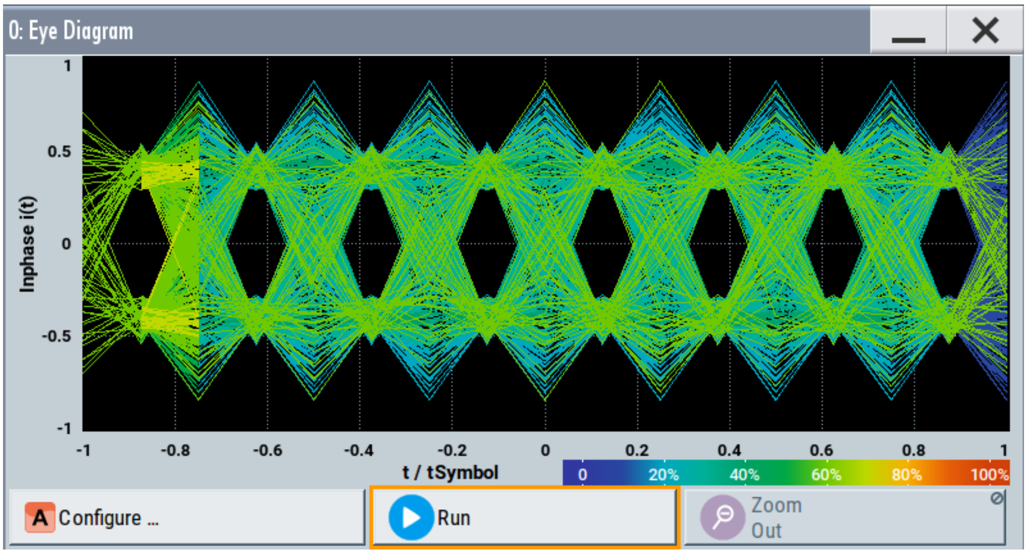


Figure 9-4: Eye diagram with partially closed eye (QPSK)

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 hundreds 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 9-2.

CCDF Display

The complementary cumulative distribution function (CCDF) displays the probability with which the output signal exceeds the average power.

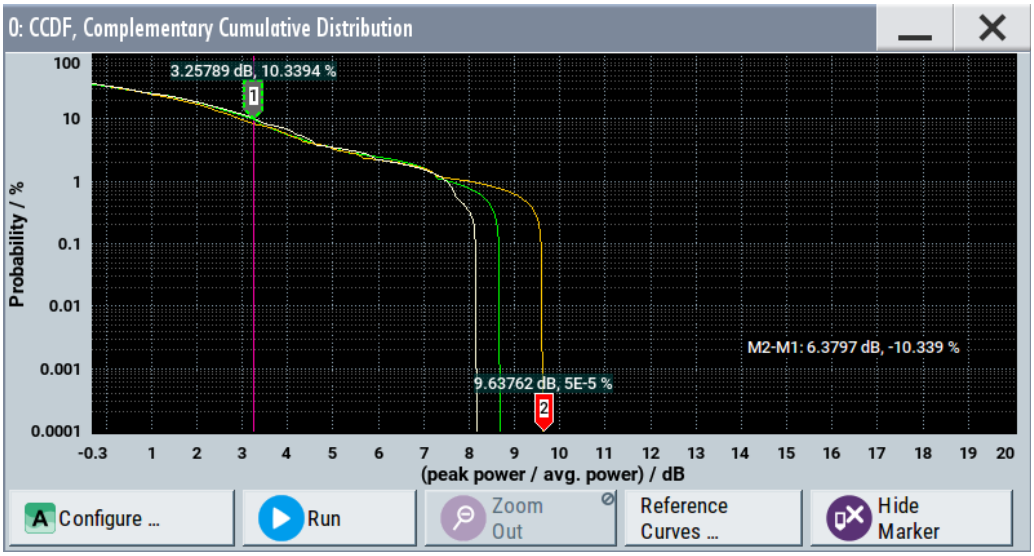


Figure 9-5: CCDF diagram of a 5 MHz LTE Signal (Level -30 dBm) and two reference curves

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: 10.3% of the samples exceed 3.3 dB above average; simularilly 1% of the samples exceed 7.5 dB above avarage (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 KSamples and corresponds to a signal with the following characteristics:

- "Baseband > LTE" and "Test Model > E-TM1_1__5 MHz"
- "Status bar > Level = - 30 dBm" and "Status bar > 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 would correspond 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 9-2.

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.

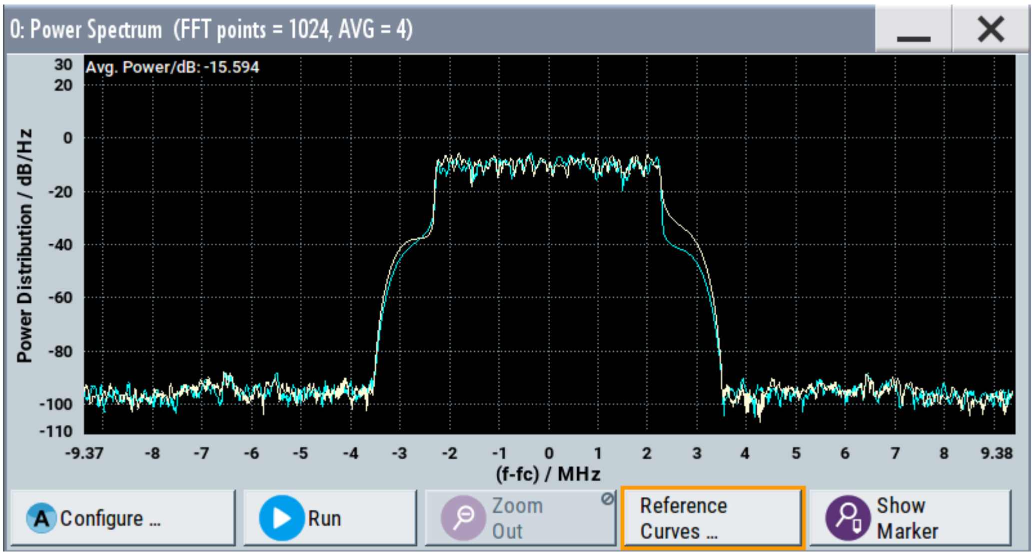


Figure 9-6: Power spectrum diagram of a 5 MHz LTE signal with enabled reference curve (blue)

"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 9-2.

9.1.2.2 Signal Acquisition Points

Signal characteristics can be displayed using different methods and different acquisition points, also at the same time.

The following signal acquisition points are available:

- Baseband signals
- Input streams of the "IQ Stream Mapper"
- Analog outputs
- Digital output streams of the "IQ Stream Mapper"

The Table 9-2 shows which signal acquisition point is suitable for which kind of graphical signal display.

Table 9-2: Signal acquisition points for the different graphical signal displays

Graphics modes	Signal acquisition points
I/Q diagram, vector diagram, CCDF diagram, power spectrum diagram	All
Constellation diagram, eye diagram	Baseband signals

9.1.2.3 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.

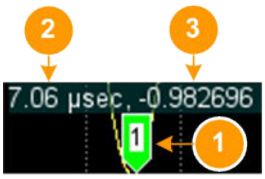
See also "To zoom into a diagram" on page 384.

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.

<table>
<tr><th>Single marker indication</th><th>Delta marker indication</th></tr>
<tr><td>

• 1 = marker number
• 2 = marker position on the x-axis in the current units
• 3 = marker value on the y-axis</td>
<td>

• 1 = delta marker
• 2, 3 = result of the marker function, i.e. the delta values in the current units</td></tr>
</table>

See also "To enable markers to readout exact measured data" on page 384.

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.

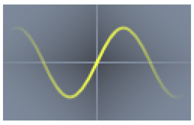
Reference trace

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 SMCV100B supports up to five reference traces. You can load reference traces and activate them simultaneously.

9.1.3 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 "Taskbar > System Config > Graphics" or use the wave icon.

   The "Graphics Configuration" dialog opens.

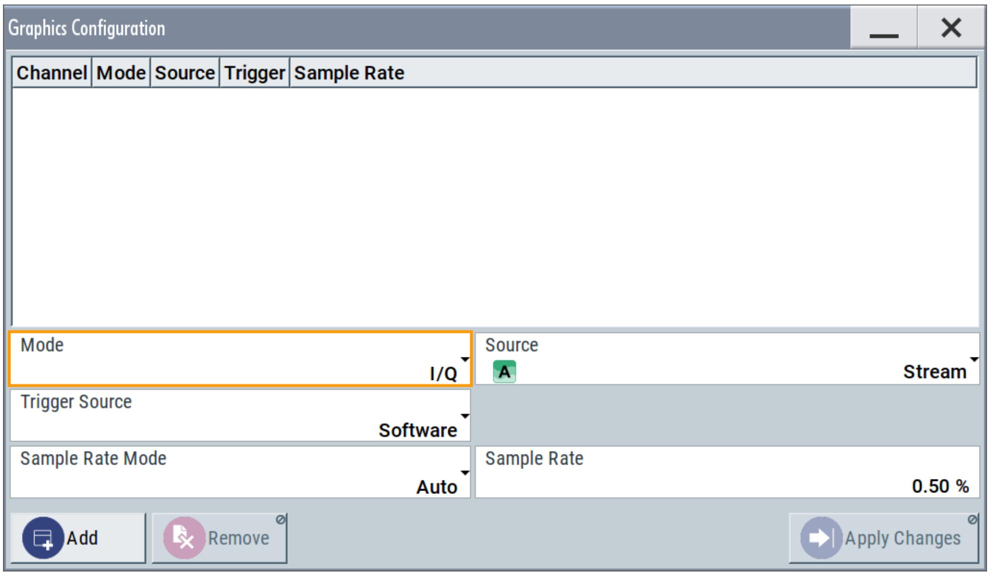


Figure 9-7: Graphics configuration dialog

2. To determine the kind of signal display, 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.

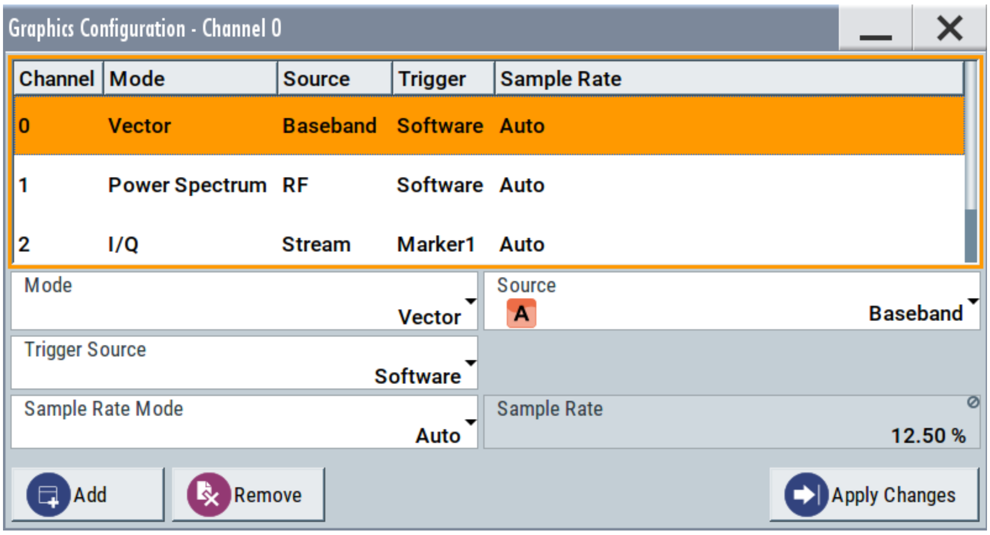


Figure 9-8: Graphics configuration dialog with active graphical signal displays

5. To enlarge the thumbnail, select it.

Settings:

Graphical Diagrams Table

The active graphical signal displays are listed in the table at the top of the dialog.

Mode

Determines the graphics mode, see Chapter 9.1, "Displaying Baseband Signal Characteristics in Real-Time", on page 368.

Remote command:
`[:SOURce<hw>]:BB:GRAPhics:MODE` on page 675

Source

Defines the signal acquisition point, see Chapter 9.1.2.2, "Signal Acquisition Points", on page 373.

Remote command:
`[:SOURce]:BB:GRAPhics:SOURce` on page 676

FFT Length
In "Mode > Power Sepectrum", selects the number of samples to be included in the graph of the power spectrum.

Remote command:
`[:SOURce]:BB:GRAPhics:FFTLen` on page 677

Full Scale (dBFS)
In "Mode > Power Spectrum", determines 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 677

Trigger Source
Defines the trigger 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 677

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 675

Sample Rate

- If "Sample Rate Mode = Auto/Full Bandwidth"
  Displays the percentage of the entire signal bandwidth which is used for the graphical signal display.
- If "Sample Rate Mode = User"
  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 676

Add

Adds a graphical signal display (as set in the "Graphics Configuration" dialog) to the taskbar/graphical diagrams table.

Remote command:
`[:SOURce]:BB:GRAPhics:ADD` on page 676

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 676.
Note, that this command closes all graphical signal displays.

9.1.4 Graphical Signal Display Settings

Access:

1. Select "Taskbar > System Config > Graphics > Add".
2. Double click the thumbnail in the taskbar.

This section focuses on the functions of the enlarged graphical signal displays.

Settings:

Configure
Opens the "Graphics Configuration" dialog, see Chapter 9.1.3, "Graphics Configuration Settings", on page 375.

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 384.

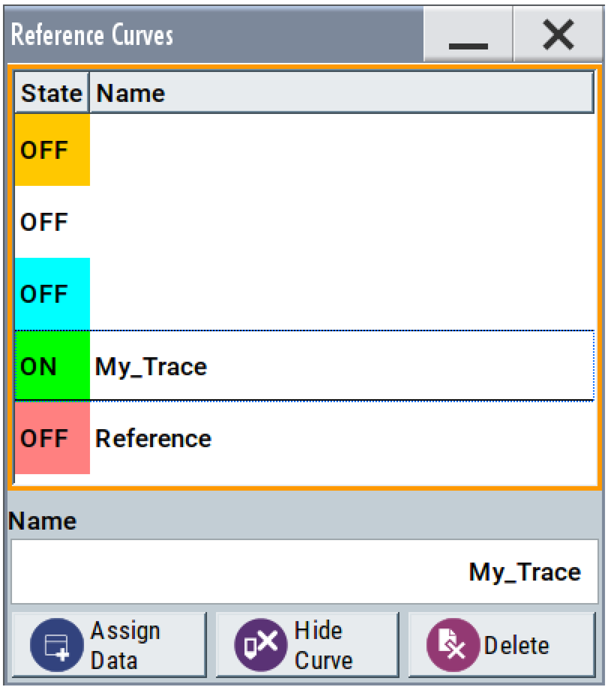
Reference Curves
Accesses the dialog for defining reference curves, see "Reference Curve" on page 379.

Display Units
Changes the units of the X-axis. The available values depend on the generated signal.

Show / Hide marker
Sets two markers to the displayed signal or hides them.

See also:
- "Using markers" on page 374
- "To enable markers to readout exact measured data" on page 384

Reference Curve
Enable the indication of up to five configurable reference curves (traces).



See "Reference trace" on page 375.

"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" Accesses the standard "File Select" function to load a file describing a reference curve

"Show Curve" Toggles the show/hide state of the selected curve

"Delete" Removes the curve

9.1.5 How to Verify the Generated Signal with the Graphics Display

This section shows you how to use the different graphic modes to visualize the signal characteristics of the generated signal. It shows also how to observe the effect of standard settings, like 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.

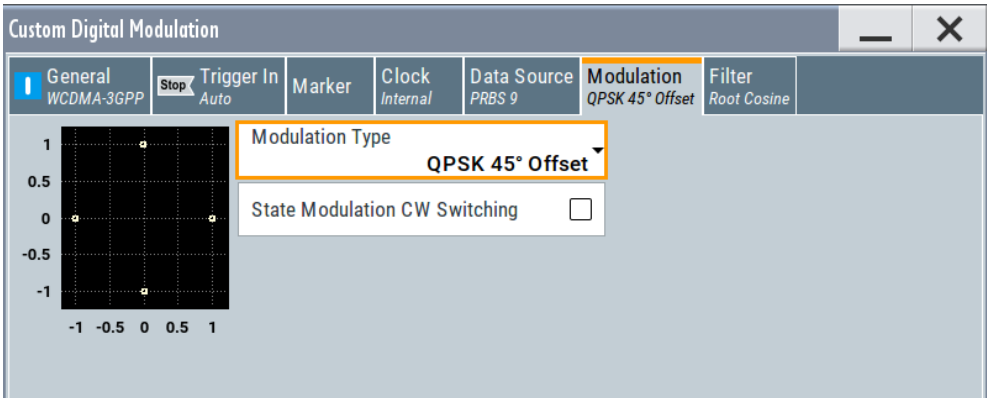
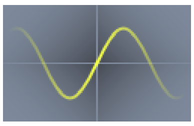


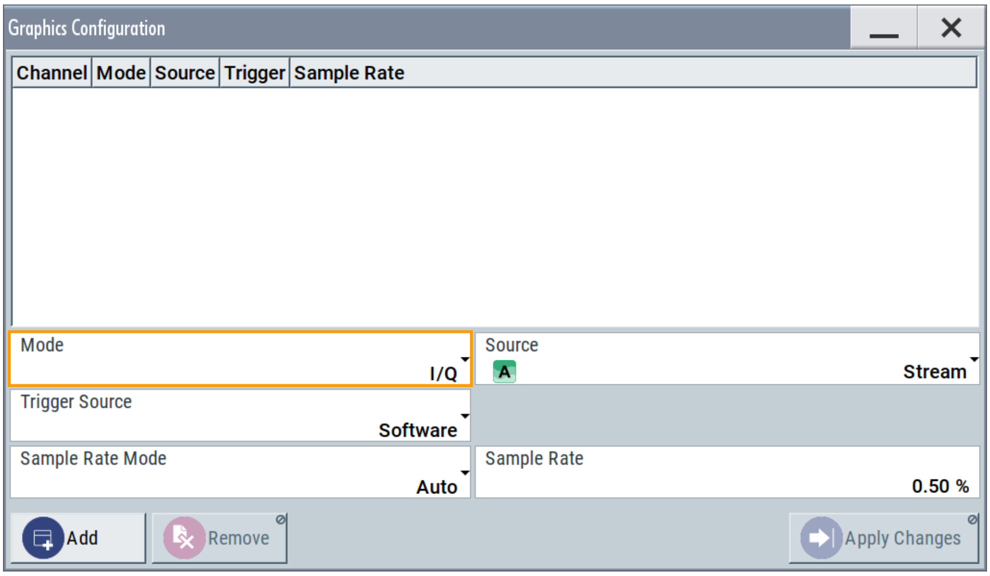
Figure 9-9: Used modulation type

Configure the graphical signal display

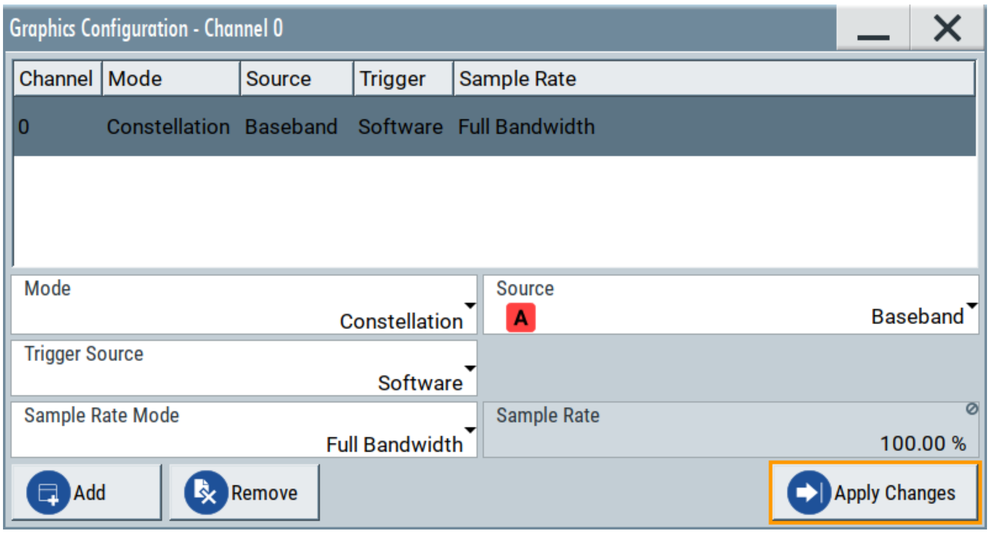
1. Select the wave icon:



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 used modulation type, see Figure 9-9.

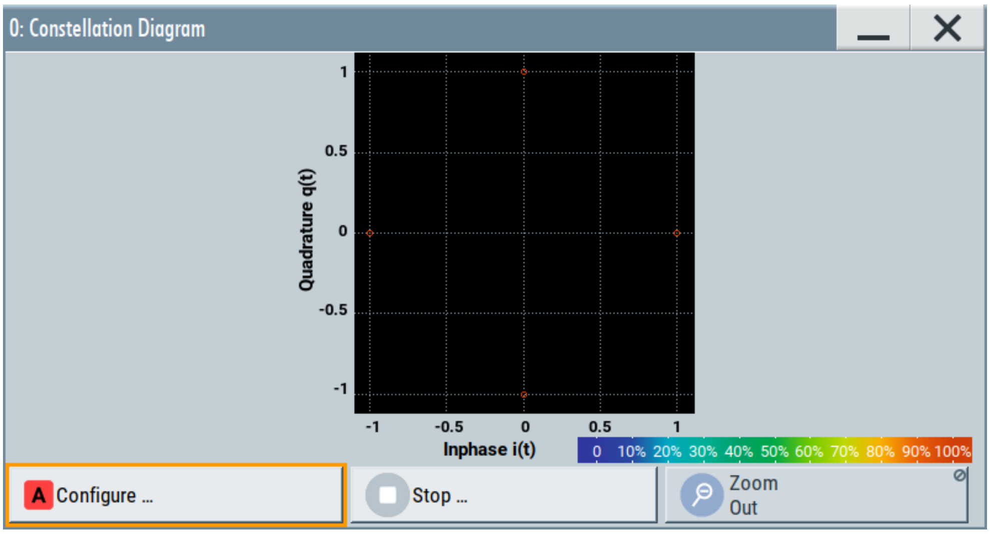
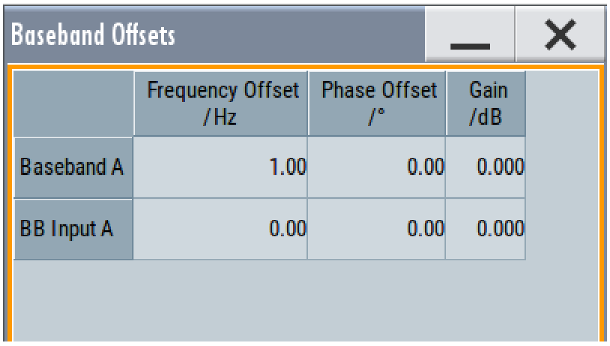


Figure 9-10: Constellation diagram of a WCDMA-3GPP (QPSK 45° offset) signal

To set and verify a baseband frequency offset

1. In "Baseband > Baseband Offsets", set "Baseband > Frequency Offset = 1 Hz"



2. In the "Constellation Diagram", select "Configure".

   The "Graphics Configuration" dialog opens.
3. Add a vector diagram with signal acquisition point "Stream" and enlarge it.

   The vector diagram rotates with 1 Hz.

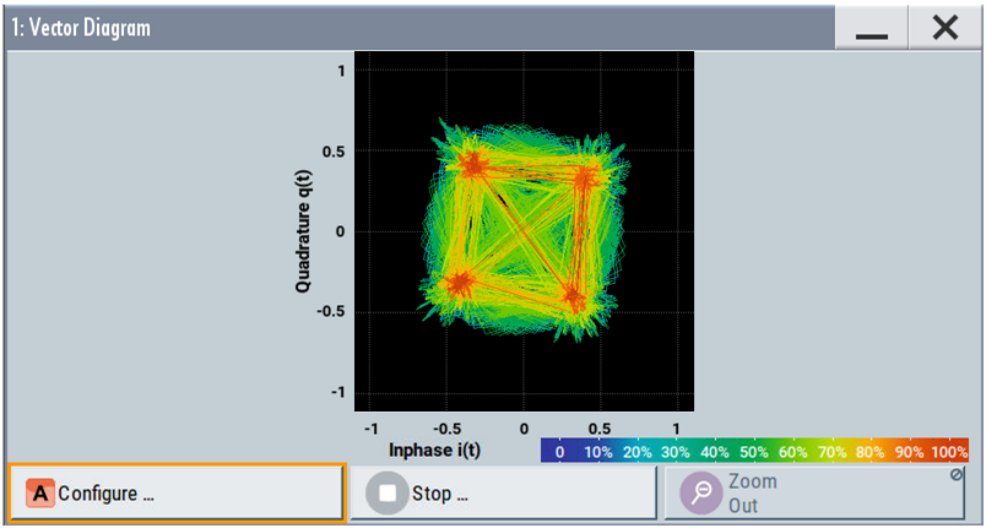


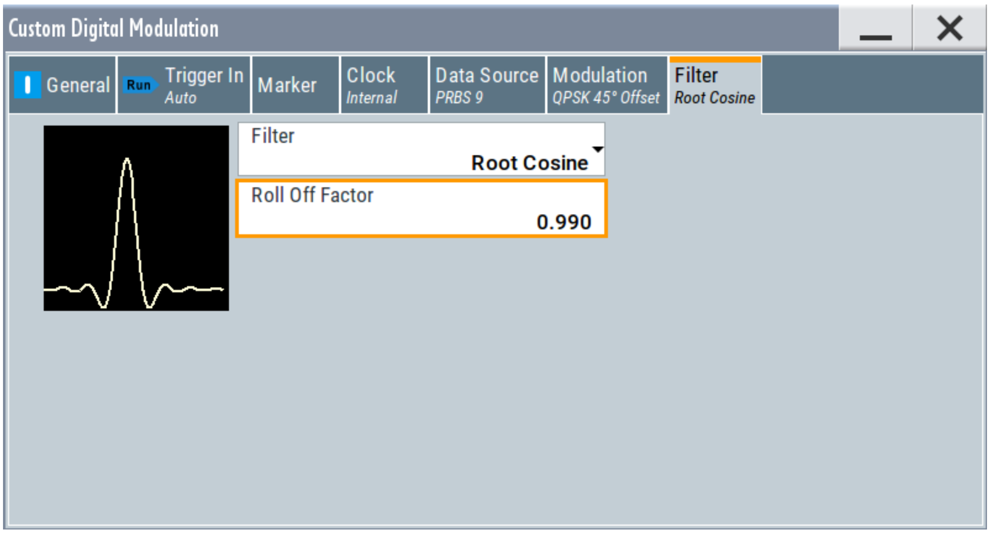
Figure 9-11: Rotating vector diagram

4. Reset the baseband frequency offset to 0 Hz.

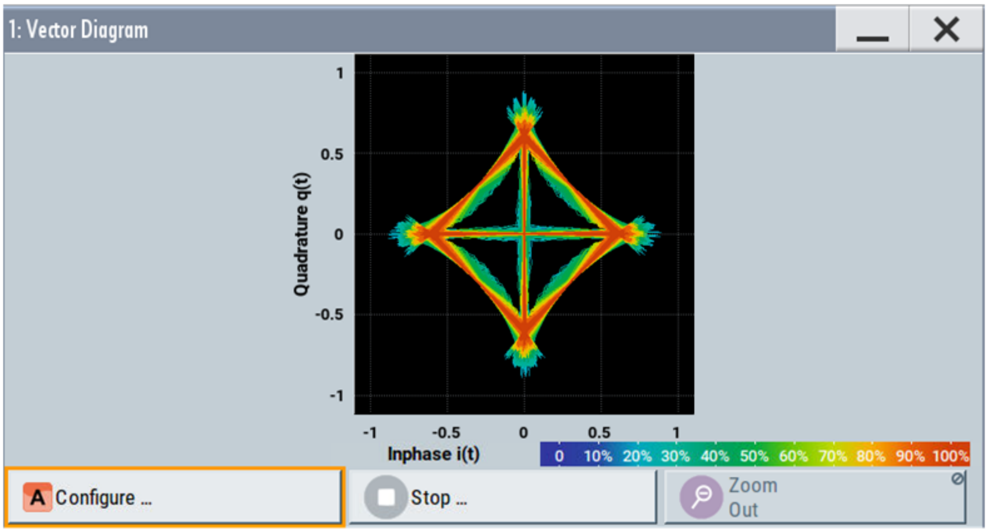
   The vector diagram does not rotate any more.

To visualize the effect of the filter parameters on the generated signal

1. Select "Baseband > Custom Digital Mod... > Filter > Roll Off Factor = 0.99"



   The vector diagram changes.



2. Select "Roll Off Factor", open the context menu, and select "Preset this parameter".

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 cell 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 readout exact measured data

In an enlarged diagram:

1. Select "Show Marker".

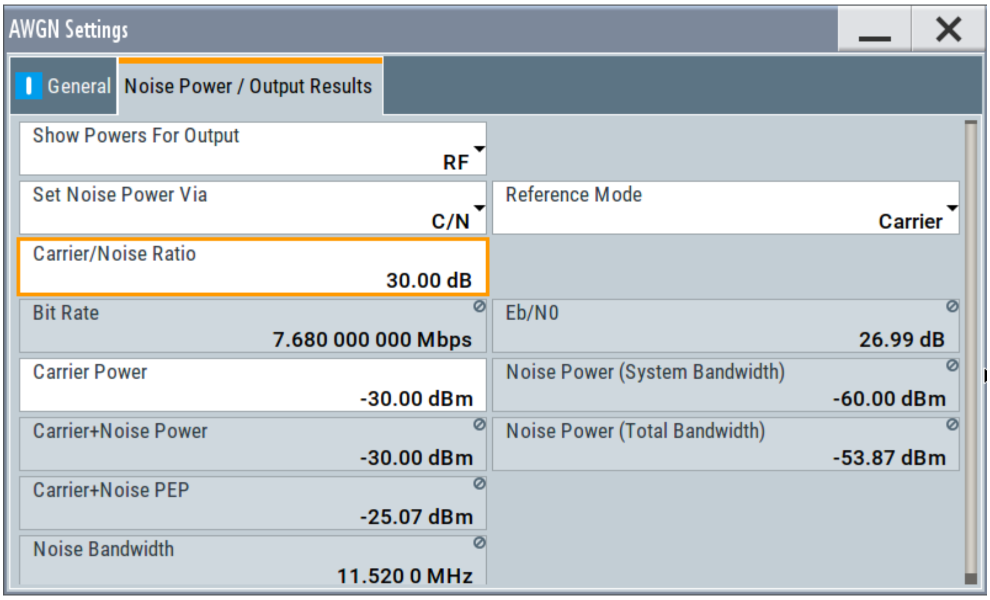
   Two markers appear, one over the other.
2. To position the markers, select and shift them.

   "M2-M1" indicates the distance of marker 1 and marker 2 on the x-axis (left value) and on the y-axis (right value).
3. To hide the markers, select "Hide Marker".

To observe the effect of enabled additive noise (AWGN)

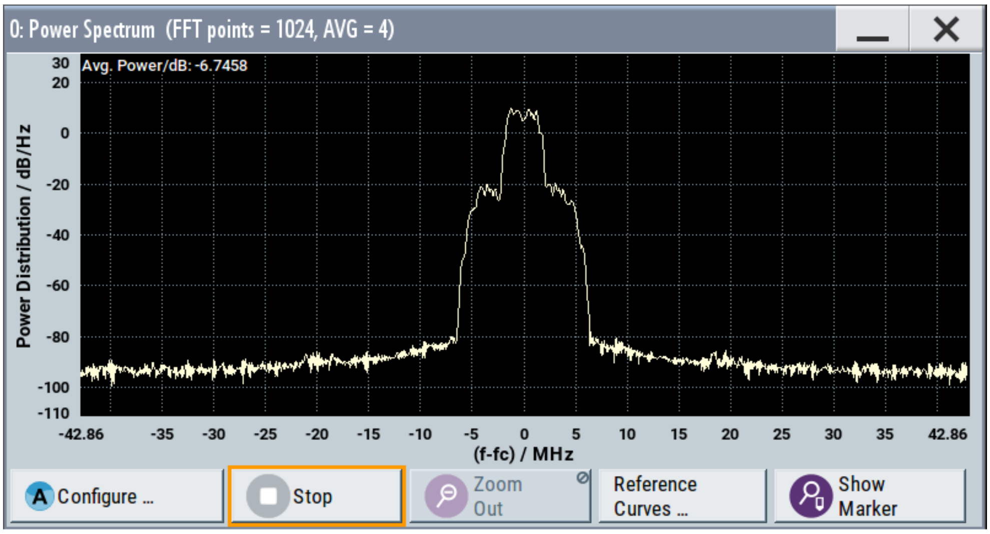
1. Select "AWGN > General > Mode > Additive Noise".
2. Select "AWGN > General > Min Noise/System Bandwidth Ratio = 3".

3. Select "Noise Power / Output Results > Carrier/Noise Ratio = 30 dB".



4. Select "AWGN > State > On"
5. Observe the power spectrum display.

   The power spectrum shows a noise floor with constant level and the spectrum of the digitally modulated signal, in this case the WCDMA signal with a bandwidth of 3.84 MHz.



To print current power spectrum

1. Select "System Config > Setup > User Interface > Hardcopy".
2. Use the default settings and 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 Chapter 10.9, "Creating Screenshots of Current Settings", on page 412.

3. Use on of the standard file transfer methods to access the user directory of the instrument. Transfer the file to a PC.
   See Chapter 10.8, "How to Transfer Files from and to the Instrument", on page 406.

4. Print the file content.

10 File and Data Management

The R&S SMCV100B uses files to save all instrument data. The instrument allows you to store 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.

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, refer to Chapter 13.5, "MMEMory Subsystem", on page 519.

For information on how to save the displayed setting in a file, refer to Chapter 10.9, "Creating Screenshots of Current Settings", on page 412.

10.1 About the File System

Depending on the contained information, two file groups can be distinguished: system and user files.

Due to security reasons, system files and the system directory are protected and therefore not accessible.

The scope of this section is only the files with user data.

This section is an overview of the R&S SMCV100B file system and covers the following topics:

- "Types of user data" on page 388
- "File storage location" on page 388
- "File handling" on page 388
- "File naming conventions" on page 389
- "File contents" on page 389

Types of user data

Depending on the **content**, the **user data** can be roughly divided into the following data types:

- *Settings*, e.g. the current instrument settings, can be saved and loaded later or used in other instrument of the same kind.
  See Chapter 10.4, "Saving and Recalling Instrument Settings", on page 395
- *SCPI scripts*, a series of commands that can be run to perform a task.
  See Chapter 10.6, "Exporting and Importing Remote Command Lists", on page 401

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 SMCV100B is switched off.

File storage location

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 SMCV100B 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 Chapter 10.7, "Using the File Manager", on page 402. 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 Chapter 10.7, "Using the File Manager", on page 402.

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 recognizes automatically 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 access the folder `/user`, that is the `/var/user/` folder on the instrument.
  For step-by-step description, see Chapter 10.8, "How to Transfer Files from and to the Instrument", on page 406.
- 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 step-by-step description, see Chapter 10.7.4, "How to Map a Network Folder", on page 405.

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 contents

Network settings and remote settings cannot be saved and restored.

10.2 Restoring the (Default) Instrument Configuration

The R&S SMCV100B has various options to set default settings. You can preset the R&S SMCV100B to an initial state at any time as a known starting point for configurations. It is often useful as a first step in troubleshooting when unusual results arise.

The graph on Figure 10-1 shows the impact of the particular reset functions.

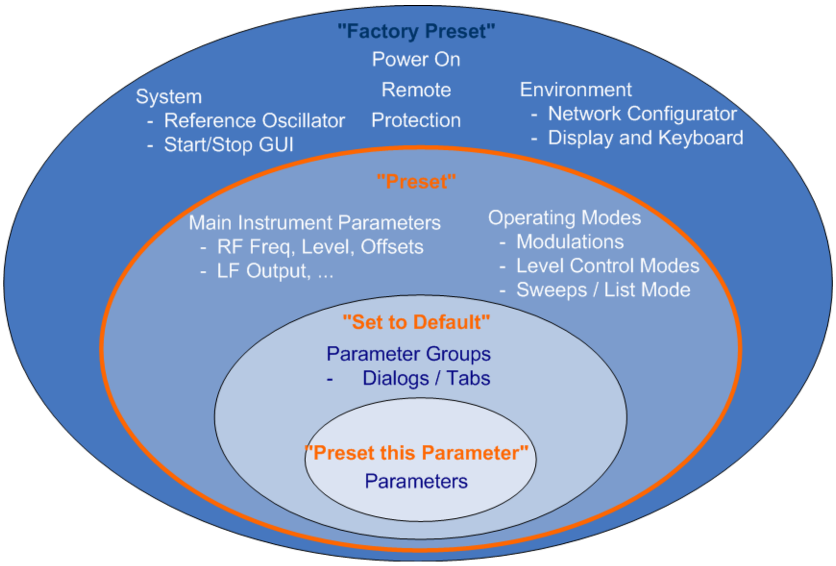


Figure 10-1: Parameter and operating modes, reset by the respective preset functions

Overview of the characteristics of the preset functions

Select the preset option that most fits to your particular application:

- [Preset]
  It is the most frequently used 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 also the states of inactive operating modes.
  Network, remote access or system settings are retained.

► To execute a preset, press the [Preset] key at the front panel.

- "Set to Default"
  Set To Default relates to individual dialogs or tabs and resets the associated settings of the corresponding dialog. All other settings are retained.

► To reset the grouped settings, click "Set To Default".

- "Preset this parameter"
  Sets a single parameter to its default value.

► To reset an individual parameter: Open its context-sensitive menu and 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.

  Retained are 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.

► To restore the factory defaults, select System Config > Setup > Settings > Factory Preset.

  Note: Perform a "Factory Preset" only if it is necessary. After a "Factory Preset", the network connection to the instrument no longer exists.

Presetting the instrument to a user-defined instrument state

The reset functions set the parameters and operating modes to default values predefined by the factory. Alternatively to these default settings, you can:

- Define user-specific recall settings to be restored after a preset
  (see Chapter 10.2.3, "How to Recall User Settings Automatically after Preset", on page 393)
- Store and reload user-defined instrument states
  (see Chapter 10.4.2, "How to Save and Recall Instrument Settings", on page 398)

Mark / Do not mark parameters changed from preset

To survey the current state of the settings concerning default values, the R&S SMCV100B offers a feature that visually identifies deviations from the default values.

For more information, see Chapter 10.2.2, "How to Identify Parameters Which Are Not in a Preset State", on page 392.

10.2.1 Preset, Set to Default and Factory Preset Settings

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 Chapter 10.2.3, "How to Recall User Settings Automatically after Preset", on page 393)
- You can reset the instrument to the factory state (see "Execute Factory Preset" on page 392)

See also Table 10-1 that contains the key parameters that are reset by the corresponding preset functions.

Remote command:
`*RST` on page 516

Set To Default

Resets the associated settings of the corresponding dialog or tab.

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 519

10.2.2 How to Identify Parameters Which Are Not in a Preset State

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 activate this display:

1. Open the context-sensitive menu (touch and hold the screen anywhere in the GUI of the R&S SMCV100B).
2. Select "Mark all parameters changed from preset".

If enabled, the corresponding settings are marked.

Example:

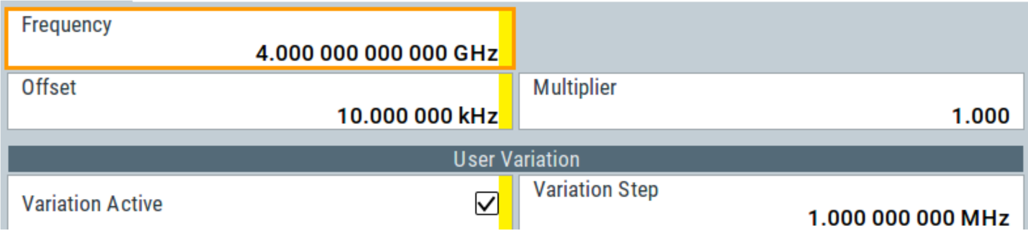


Figure 10-2: Labeled parameters show that the value deviates from its default

Frequency = changed (default = 1 GHz)
Offset = changed (default = 0 kHz)
Multiplier = unchanged
Variation active = changed (default = disabled)
Variation step = unchanged

10.2.3 How to Recall User Settings Automatically after Preset

You can define the settings that are restored when you preset the instrument.

1. Configure the settings as required. Save them as described in Chapter 10.4.2, "How to Save and Recall Instrument Settings", on page 398.
2. Save the settings as a file with the predefined filename **`UserPreset.savrcltxt`**. Save this file in the directory **`/var/user/`**.

   The filename `UserPreset.savrcltxt` and the directory `/var/user/` are mandatory.

   Now when you press the [Preset] key or send the `*RST` command to the instrument, the defined settings are restored.
   An "Info" message appears and confirms, that a file with user-defined preset setting is loaded.

10.2.4 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, refer to 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 OFF mode	-	-	x
Offsets	0	x	x
Modulation state	off	x	x
Reference frequency settings (reference oscillator)	-	-	x
Network settings	-	-	x
Hostname	-	-	x
Start/Stop display update	-	-	x
Display and keyboard settings	-	-	x
Password and settings protected by passwords (e.g. disabled LAN or USB)	-	-	-
Security settings	-	-	-
User files (setups[2]), data lists, etc.)	-	-	-

- [2]) `UserPreset.savrcltxt` is renamed as `UserPresetInactive.savrcltxt`; an existing file with the same name is overwritten.

If the default values in the "Remote Access" dialog had been changed, a factory preset via remote control (`:SYSTem:FPReset`) terminates the connection to the instrument.

Security settings are never reset.

Resets all parameters and switching states, and closes all opened dialogs.

10.3 Protecting Data

During operation, the R&S SMCV100B saves user data permanently in the user directory, see "File storage location" on page 388.

To protect any classified data and to avoid saving any sensitive data on the R&S SMCV100B permanently, you have the following options:

- Activate the **volatile mode**. This mode redirects user data to the volatile memory. Instead, you can redirect the user data to an **external storage medium**, as, e.g., a USB stick.

  See also:

  – "Default storage location" on page 388
  – "Volatile Mode" on page 444

  - Chapter 10.8.4, "Using a USB Storage Device for File Transfer", on page 410
- 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 Chapter 10.7.3, "How to Display All Saved Files", on page 405.

10.4 Saving and Recalling Instrument Settings

Possibly you would like to restore or repeat a signal generation you performed under specific conditions on the instrument. Or, in a test setup with more than one signal generator, you want to transfer the used settings to another R&S SMCV100B. Some test setups also require similar settings in all instrument paths. In these cases, you can save and recall instrument and user settings, and possibly other related data.

In each of these cases, you can create a file with the complete instrument settings or you can choose to save only the settings belonging to a particular digital standard. The instrument uses a similar save/recall principle; both ways are scope of this section.

Save/Recall the complete instrument settings

Two different methods are available for managing *complete instrument settings*:

- Immediate (quick) 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 stored 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 stored 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 "T-DMB/DAB" dialog.

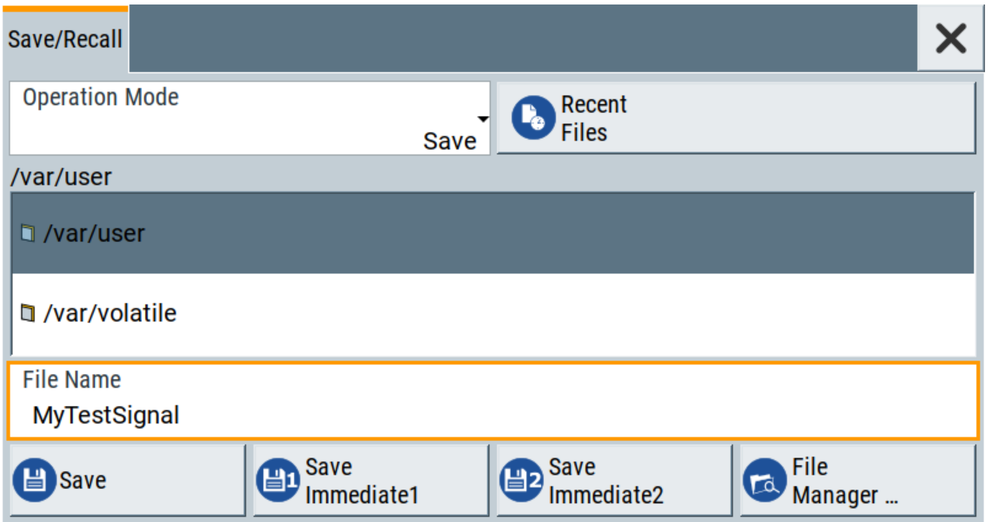
The "Save/Recall" function creates files with user-defined names, predefined file extension and on a definable storage location. The files are accessible with the supported methods for file handling.

10.4.1 Save/Recall Settings

To access the dialog for storing and loading the complete instrument settings

1. Press the [Save/Rcl] key.
2. Select "Operation Mode > Save or Recall" to access the corresponding settings.

   The provided settings for both operations are similar and closely related.



Settings:

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 Chapter 10.6, "Exporting and Importing Remote Command Lists", on page 401.

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 perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Chapter 10.7, "Using the File Manager", on page 402).

Remote command:
To list all files in a directory:
`:MMEMory:CDIRectory` on page 525
`:MMEMory:CATalog?` on page 524

Recent files
Displays the files last used.

Show SCPI List
Opens the "SCPI List", which lists the current settings of the R&S SMCV100B as SCPI commands.

The R&S SMCV100B provides this function for Operation Mode > SCPI-Export.

SCPI List
Contains a list of all SCPI commands corresponding to the current instrument settings.

See also "How to create a SCPI list with the current instrument settings in one step" on page 499

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 529
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`

Save Immediate 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 516

Exclude Frequency
The current frequency is retained when a stored instrument setting is loaded.

Remote command:
`[:SOURce<hw>]:FREQuency[:CW|FIXed]:RCL` on page 688

Exclude Level
The current level is retained when a stored instrument setting is loaded.

Remote command:
`[:SOURce<hw>]:POWer[:LEVel][:IMMediate]:RCL` on page 719

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 527

Recall Immediate 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 516

File Manager
Accesses the "File Manager" dialog, see Chapter 10.7, "Using the File Manager", on page 402.

10.4.2 How to Save and Recall 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 Chapter 11.3.4, "How to Assign Actions to the [★ (User)] Key", on page 435.

To save and recall instrument settings

1. Select Save/Rcl > "Operation Mode > Save".
2. Select "Save Immediate 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 "Save Immediate 2"
4. To restore the settings, select the "Operation Mode > Recall"

5. Select "Recall Immediate 1"

   The instrument is restored to the previous state.

6. Select "Recall Immediate 2" to switch to the settings stored in the second file.

To save complete instrument settings

1. Select Save/Rcl > "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 instrument's configuration

Save the configuration as described in "To save complete instrument settings" on page 399.

1. To restore settings, select Save/Rcl > "Operation Mode > Recall".
2. To retain the current frequency and level settings, enable "Save/Recall > Exclude Frequency/Level"
3. In the file selection 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 Chapter 10.2.3, "How to Recall User Settings Automatically after Preset", on page 393.

10.5 Accessing Files with User Data

Signal generation in list mode, the generation of pulse train signals or applying user correction values use data from list files. Whenever a list file is required 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 list files.

10.5.1 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 ""RF" > "Sweep/List" > List Mode Data > List Mode = Data".

   A "File Select" dialog for loading, creating and modifying a file is displayed.

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
5. Edit the file content.
   Confirm with "Save".

Settings:

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 perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Chapter 10.7, "Using the File Manager", on page 402).

Remote command:
To list all files in a directory:
`:MMEMory:CDIRectory` on page 525
`:MMEMory:CATalog?` on page 524

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 610

"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

Recent files
Displays the files last used.

File Manager
Accesses the "File Manager" dialog, see Chapter 10.7, "Using the File Manager", on page 402.

10.6 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 SMCV100B also offers a SCPI macro recorder with code generator that is used to record manual settings and create an executable script, see Chapter 12.8.4, "How to Record / Create SCPI Lists", on page 498.

Completed scripts are stored in files and possibly converted to different formats, depending on the used language of the source code.

The R&S SMCV100B 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, see Chapter 12.8.5, "How to Convert and Save SCPI Lists", on page 501.

10.7 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 stored on the R&S SMCV100B.

You can perform the following tasks:

- Copying multiple files from disk to other media
  See Chapter 10.8, "How to Transfer Files from and to the Instrument", on page 406
- 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 Chapter 10.7.4, "How to Map a Network Folder", on page 405
- Displaying saved files
  See Chapter 10.7.3, "How to Display All Saved Files", on page 405

Access:

► Select Save/Rcl > "File Manager".

  Tip: Each "Save/Recall" dialog and each "File Select" dialog provides a quick access to the "File Manger", i.e. whenever you select data lists or files with user data.

  The "File Manager" dialog provides all standard functions required for file management. It displays the contents of the selected folder on the R&S SMCV100B and provides functions to rename, delete, copy, or move individual files.

10.7.1 File Manager Settings

Access:

► Select Save/Rcl > "File Manager".

Settings:

Map Network Share

Accesses the Map Network Share Settings dialog where you can map one or more network folders.

See also Chapter 10.7.4, "How to Map a Network Folder", on page 405.

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.

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 525

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 527
`:MMEMory:COPY` on page 525

Rename

Renames the selected file or directory.

Remote command:
`:MMEMory:MOVE` on page 528

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 528

10.7.2 Map Network Share Settings

Access:

► Select Save/Rcl > "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 Chapter 10.7.4, "How to Map a Network Folder", on page 405.

Settings:

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 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.

10.7.3 How to Display All Saved Files

To display all files on the internal memory

1. Select Save/Rcl > "File Manager".
2. Navigate to `/var/user/`.

To display all files on a connected USB flash drive

1. Select Save/Rcl > "File Manager".
2. Navigate to `/usb/`.

To display all files in the volatile memory

1. Select Save/Rcl > "File Manager".
2. Navigate to `/var/volatile/`.

10.7.4 How to Map a Network Folder

Possibly you would like to transfer instrument or user settings to another R&S SMCV100B, distribute waveform files to several instruments or you have to access frequently the same network drive. In these cases, on a R&S SMCV100B connected to a LAN you can create a shortcut to this network folder or this computer.

How to: see Chapter 12.6.3, "How To Connect to LAN", on page 482.

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.
   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 SMCV100B, enable file transfer via SMB (samba).
3. Select "System Config > Setup > Remote Access > Network".
   Select:
   a) "Address Mode > Auto (DHCP)"
   b) Check that the "DNS Suffix" and "DNS Server" are correct.

4. In the "Save/Recall" dialog, select "File Manager > Map Network Share".
5. In the "Map Network Share" dialog, select:
   a) In the "Network Folder" field, enter `//<IP Address>/user` or `//<Server Name>/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.
6. 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 Chapter 10.8.5, "Using a File Server for Test Files Exchange", on page 411.

10.8 How to Transfer Files from and to the Instrument

As explained in "File handling" on page 388, you access the file system of the R&S SMCV100B via one of the following ways:
- Via the built-in "File Manager"
  See Chapter 10.7, "Using the File Manager", on page 402.
- On an instrument connected to a LAN:
  – Via one of the standard functions ftp or SMB (samba)
    See Chapter 10.8.2, "Accessing the File System of the R&S SMCV100B via ftp", on page 408 and
    Chapter 10.8.3, "Accessing the R&S SMCV100B File System via SMB (Samba)", on page 409
  – Via mapped network drives
    See Chapter 10.7.4, "How to Map a Network Folder", on page 405.
- Via a connected USB storage device
  See Chapter 10.8.4, "Using a USB Storage Device for File Transfer", on page 410

Mainly because of security reasons, the access to the file system of your R&S SMCV100B 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 Chapter 10.8.1, "Removing File System Protection", on page 407 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.

10.8.1 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 > General"
2. Enable "Volatile Mode"
3. Enter the "Security Password".
   The default password is *123456*. For more information, see Chapter 11.5, "Using the Security Settings", on page 440.
4. Select "System Config > Setup > Maintenance > Shut Down"
5. Select "Reboot".

   The system reboots. The enabled settings are active.

To enable file transfer via ftp

1. Select "System Config > Setup > Security > Security > LAN Services".
2. Enable "LAN Interface"
3. Enable "FTP"
4. Enter the "Security Password".
   The default password is *123456*. For more information, refer to Chapter 11.5, "Using the Security Settings", on page 440.
5. Select "Accept".

To enable file transfer via SMB (samba)

1. Select "System Config > Setup > Security > Security > LAN Services"
2. Enable "LAN Interface"

3. Enable "SMB (Samba)"
4. Enter the "Security Password".
   The default password is *123456*. For more information, refer to Chapter 11.5, "Using the Security Settings", on page 440.
5. Select "Accept".

To enable file transfer via USB

1. Select "System Config > Setup > Security > Security > General"
2. Enable "USB Storage"
3. Enter the "Security Password".
   The default password is *123456*. For more information, refer to Chapter 11.5, "Using the Security Settings", on page 440.
4. Select "Accept".

10.8.2 Accessing the File System of the R&S SMCV100B via ftp

If the R&S SMCV100B 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: see Chapter 12.6.3, "How To Connect to LAN", on page 482.

To access the file system via 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 SMCV100B indicates its IP address on the block diagram.

   A log-on dialog opens and requests a password.

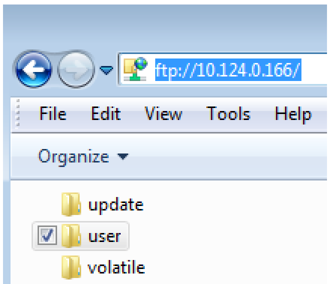
   The default user name and password is *instrument*.

   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 Chapter 11.5.4, "Password Management", on page 449.
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 Save/Rcl.
   Open the `/var/user/` directory.

   The dialog displays the `/var/user/test ftp` directory.

10.8.3 Accessing the R&S SMCV100B File System via SMB (Samba)

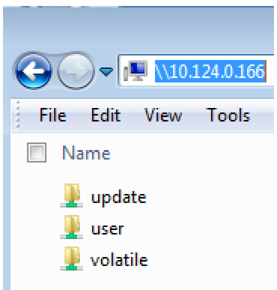
The SMB (Samba) protocol is an alternative way to access the file system of the instrument from a remote PC. This protocol works if both the instrument and the PC are connected to a LAN.

How to: see Chapter 12.6.3, "How To Connect to LAN", on page 482.

To access the file system via 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 SMCV100B 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 SMCV100B 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 *//SMCV100B-102030/user*.
      Tip: The R&S SMCV100B indicates its IP address on the screen.
   c) Select "Finish".

   A log-on dialog opens and requests a user name and a password.

   The default user name and password is *instrument*.

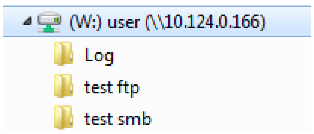
   Tip:
   Default password

   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 Chapter 11.5.4, "Password Management", on page 449.
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 storing files.

10.8.4 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 SMCV100B recognizes the connected USB storage device automatically.
2. Enable file transfer via USB
3. Enable write permission on the file system
4. Select Save/Rcl.

   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.

10.8.5 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 store 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 SMCV100Bs 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 SMCV100B, map the required directory of the file server to the instrument.
   Perform the steps described in Chapter 10.7.4, "How to Map a Network Folder", on page 405.
2. On each R&S SMCV100B, 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 SMCV100B, 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.

10.9 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 hardcopy of the current display.

10.9.1 Hardcopy Settings

Access:

► Select "System Config > Setup > User Interface > Hardcopy".

The remote commands required to define these settings are described in Chapter 13.10, "HCOPy Subsystem", on page 541.

Settings:

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 545

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 543

Format
Selects the output file format, for example `*.bmp`, `*.jpg*.xpm` and `*.png`.

Remote command:
`:HCOPy:IMAGe:FORMat` on page 542
`:HCOPy:DEVice:LANGuage` on page 542

Options...
Accesses Hardcopy Options dialog.

Save
Saves a hardcopy of the current display as a file.

Remote command:
`:HCOPy[:EXECute]` on page 543

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 545

Format ← Hardcopy Options > Common
Selects the output file format, for example `*.bmp`, `*.jpg*.xpm` and `*.png`.

Remote command:
`:HCOPy:IMAGe:FORMat` on page 542
`:HCOPy:DEVice:LANGuage` on page 542

Region ← Hardcopy Options > Common
Displays the snapshot area.

Remote command:
`:HCOPy:REGion` on page 543

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 544

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 544

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 546
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:PREFix:STATe` on page 546
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe` on page 545
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:MONTh:STATe` on page 545
`:HCOPy:FILE[:NAME]:AUTO[:FILE]:DAY:STATe` on page 545

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 545

10.9.2 How to Save a Hardcopy of the Display

1. Select "System Config > Setup > User Interface > Hardcopy".
2. To define the output format, select "Format > JPG".
3. To enable the instrument to create output filenames, select "Automatic Naming > On".
4. Select "Options...".
5. In the "Hardcopy Options" dialog:

   a) To change the default directory the file is saved in, select "Automatic Naming Settings > Path" and define a path and a filename. For example, select the default directory `/var/user`.
   b) If necessary, disable or change some of the parameters in the "Automatic Naming Settings".
   c) Close the "Hardcopy Options" dialog.

6. In the "Hardcopy" dialog, select "Save".

   The instrument saves a hardcopy of the current instrument display as a `*.jpg` file. The filename is automatically created.

7. To print the hardcopy, connect the instrument to a LAN and:
   a) Transfer the file to a remote computer as described in Chapter 10.8, "How to Transfer Files from and to the Instrument", on page 406.
   b) On the remote computer, navigate through the file system.
   c) Print the selected file.
   For more information, refer to the online help of the operating system.

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:

- Chapter 11.1, "Customizing the User Interface", on page 416
  Allows you to adjust the display and keyboard language settings.
- Chapter 11.2, "Configuring the Global Connectors", on page 420
  Allows you to map internal or external signals to the multipurpose connectors.
- Chapter 11.3, "Organizing Frequently Used Settings as Favorites", on page 430
  Enables you to group user defined settings in a favorites list or to assign actions to the [★ (User)] as quick access for later retrieval.
- Chapter 11.4, "Managing Licenses and License Keys", on page 436
  If you have purchased an additional option for the R&S SMCV100B, you can enable it using a license key.
- Chapter 10.2, "Restoring the (Default) Instrument Configuration", on page 389
  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.
- Chapter 16.3, "Performing Maintenance Tasks", on page 775
  Special functions like calibration routines and selftests put your instrument to an initial state.
- Chapter 11.5, "Using the Security Settings", on page 440
  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 SMCV100B 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.

Start / stop display update

The operating system of the R&S SMCV100B 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.

In detail described in the following paragraphs, you can:

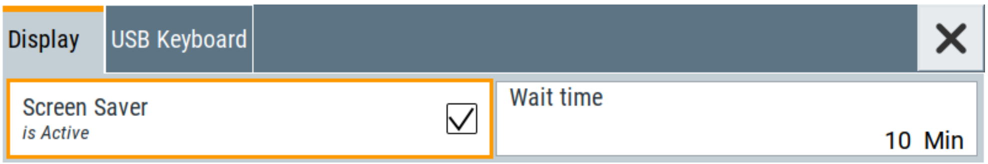
- Set display and keyboard language, see Chapter 11.1.1, "Display and Keyboard Settings", on page 417

- Set date and time for the system clock, see Chapter 16.3.1, "Date and Time", on page 776
- Configure and activate a Screen Saver
- Deactivate display update to improve performance, see Chapter 11.1.2, "Display Update Settings", on page 418
- Determine the state of the RF signal, and the level display in the status bar when you turn on the R&S SMCV100B, see Chapter 11.1.3, "Defining the RF Signal State On Power On ", on page 418.

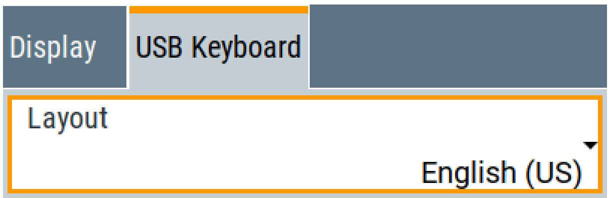
11.1.1 Display and Keyboard Settings

Access:

1. Select "System Config > Setup > User Interface > Display/Keyboard > Display".



2. Select "Display/Keyboard > USB Keyboard".



In the "Display/Keyboard" dialog, you can change regional and language options for the GUI and an external keyboard, and define the screen saver settings.

The remote commands required to configure the display and keyboard are described in Chapter 13.8, "DISPlay Subsystem", on page 535 and Chapter 13.11, "KBOard Subsystem", on page 546.

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 537

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 536

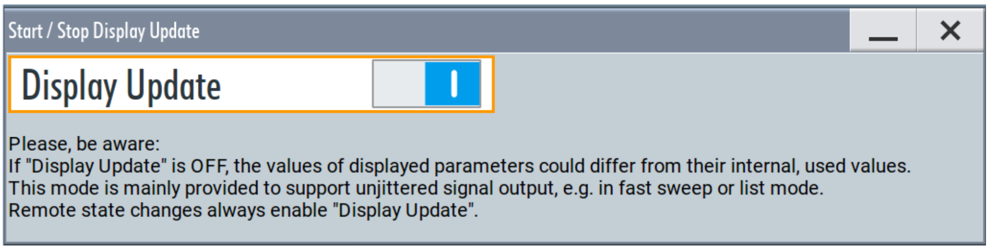
USB Keyboard > Layout
Selects the language of an externally connected keyboard via USB. The function assigns the corresponding keys automatically.

Remote command:
`:KBOard:LAYout` on page 546

11.1.2 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 Chapter 13.8, "DISPlay Subsystem", on page 535.

Display Update is
Disables the automatic refreshing of the displayed values.

Remote command:
`:DISPlay:UPDate` on page 537

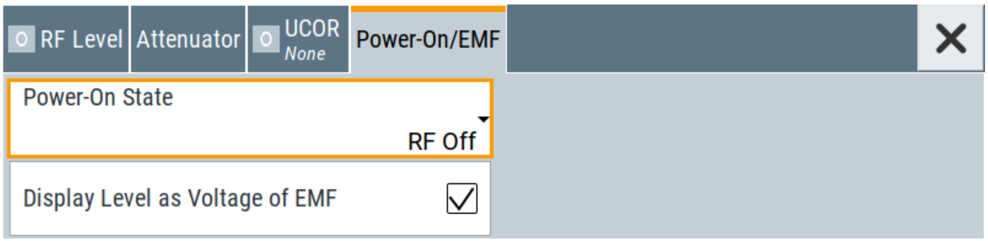
11.1.3 Defining the RF Signal State On Power On

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 SMCV100B.

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

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 547

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 714

11.1.4 How to Set the Initial Instrument Settings

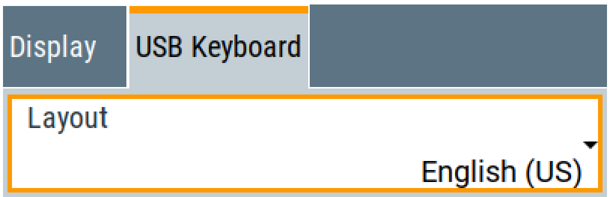
This section describes how to set up the R&S SMCV100B initially.

11.1.4.1 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".

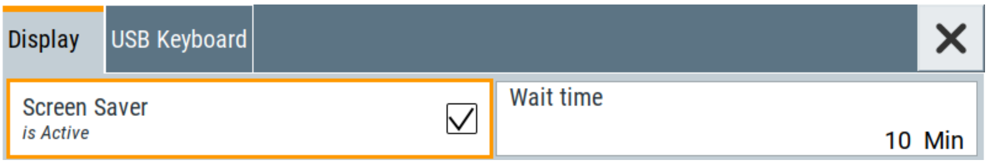
   The dialog closes and the changes take effect immediately.

11.1.4.2 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.

11.2 Configuring the Global Connectors

The R&S SMCV100B is equipped with multipurpose bi-directional connectors.

Grouped according to their impact on the baseband or on the RF signal, the same connectors are divided into:

- Chapter 11.2.3, "Trigger Marker Clock Settings", on page 423

- Chapter 11.2.4, "RF Connectors Settings", on page 425

11.2.1 Required Options

The R&S SMCV100B is always equipped with two "User" interfaces.

Additional options are not required.

11.2.2 About the Global Connectors

Signal to connector mapping

As described in Chapter 4.4.1, "Basics on Signals, Modulation Types and Filters Used the Baseband Domain", on page 76, the R&S SMCV100B uses several internally generated and externally supplied signals.

To handle these signals, the R&S SMCV100B 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 two "User" 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 dialog.

For an overview of the required configuration steps, refer to "General Workflow" on page 429.

11.2.2.1 Global Connectors

The R&S SMCV100B 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.

See Chapter 8.9, "Varying the RF Signal in List or Sweep Mode", on page 304.

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 1/2"	"Input"	"Global Trigger" "Global Next Seg-ment" "Instrument Trigger"	-
"User 1/2"	"Output"	"Baseband Marker"	Both "User x" connectors output the same "Base-band Marker" signal. Per default, "Marker 1" signal is output.
"User 1/2"	"Not Used"	"None"	No signal is input or output. The setting constitutes a switched-off "User" connector.
"User 1"	"Input"	"TS" "ETI" "S/PDIF"	-
"User 2"	"Input"	"1 PPS"	-

11.2.2.2 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 settings.

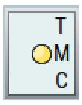
11.2.2.3 Status Indicators

Connector status LEDs

A dedicated LED indicates the connector status:

- green: an input connector
- yellow: an output connector
- red: error
- no light / gray: the connector is not active
- blinking LED: connection indication as result of the "Identify Connector" function

T/M/C status LEDs



For quick overview of the source (internal/external) of the used trigger, marker and clock signals, the block diagram displays *T/M/C status LEDs* on the left side of the "Baseband" block.

If the baseband generator is active, a dedicated LED indicates the status:

- green: an external signal is used.
- yellow: the signal is available at the output connector.

The "T/M/C" block is only displayed for arbitrary waveform baseband signals and custom digital modulation baseband signals ("Baseband > ARB/Custom Digital Mod").

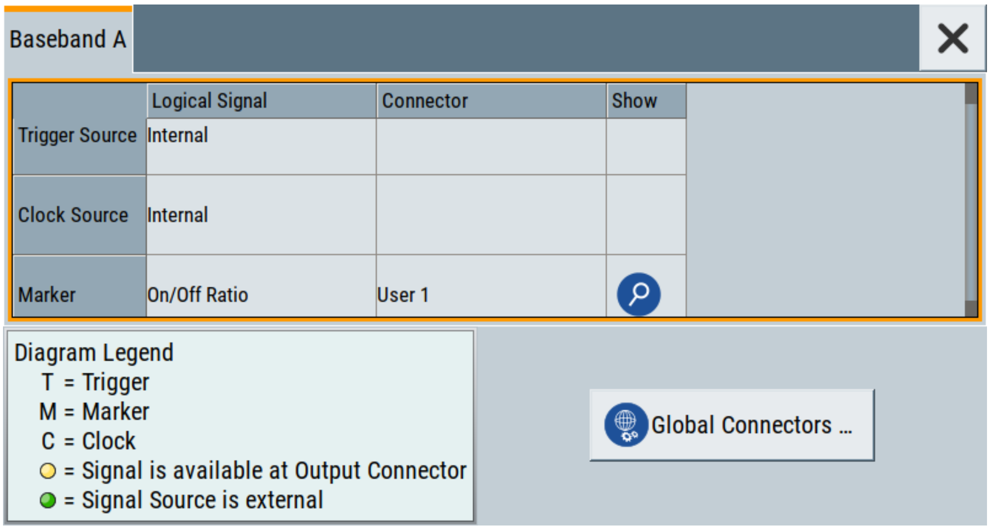
Other baseband signals do not have the trigger, marker and clock signals.

11.2.3 Trigger Marker Clock Settings

Access:

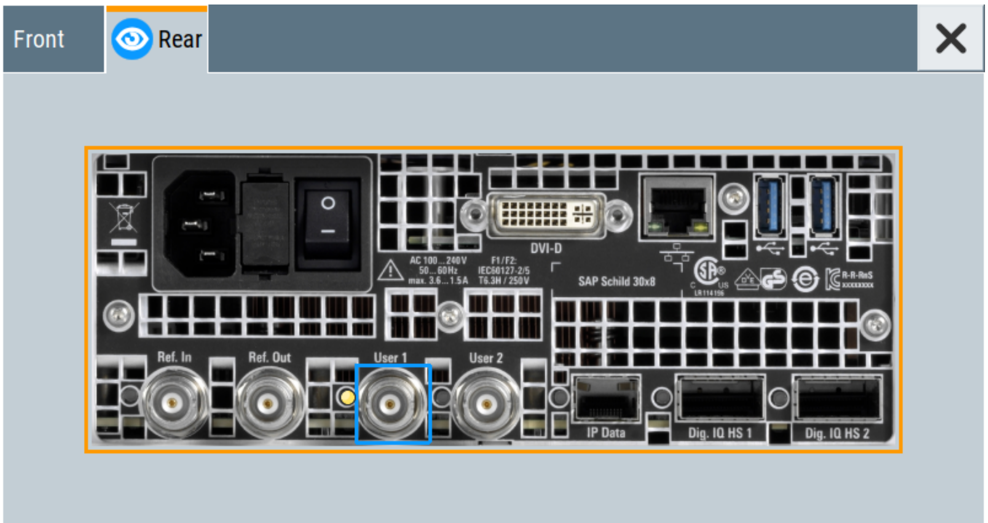
1. Perform one of the following:
   - In the "Block Diagram", select the T/M/C status LEDs on the left side of the "Baseband" blocks.
   - Select "Baseband > Trigger Marker Clock".

   The "Trigger Marker Clock" gives an overview of the current mapping of the logical signals to the connectors, as configured in the Global Connectors dialog. Clicking the connector name directly accesses the related connector settings.



2. Use the built-in 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 location of the connector on the panel (front, rear or both).

11.2.3.1 Overview Table

Logical Signal

Displays the logical signal, as configured in the "Trigger In", "Marker" or "Clock" tab of the active baseband signal. Only the signals as configured in the "Baseband > ARB/ Custom Digital Mod" tabs are applied. See for example Chapter 4.6.3, "ARB Settings", on page 136.

Connector

Displays the assigned connector.

Show Connector

Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Chapter 11.2.2.3, "Status Indicators", on page 422).

11.2.3.2 Global Connector Settings

The "Input Signal" dialog, the "Trigger/Marker/Clock" dialog and "Trigger In", "Marker" and "Clock" tabs in "Baseband > ARB/Custom Digital Mod" configuration dialogs provide quick access to the related connector settings. Click the "Global Connectors" button to access the settings.

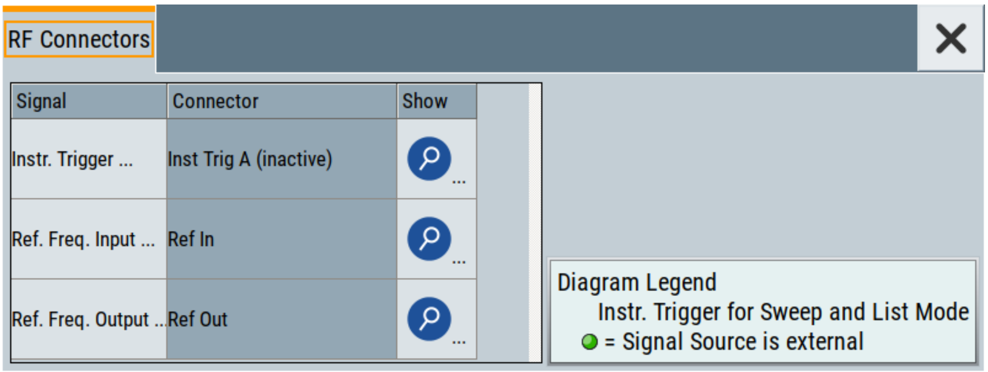
See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

11.2.4 RF Connectors Settings

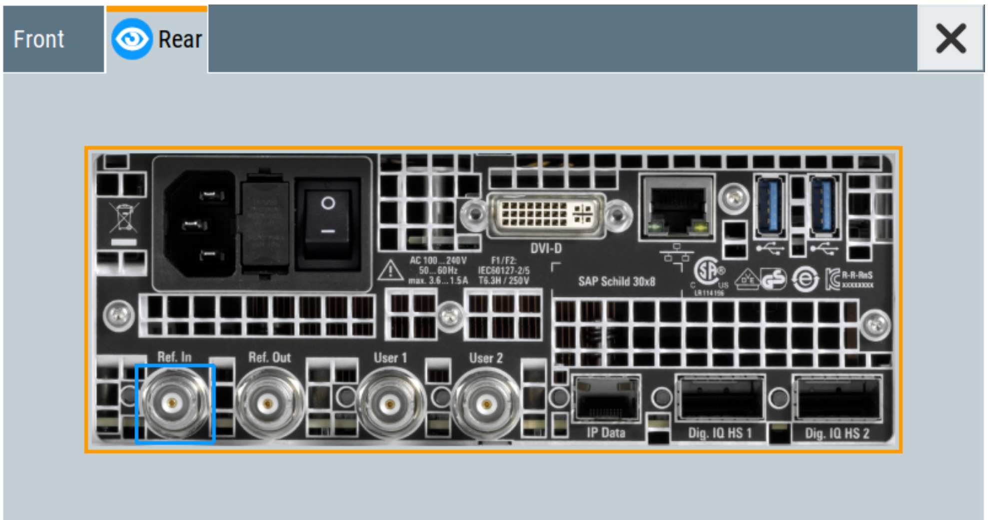
Access:

1. Perform one of the following:
   - In the "RF block", select "RF" > "RF Frequency" > "RF Connectors".
   - In the "control signal block" next to the RF block, select "Instr. Trigger".
   - Select "System Config > Setup > RF Connectors".

   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. Selecting a connector name accesses directly the related connector settings.



2. Select the "Signal" name to access the dialog with respective settings.
3. Use the built-in Show Connector function to display the physical location of the selected connector.



The eye icon in the tab header indicates the panel (front, rear or both) the selected connector is located at.

Settings:

Signal

Opens the dialog with the corresponding settings.

Connector

Displays the assigned connector.

Show Connector

Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

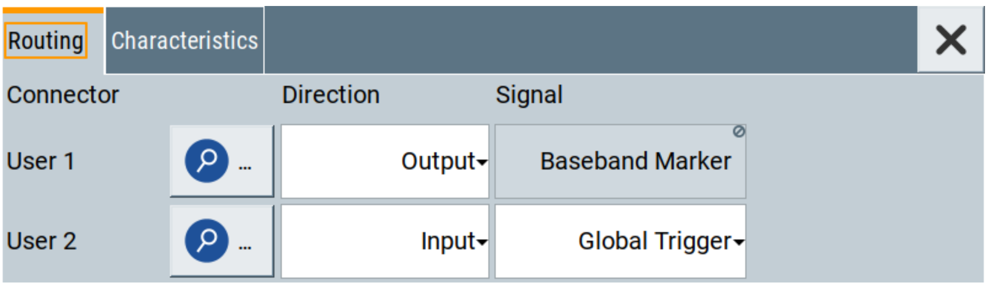
A blinking LED on the front/rear panel indicates the selected connector, too (see Chapter 11.2.2.3, "Status Indicators", on page 422).

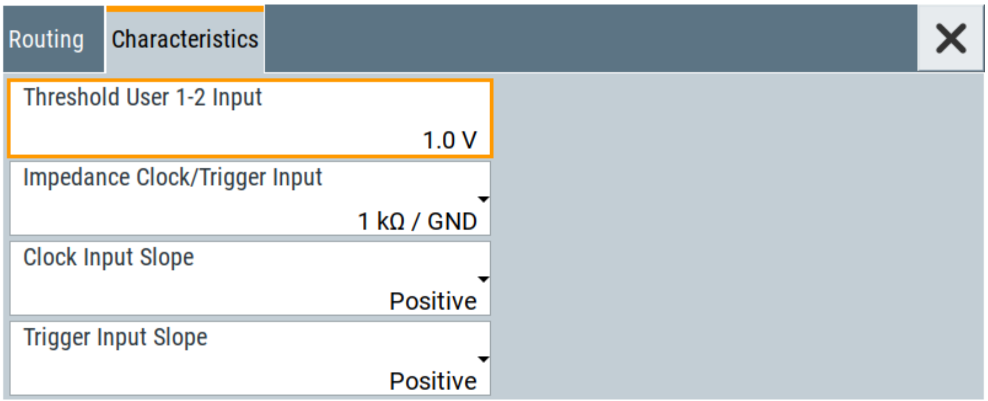
11.2.5 Global Connectors Settings

Access:

1. Perform one of the following:
   - In the "Block Diagram", select the T/M/C status LEDs to access the "Trigger Marker Clock" dialog and try one of the following:
     – Select a "Connector > "User"" setting.
     – Select "Global Connector Settings".
   - Select "Baseband > ARB/Custom Digital Modulation > Trigger In > Global Connector Settings" or the tab "Input Signal > Global Connector Settings" in some baseband standard signal generation configuration dialog.

   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.





2. Use the built-in Show Connector function to display the physical location of the selected connector.

   A blinking LED on the rear panel indicates the selected connector, too.

Settings

Show Connector

Accesses a dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see Chapter 11.2.2.3, "Status Indicators", on page 422).

User x Connector Direction

Determines whether the connector is used as an input or an output.

A connector with no specified direction is in a "Not Used" state.

Remote command:
`[:SOURce]:INPut:USER<ch>:DIRection` on page 578
`:OUTPut:USER<ch>:DIRection` on page 578

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.

"Baseband Marker"
: Marker signal output for triggering and control of external devices with user-definable marker signals. The output signal is available at "User 1/2" connectors.

"Global Trigger"
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.
The input signal is available at "User 1/2" connectors.

"Global Next Segment"
Input next segment for triggering of multi-segment waveform files, see Chapter 4.8, "Generating Multi-Segment Waveform Files", on page 179.
The input signal is available at "User 1/2" connectors.

"Instrument Trigger"
Input for triggering sweeps and list mode available at "User 1/2" connectors.

See Chapter 8.9, "Varying the RF Signal in List or Sweep Mode", on page 304.

"TS"
Transport stream (TS) input signal for transport stream application available at "User 1" connector only.

"ETI"
Ensemble transport interface (ETI) input signal available at "User 1" connector only.

"S/PDIF"
Sony/Philips digital interface (S/PDIF) input signal available at "User 1" connector only.

"1 PPS"
1PPS (one pulse per second) input signal available at "User 2" connector only.

"None" No signal is assigned to the connector.

Remote command:
`[:SOURce]:INPut:USER<ch>:SIGNal` on page 578
`:OUTPut:USER<ch>:SIGNal` on page 579

Threshold User1-2 Input

Sets the high/low threshold in volts for the signal at the "User"1-2 connectors.

The input signal is defined with the parameter Signal. The same threshold applies for both connectors and any input signal.

Remote command:
`[:SOURce]:INPut:USER:TRIGger:LEVel` on page 579
`[:SOURce]:INPut:USER:CLOCk:LEVel` on page 579

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 579
`[:SOURce]:INPut:USER:CLOCk:IMPedance` on page 579

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 580

Trigger Input Slope
Sets the polarity of the active slope of an applied instrument trigger.

Remote command:
`[:SOURce]:INPut:USER:TRIGger:SLOPe` on page 580

11.2.6 How to Enable Signals and Perform Signal to Connector Mapping

This section introduces the general principle of connector configuration.

General Workflow

The Figure 11-1 shows the main configuration stages, together with the corresponding user interface dialogs.

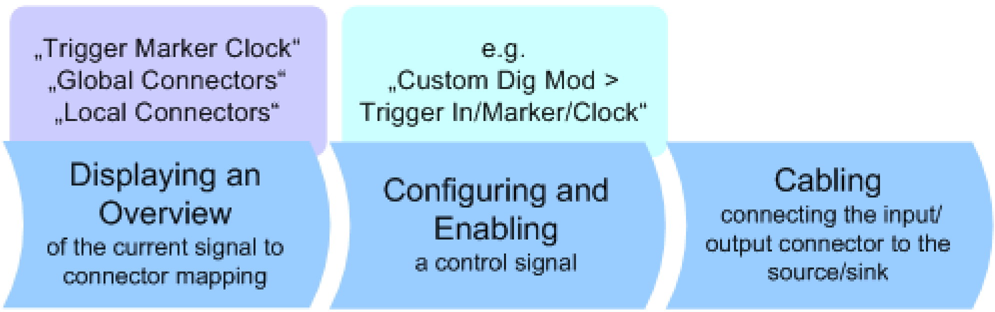


Figure 11-1: The principle of the signal to connector mapping

To perform the signal to connector mapping, perform the following:

1. Verify the current connector configuration and mapping and if necessary (re)define it.
2. Configure and enable the required signal, e.g. trigger, marker, clock signal.
3. Connect the configured connector, e.g. to the external instrument or device.

   For a step-by-step description:
   See Chapter 3.3.4, "Enabling and Configuring a Marker Signal", on page 47.

To find out the physical location of the connector on the front/rear panel of the instrument

Proceed as follows:

1. Select T/M/C status LEDs or "Instr. Trigger" to open the "Trigger Marker Clock" and the "RF Connectors" dialog.
2. For the corresponding connector, select the "Find" icon.

   The "Find Connector" dialog opens and displays the physical location of the selected connector on the front/rear panel of the instrument.
   A blinking LED on the front/rear panel indicates the selected connector, too.
   See also "Connector status LEDs" on page 422.

11.3 Organizing Frequently Used Settings as Favorites

The R&S SMCV100B 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 the frequently loading and executing of certain SCPI scripts. Refer to Chapter 12.8.4, "How to Record / Create SCPI Lists", on page 498 for information on how to create an SCPI script.
- 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 SMCV100B provides two options:

- "Save/Recall" function
  For a detailed description, refer to Chapter 10.4, "Saving and Recalling Instrument Settings", on page 395.
- "Recall Setup" function
  If the "Recall Setup" is the only user action assigned to the [★ (User)] key, pressing this key triggers the R&S SMCV100B to load the user-defined preset file immediately.

11.3.1 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.

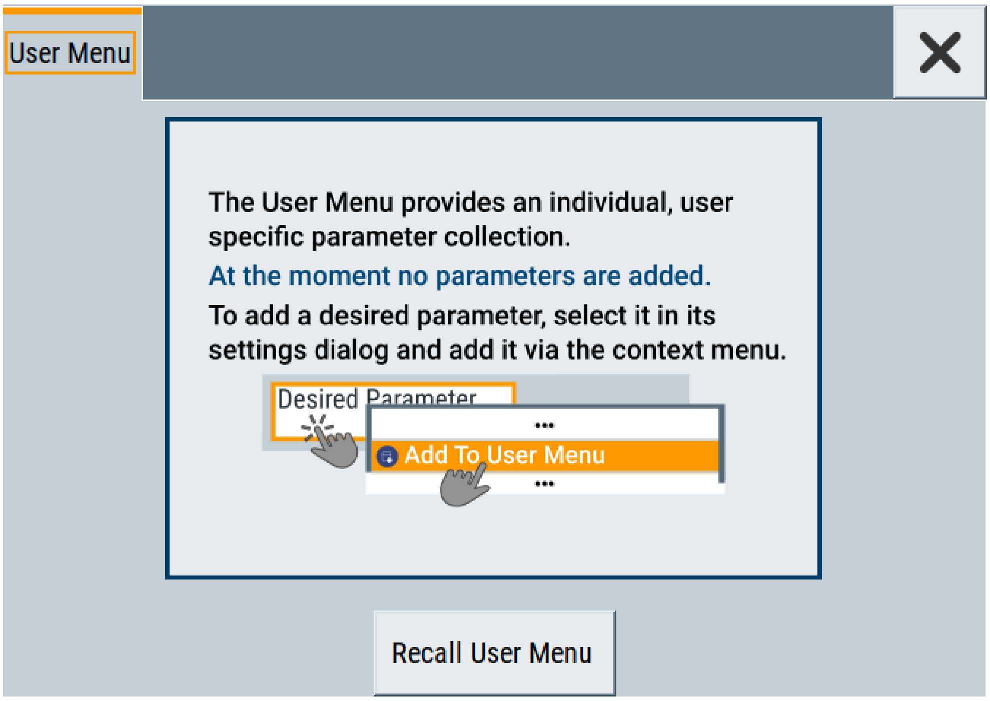
This function enables you to use the user specific favorites file on another instrument. However, if functions or parameters are not provided due to varying configuration of the instrument, the settings of these particular parameters take no effect.

11.3.2 How To Use the User Menu for Fast Adjustments

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".

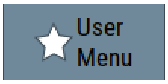
2. If you already have a saved user menu file on the instrument, you can load with "Recall User Menu".

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".

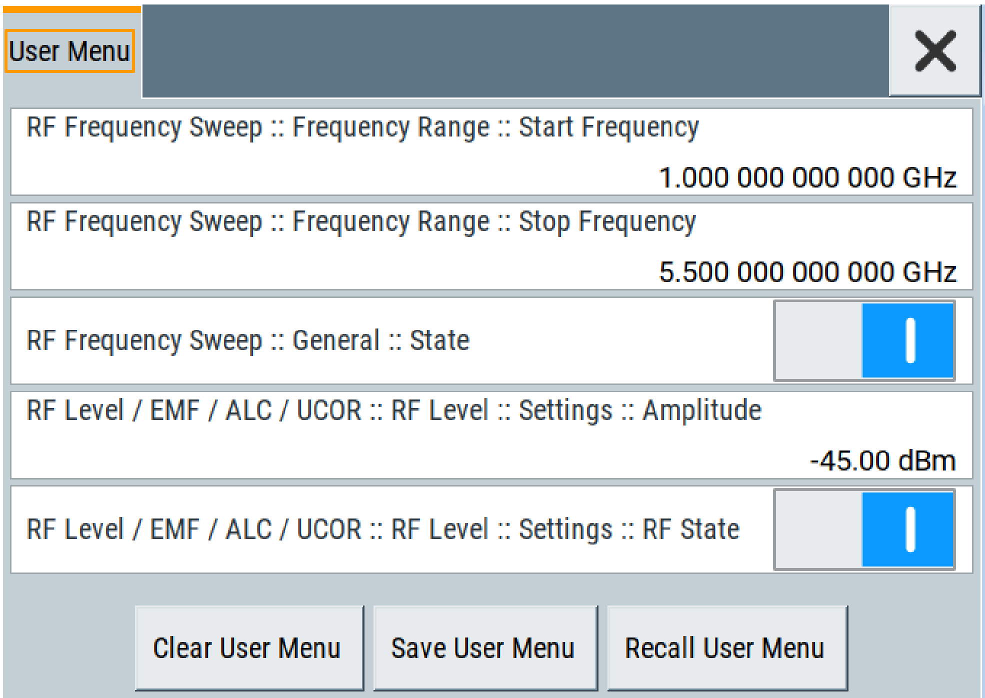
A favorites icon ★ indicates that the parameter is used in the "User Menu".



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

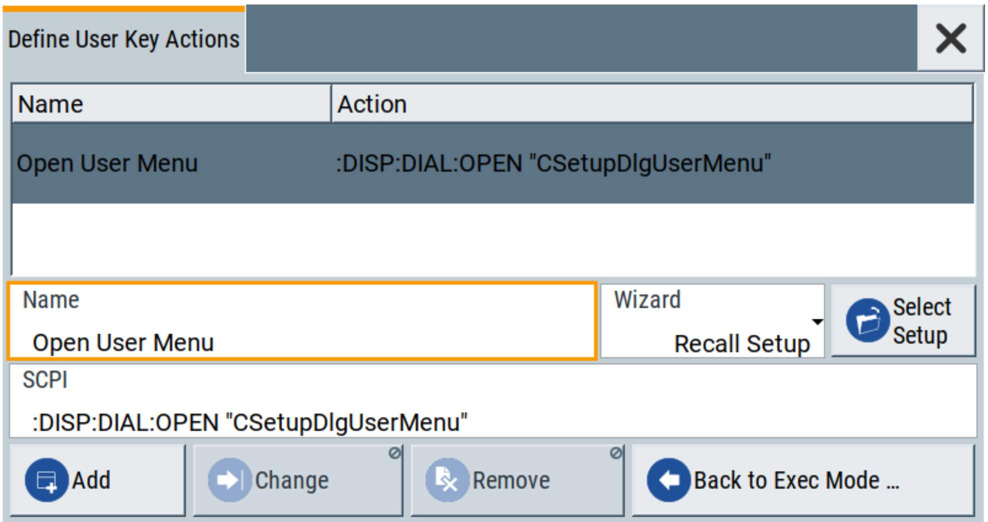
To transfer files from or to an instrument:

1. Create the favorites list, as described in "Creating a "User Menu"" on page 432.
2. Save the favorites list.
3. To tansfer a file from or to an instrument, the R&S SMCV100B provides several options, see "File handling" on page 388.

11.3.3 Define User Key Actions Settings

Access:

► Select "System Configuration > 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 Chapter 11.3.4, "How to Assign Actions to the [★ (User)] Key", on page 435.

The remote commands required to define these settings are described in Chapter 13.8, "DISPlay Subsystem", on page 535.

Name
Enters a user-defined name for the action.

Wizard
Defines the action to be executed.

"Load SCPI Script"
Selecting the action load and executes the SCPI script.

"Recall Setup" Load a setup for quick access to the user-defined settings.

Select
Depending on the selected "Wizard", provides access to:
- The standard "File Select" function for loading of an SCPI script or setup file
- A list of the dialog IDs of all currently opened dialogs. The dialog ID is used for dialog identification in the remote control.
  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 539
See also `:DISPlay:DIALog:ID?` on page 538

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
Accesses the "Define User Key Actions" dialog.

11.3.4 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.
2. Select "System Configuration > Setup > User Interface > Define User Key".
3. To create an action:
   a) Specify the "Name".
      E.g. *OpenUcorImportExportList*.
   b) Select "Wizard > Open Dialog"
   c) Select "Select" and select the dialog ID from the list

   The corresponding SCPI command is automatically displayed and can be later modified.
4. Select "Add" to store the new action in the list of user key actions.
5. To execute the created action, press ★ (User).

In the list of actions ("Select Action to Execute" dialog), navigate to the required action.

The R&S SMCV100B executes the action and opens the dialog.

11.4 Managing Licenses and License Keys

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.

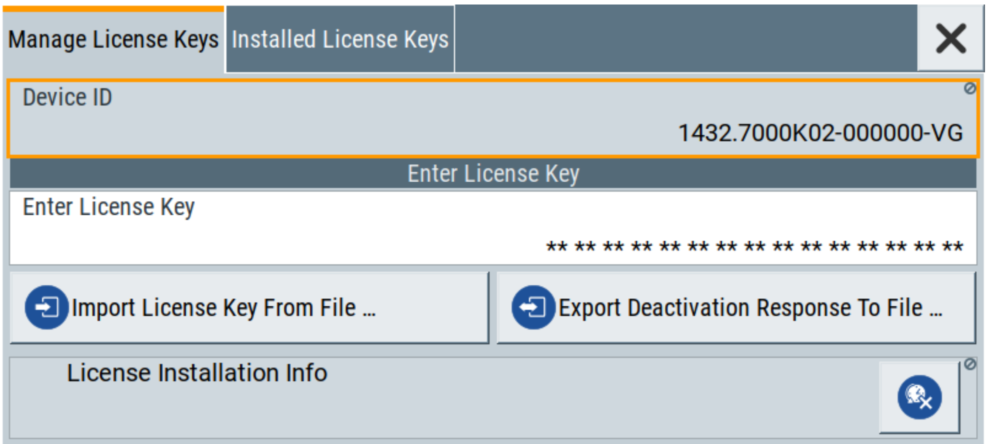
The firmware update is described in the R&S SMCV100B service manual.

11.4.1 Manage License Keys Settings

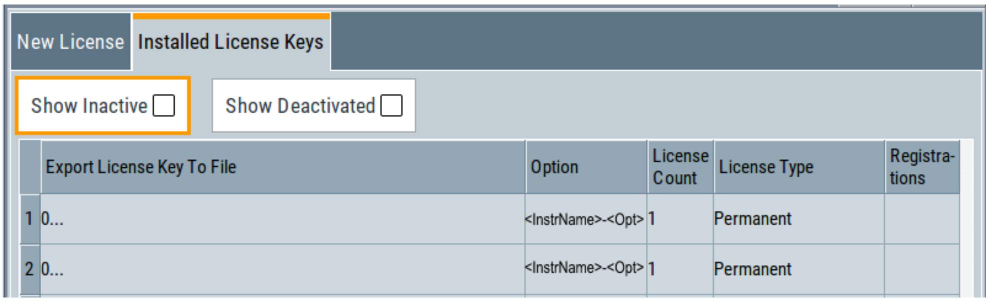
This dialog is the central dialog for licenses registration and performing the required instrument-related steps during the process of unregistration.

Access:

1. Select "System Config > Setup > Instrument Assembly > Manage License Keys > Manage License Keys".



2. Select "System Config > Setup > Instrument Assembly > Manage License Keys > Installed License Keys".



In the "New License" tab, you can activate licenses for newly purchased or newly registered options. The "Installed License Keys" tab enables you to cancel already registered options, or move licenses.

Settings

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 option short designation.

"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)

11.4.2 How to Move a Portable License

This example is intended to explain how to perform the required steps at the instrument.

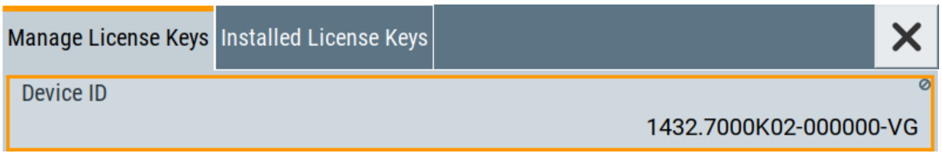
Use a USB flash drive to transfer the license key files between the instruments and the browser.

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 > Manage License Keys > Device ID".

   b) On the target instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > New License > Device ID".
   c) In the browser, select "Manage Licenses > Move Portable License > Select Devices" and enter the Device IDs.
3. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Installed License Keys > License Keys Table".
   Navigate to the portable license you want to move.
   Select the "Export License to File" column.

   A standard file manager dialog opens.
4. Enter a filename. Save the exported license key, e.g.
   `k123_portable_key_to_move.xml`.
5. In the browser, select "Manage Licenses > Move Portable License > Select License (from file)" and select the exported license key.
   Check the selection. Create the deactivation key. Save it to file.
6. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Manage License Keys > Import License Keys from File".
   Select the transferred deactivation key.
7. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Manage License Keys > Export Deactivation Response to File".
8. In the browser, go to "Manage Licenses > Move Portable License > Install Deactivation Key (from file)".
   Enter the deactivation response of the instrument.

   The license is deactivated for the source instrument.
9. 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.
   Download the license key as a file. Transfer it to the target instrument.
10. In the target instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > New License > Import License Keys from File".
    Select the created license key file.

    The portable option is installed on the target instrument.

11.5 Using the Security Settings

The protection function of the R&S SMCV100B offers 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, the protection levels, that means all protected functions are locked.

To unlock a protection level:

► In the "System Config > Setup > Security > Protection", 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 SMCV100B helps you to protect your instrument against uncontrolled access and changes. All provided security services require that you enter the security password.

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.
  – **Secure Update Policy** check that verifies the integrity and origin of the firmware package to be installed.

To access the settings of these topics, see Setting Security Parameters > "Secure Update Policy" on page 443.

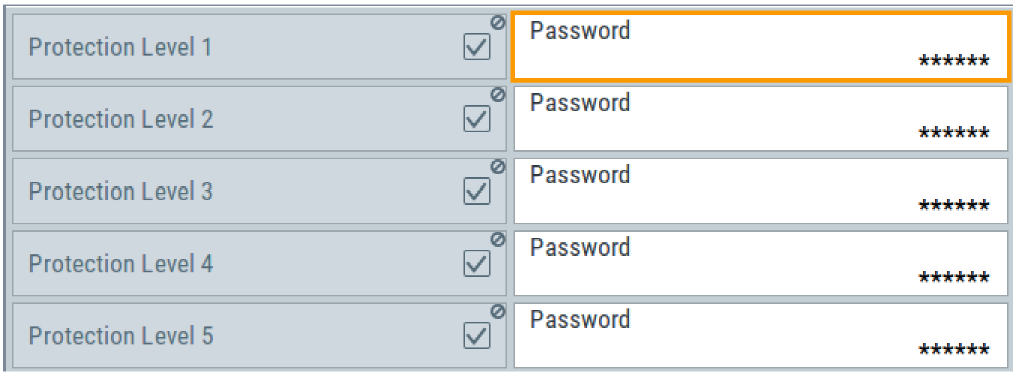
- **Password** management secures controlled user access to the instrument
  With the two-step password concept, you can assign a user-defined password for the operating system, and a security password for accessing the mass storage of the instrument.
  See also Chapter 11.5.4, "Password Management", on page 449.
- **LAN services** secure controlled network access
  You can individually lock and unlock supported LAN interface services. Also you can activate and deactivate SMB client and SMB server, that use versions 1.0 and 2.0 of the SMB protocol. See Chapter 11.5.3, "Configuring LAN Services", on page 447.
  Remote control via LAN interface requires that the interface is activated, but you can enable the required services specifically.
- **User interface** prevents front panel operation and/or reading the display.

For more information, see the document R&S SMCV100B Instrument Security Procedures.

11.5.1 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 440.

The remote commands required to unlock a protected stage are described in Chapter 13.16, "SYSTem Subsystem", on page 732.

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.

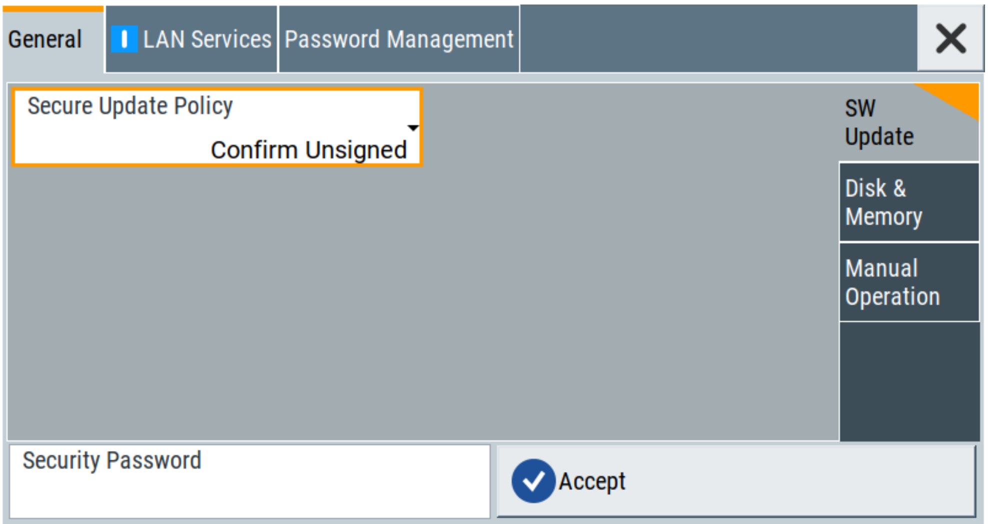
Remote command:

:SYSTem:PROTect<ch>[:STATe] on page 740

11.5.2 Setting Security Parameters

Access:

► Select "System Config > Setup > Security > Security > General".



In the "General" tab, you can determine the security level for firmware updates, and configure the security settings for the mass memory and manual operation.

All modified settings in this dialog are not applied until you enter the Security Password and confirm with Accept.

11.5.2.1 Update Policy Security Settings

Access:

► Select "System Config > Setup > Security > Security > General > SW Update".

The SW Update tab enables you to select the security mode for firmware updates.

The remote commands available to control security settings are described in Chapter 13.16, "SYSTem Subsystem", on page 732.

Secure Update Policy
Allows you to configure the automatic signature verification for firmware installation.

To apply the change: enter the security password and confirm with "Accept". Otherwise the change has no effect.

See also:
- Chapter 11.5, "Using the Security Settings", on page 440 for more information on the security concept.
- The release notes for details on signature verification when installing new or former firmware versions, available at www.rohde-schwarz.com/firmware/smcv100b.

"Confirm Unsigned"
Performs the signature verification.
If the check detects any discrepancies, the instrument issues a warning message. You can still update the firmware or reject updating.
This setting also enables you to downgrade the firmware version.

"All Packages" Accepts all packages without signature verification.

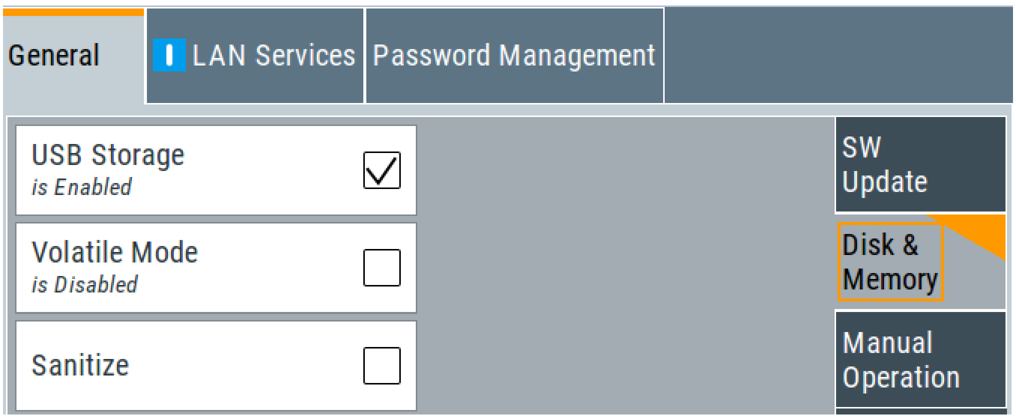
"R&S Signed Packages"
Performs the signature check.
If the check detects any discrepancies, the instrument issues a warning message and locks the update to this firmware.

Remote command:
`:SYSTem:SECurity:SUPolicy` on page 747

11.5.2.2 Disk & Memory Security Settings

Access:

► Select "System Config > Setup > Security > Security > 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 Chapter 13.16, "SYSTem Subsystem", on page 732.

USB Storage

Activates the access to external USB storage media.

To apply the change: enter the security password and confirm with "Accept". Otherwise the change has no effect.

See also Chapter 10.8.4, "Using a USB Storage Device for File Transfer", on page 410.

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 Chapter 10.3, "Protecting Data", on page 394.
- 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 activate volatile mode: enter the security password, confirm with "Accept" and reboot the instrument. Otherwise the change has no effect.

Activated volatile mode is indicated by the icon .

Remote command:
`:SYSTem:SECurity:VOLMode[:STATe]` on page 741

Sanitize

Executes the erase procedure that sanitizes the internal memory.

If the instrument is subject to high security, and you have not enabled the volatile mode, the internal flash memory holds user-data, i.e. it poses a security risk. 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". Otherwise the change has no effect.

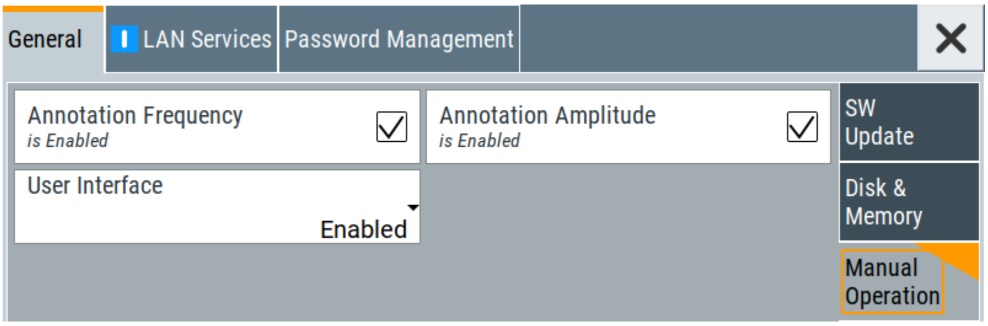
See also Chapter 11.5, "Using the Security Settings", on page 440 for more information on the security concept.

Remote command:
`:SYSTem:SECurity:SANitize[:STATe]` on page 747

11.5.2.3 Manual Operation Security Settings

Access:

► Select "System Config > Setup > Security > Security > General > Manual Operation".



The "SW Update" tab enables you to lock front panel operation and/or reading the display.

The remote commands available to control security settings are described in:

- Chapter 13.8, "DISPlay Subsystem", on page 535
- Chapter 13.16, "SYSTem Subsystem", on page 732.

Annotation Frequency

Enables the display of the currently used frequency in the status bar.

How to: see "Disabling the frequency and level indication in the status bar" on page 453.

Remote command:
`:DISPlay:ANNotation:FREQuency` on page 537

Annotation Amplitude

Enables the display of the currently selected level in the status bar.

How to: see "Disabling the frequency and level indication in the status bar" on page 453.

Remote command:
`:DISPlay:ANNotation:AMPLitude` on page 537

User Interface

Allows you to lock the controls for manual operation and the display individually.

How to: see "Deactivating the user interface" on page 453.

See also Chapter 11.5, "Using the Security Settings", on page 440.

"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 453.

"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 453.

Remote command:
`:SYSTem:ULOCk` on page 738
`:SYSTem:DLOCk` on page 737
`:SYSTem:KLOCk` on page 738

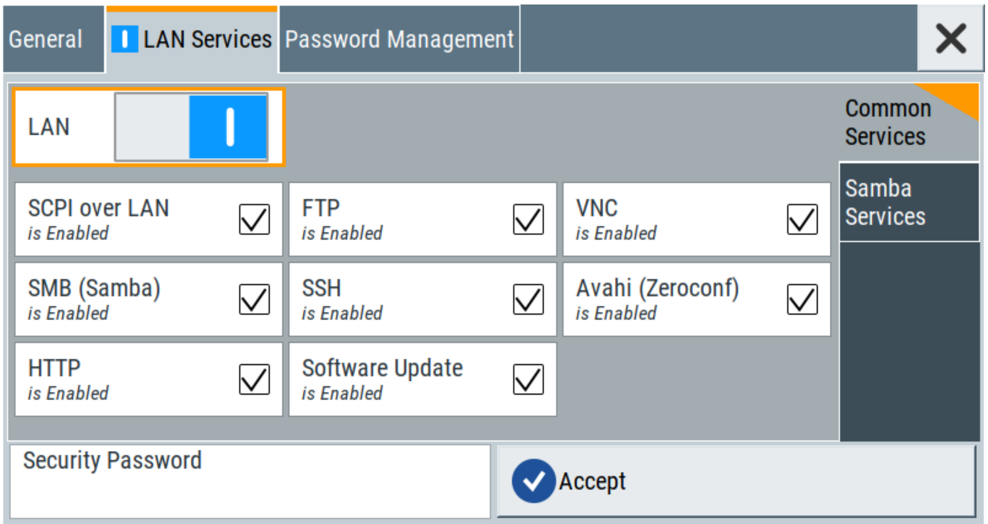
Enabling a locked user interface for manual operation
Follow the instructions listed in "Unlocking (reactivating) the user interface for manual operation" on page 453.

Remote command:
`:SYSTem:ULOCk` on page 738
`:SYSTem:DLOCk` on page 737
`:SYSTem:KLOCk` on page 738

11.5.3 Configuring LAN Services

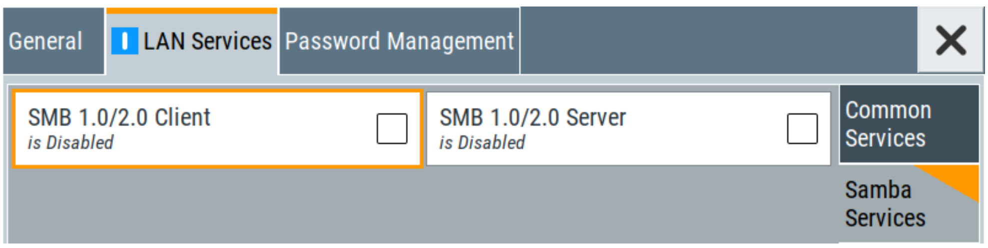
Access:

1. Select "System Config > Setup > Security > Security > LAN Services > Main Services".



   In the "Main Services" side tab, you can individually enable or disable the supported LAN interface services.

2. Select "System Config > Setup > Security > Security > LAN Services > Samba Services".



   In the "Samba Services" side tab, you can activate older versions of the SMB client and SMB server.

How to:

- "Disabling the LAN interface" on page 452
- "Disabling LAN services" on page 453
- "Activating SMB version 1.0/2.0 client and server" on page 453

Common Services

Enable or disable the LAN interface and supported LAN interface services.

LAN ← Common Services

Enables the LAN interface in general, and thus provides remote access via all unlocked services.

Enable LAN Services individually ← Common Services

Enables or disables the following interface services individually.

"SCPI over LAN"
: Activates access over LAN to control the instrument remotely, by using SCPI (Standard Commands for Programmable Instruments) commands.
See also "Starting a remote control session over LAN with R&S VISA" on page 489.

"VNC"
: Activates access via VNC (Virtual Network Computing) interface, a graphical desktop sharing system that uses RFB protocol to control the instrument remotely.
See also Chapter 12.9, "Operating the R&S SMCV100B Remotely via VNC", on page 503.

"SSH"
: Activates access via SSH (Secure Shell), a network protocol for secure data communication.

"HTTP"
: Activates access via HTTP (Hyper Text Transfer Protocol), the application protocol for hypermedia information systems.

"FTP"
: Activates access via FTP (File Transfer Protocol), used to transfer files from a host to the instrument and vice versa.
See also Chapter 10.8.2, "Accessing the File System of the R&S SMCV100B via ftp", on page 408.

"SMB (Samba)"
: Activates access to SMB (Server Message Block), used for providing shared access to files, printers and serial ports of a network.
See also Chapter 10.8.3, "Accessing the R&S SMCV100B File System via SMB (Samba)", on page 409.

"Avahi (Zeroconf)"
: Activates Avahi, a service for automatic configuration of the instrument in a network environment.

"Software Update"
: Allows updating the software.

Samba Services

Activate or deactivate 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 versions up to version 4.

SMB 1.0/2.0 Client ← Samba Services
Activates support of the SMB client compatible with SMB protocol versions 1.0 and 2.0.

SMB 1.0/2.0 Server ← Samba Services
Activates 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*.

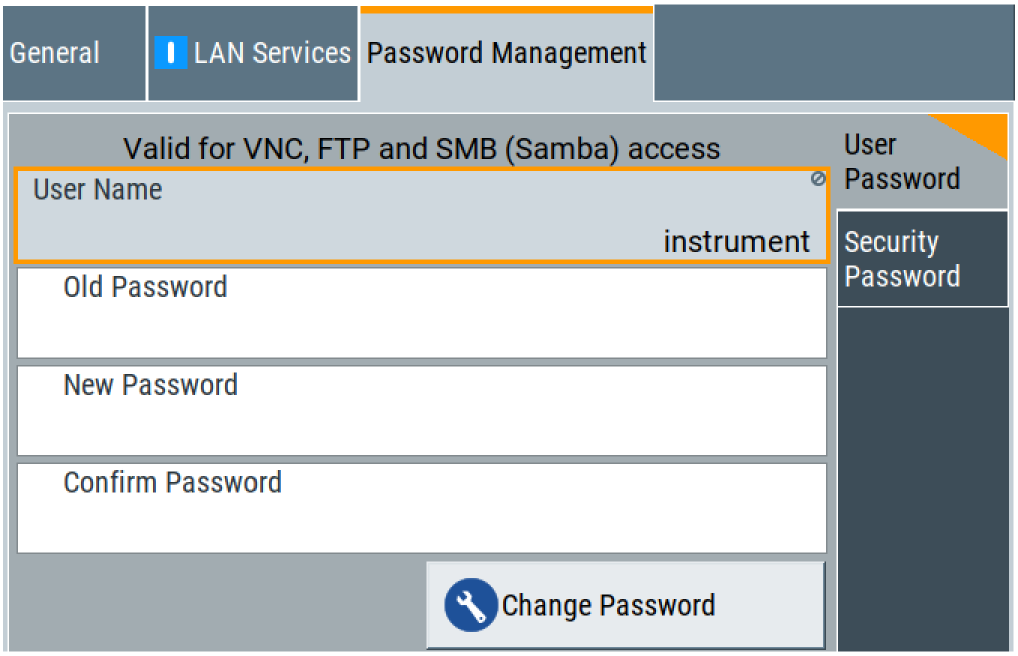
How to:
- "Disabling the LAN interface" on page 452
- "Disabling LAN services" on page 453
- "Changing the default security password" on page 452.

Accept
Applies the modified settings, provided the security password is entered and correct.

11.5.4 Password Management

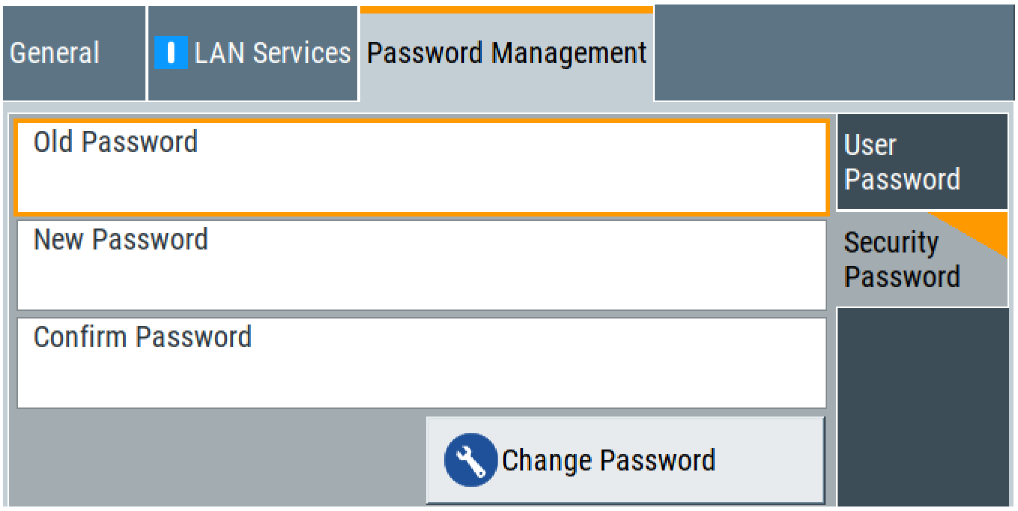
Access:

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:
- "Changing the default user password of the instrument" on page 452.
- "Changing the default security password" on page 452.

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
Access: select "System Config > Setup > Security > Security > Password Management > 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:
- "Changing the default user password of the instrument" on page 452.
- "Changing the default security password" on page 452.

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:
- "Changing the default user password of the instrument" on page 452.
- "Changing the default security password" on page 452.

Change Password ← User Password
Changes the user password accordingly.

Security Password
Access: select "System Config > Setup > Security > Security > Password Management > 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:
- "Changing the default user password of the instrument" on page 452.
- "Changing the default security password" on page 452.

The security password is required when changing the status of the USB and LAN interface.

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:
- "Changing the default user password of the instrument" on page 452.
- "Changing the default security password" on page 452.

Change Password ← Security Password
Changes the password accordingly.

11.5.5 How to Prevent 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 interface.

To prevent unauthorized access, use the following configurations exclusively or complementary:
- "Changing the default user password of the instrument" on page 452

- "Changing the default security password" on page 452
- "Disabling the LAN interface" on page 452
- "Disabling LAN services" on page 453
- "Activating SMB version 1.0/2.0 client and server" on page 453
- "Disabling the frequency and level indication in the status bar" on page 453
- "Deactivating the user interface" on page 453

If security is a concern, see the document instrument security procedures for comprehensive description.

Changing the default user password of the instrument

► **Note:** We recommend that you change the default password before connecting the instrument to a network.

How to:

- "Changing the default user password of the instrument" on page 452.
- "Changing the default security password" on page 452.

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").

Changing the default security password

► **Note:** We recommend that you change the default password before connecting the instrument to a network.

How to:

- "Changing the default user password of the instrument" on page 452.
- "Changing the default security password" on page 452.

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".

Disabling the LAN interface

1. Select "System Config > Setup > Security > Security > LAN Services > Main Services".
2. Select "LAN > Off".

   All LAN connections and hence all LAN services are disabled.

Disabling LAN services

1. Select "System Config > Setup > Security > Security > LAN Services > Main Services".
2. Select, for example, "FTP > Off" or "VNC > Off".
3. Enter the Security Password.
4. Select "Accept".

Activating 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 deactivated.

Activate support only, if needed:

1. Select "System Config > Setup > Security > Security > LAN Services > Samba Services".
2. Select "SMB 1.0/2.0 Client > On" and "SMB 1.0/2.0 Server > On".
3. Enter the Security Password.
4. Select "Accept".

Disabling the 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".

Deactivating the user interface

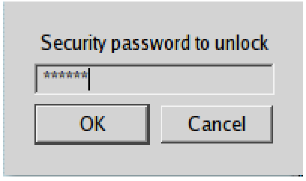
1. Select "System Config > Setup > Security > General > Manual Operation".
2. Select "User Interface > Disabled".
3. Enter the Security Password.
4. Select "Accept".

   The screen shuts off and displays a padlock symbol 🔒 instead.
   There are further possible configurations. For details, see "User Interface" on page 445.

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.

11.6 Undoing or Restoring Actions

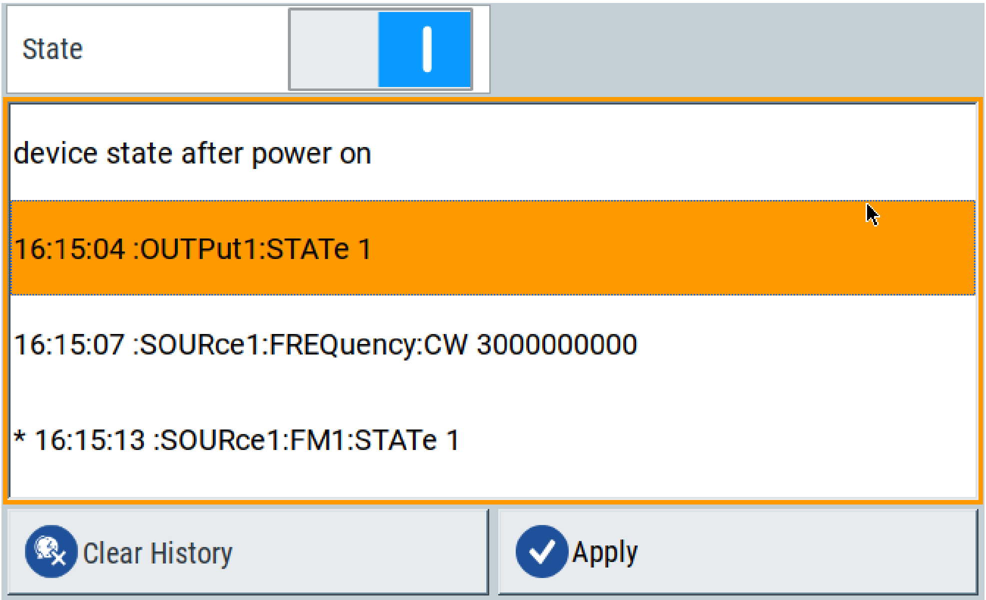
"Undo" is a function that removes the effect of the last action on the instrument and reverts it to an older state. Conversely, "Redo" restores a previously undone action.

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

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.

11.7 Shutting Down and Rebooting the Instrument

The On/Standby front panel 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 753
- `:SYSTem:SHUTdown` on page 754

12 Network Operation and Remote Control

The description in this section requires basic knowledge of the remote control operation. Definitions specified in the SCPI standard are not provided.

You find some basic information to the SCPI syntax, command lists, and general programming recommendations in Chapter A.1, "Additional Basics on Remote Control", on page 786.

See also Chapter A.1.5, "Status Reporting System", on page 799.

As an alternative to the interactive operation directly at the instrument, you can operate the R&S SMCV100B also from a remote location.

The Figure 12-1 shows the possibilities of the physical connection (interfaces) for the remote access.

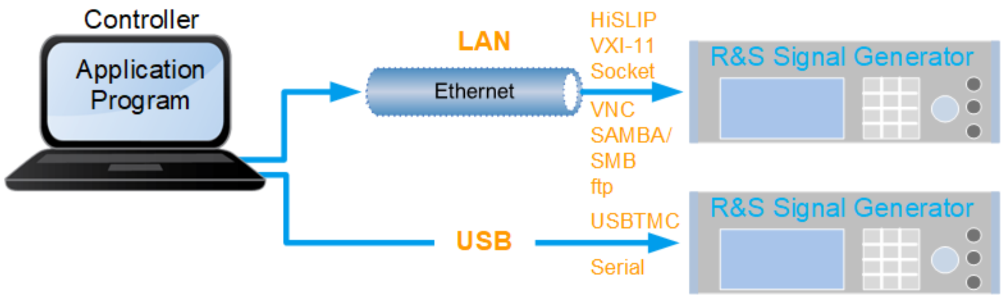


Figure 12-1: Supported remote connections

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.

See:

- Overview of Remote Access Modes
- 1GP72: Connectivity of Rohde&Schwarz Signal Generators
- Chapter 3.1.7, "Connecting to LAN", on page 25

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 Chapter 12.9, "Operating the R&S SMCV100B Remotely via VNC", on page 503.

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.
	• 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:

Chapter 10.8, "How to Transfer Files from and to the Instrument", on page 406.

"Activating SMB version 1.0/2.0 client and server" on page 453

12.2 Remote Control Interfaces and Protocols

The instrument supports various interfaces for remote control. The table 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 interface is based on TCP/IP and supports various protocols.
		For a description of the protocols, refer to:
		• Chapter 12.2.1.2, "HiSLIP Protocol", on page 461
		• Chapter 12.2.1.3, "VXI-11 Protocol", on page 462
		• Chapter 12.2.1.4, "Socket Communication", on page 462

USB	• **USBTMC** `USB::<vendor ID>::<product ID>::<serial number>[::INSTR]` VISA	The "USB In" connector is at the rear panel of the instrument. For a description of the interface, refer to Chapter 12.2.2, "USB Interface", on page 463
*) 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. For remote control via socket communication VISA installation is optional. For more information, see Chapter 12.3.1, "VISA Library", on page 464.		

Rohde & Schwarz provides the standardized I/O software library R&S VISA for communication with the instruments via TCP/IP (LAN: HiSLIP, VXI-11 and raw socket) or USB (USBTMC) interfaces.

R&S VISA is available for download at the Rohde & Schwarz website http://www.rohde-schwarz.com/rsvisa.

How to configure the remote control interfaces is described in Chapter 12.7, "Controlling the R&S SMCV100B Remotely", on page 484.

SCPI (Standard Commands for Programmable Instruments)

SCPI commands - messages - are used for remote control. Commands that are not taken from the SCPI standard follow the SCPI syntax rules. The instrument supports the SCPI version 1999. The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers. The tutorial "Automatic Measurement Control - A tutorial on SCPI and IEEE 488.2" from John M. Pieper (Rohde & Schwarz order number 0002.3536.00) offers detailed information on concepts and definitions of SCPI.

Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers.

For more information, see also Chapter A.1, "Additional Basics on Remote Control", on page 786.

12.2.1 LAN Interface

To be integrated in a LAN, the instrument is equipped with a LAN interface, consisting of a connector, a network interface card and protocols.

For remote control via a network, the PC and the instrument must be connected via the LAN interface to a common network with TCP/IP network protocol. The TCP/IP network protocol and the associated network services are preconfigured on the instrument. Software for instrument control and (for specified protocols only) the VISA program library must be installed on the controller.

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.

12.2.1.1 VISA Resource Strings

The VISA resource string is required to establish a communication session between the controller and the instrument in a 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 on the network. Alternatively, you can also assign its **LAN device name**.

If assigned, the IP address is displayed on block diagram. You can adjust it manually with the parameter the "System Config > Remote Access > Network" > IP AddressEnabling a locked user interface for manual operation.

The following section lists the characteristics of the VISA resource strings for the corresponding interface protocols. The highlighted characters are crucial.

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.

For details of the HiSLIP protocol, refer to Chapter 12.2.1.2, "HiSLIP Protocol", on page 461.

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.

For details of the VXI-11 protocol, refer to Chapter 12.2.1.2, "HiSLIP Protocol", on page 461.

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 VISA resource string with the associated protocol used.

The registered port for socket communication is port 5025.

See also Chapter 12.2.1.4, "Socket Communication", on page 462.

12.2.1.2 HiSLIP Protocol

The HiSLIP (**Hi**gh **S**peed **L**AN **I**nstrument **P**rotocol) is the successor protocol for VXI-11 for TCP-based instruments specified by the IVI foundation. The protocol uses two TCP sockets for a single connection - one for fast data transfer, the other for non-sequential control commands (e.g. `Device Clear` or `SRQ`).

HiSLIP has the following characteristics:

- High performance as with raw socket network connections

- Compatible IEEE 488.2 support for Message Exchange Protocol, Device Clear, Serial Poll, Remote/Local, Trigger, and Service Request
- Uses a single IANA registered port (4880), which simplifies the configuration of firewalls
- Supports simultaneous access of multiple users by providing versatile locking mechanisms
- Usable for IPv6 or IPv4 networks

Using VXI-11, each operation is blocked until a VXI-11 device handshake returns. However, using HiSLIP, data is sent to the device using the "fire and forget" method with immediate return. Thus, a successful return of a VISA operation such as `viWrite()` does not guarantee that the instrument has finished or started the requested command, but is delivered to the TCP/IP buffers.

For more information see also the application note:

1MA208: Fast Remote Instrument Control with HiSLIP

12.2.1.3 VXI-11 Protocol

The VXI-11 standard is based on the ONC RPC (Open Network Computing Remote Procedure Call) protocol which in turn relies on TCP/IP as the network/transport layer. The TCP/IP network protocol and the associated network services are preconfigured. TCP/IP ensures connection-oriented communication, where the order of the exchanged messages is adhered to and interrupted links are identified. With this protocol, messages cannot be lost.

12.2.1.4 Socket Communication

An alternative way for remote control of the software is to establish a simple network communication using sockets. The socket communication, also referred to as "Raw Ethernet communication", does not necessarily require a VISA installation on the remote controller side. It is available by default on all operating systems.

The simplest way to establish socket communication is to use the built-in telnet program. The telnet program is part of every operating system and supports a communication with the software on a command-by-command basis. For more convenience and to enable automation by means of programs, user-defined sockets can be programmed.

Socket connections are established on a specially defined port. The socket address is a combination of the IP address or the host name of the instrument and the number of the port configured for remote-control. All R&S SMCV100B use port number 5025 for this purpose. The port is configured for communication on a command-to-command basis and for remote control from a program.

12.2.2 USB Interface

For remote control via the USB connection, the PC and the instrument must be connected via 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 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, it supports service request, triggers, and other specific operations.

12.2.2.1 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 on the rear of the instrument
[::INSTR] = indicates the instrument resource class (optional)

To set the USB resource string, see Remote Access Settings.

Example:

`USB::0x0AAD::0x01df::100001`

0x0AAD is the vendor ID for Rohde & Schwarz.

0x01df is the product ID for the R&S SMCV100B

100001 is the serial number of the particular instrument.

12.2.3 LXI Browser Interface

The LXI browser interface allows easy configuration of the LAN and remote control of the R&S SMCV100B without additional installation requirements. The instrument's LXI browser interface works correctly with all W3C compliant browsers.

See Chapter 12.10.1, "LXI Functionality", on page 508 for more about LXI.

The LAN settings are configured using the instrument's LXI browser interface described in Chapter 12.5.2.1, "LAN Configuration", on page 477. The LXI status settings in the R&S SMCV100B are described in Chapter 12.5.1, "LXI Status Settings", on page 475.

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 appropriate interface protocols.

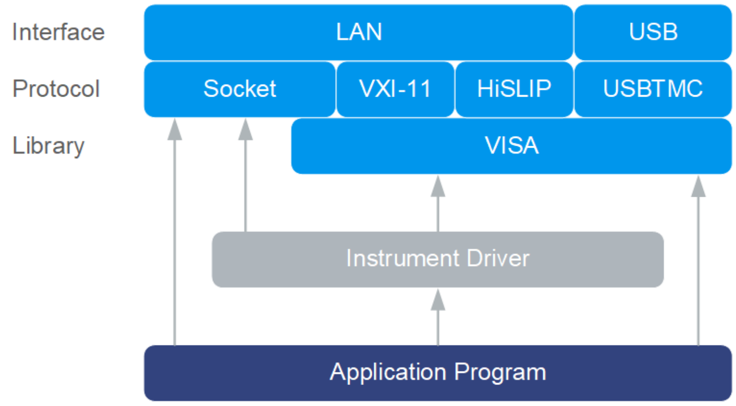


Figure 12-2: Overview of remote control interfaces, protocols and libraries

12.3.1 VISA Library

VISA is a standardized software interface library providing input and output functions to communicate with instruments. Thus, you can configure the interface without having to adjust the application program to the used interface.

The I/O channel (LAN or TCP/IP, USB, etc.) is selected at initialization time with the channel–specific address string ("VISA resource string"), or by an appropriately defined VISA alias (short name). See also Table 12-2 for an overview.

Instrument access via VXI-11 or HiSLIP protocols is achieved from high level programming platforms using VISA as an intermediate abstraction layer. VISA encapsulates the low-level VXI function calls and thus makes the transport interface transparent for the user.

A VISA installation is a prerequisite for remote control using the following interfaces:

- LAN interface using HiSLIP Protocol
- LAN interface using VXI-11 Protocol
- USB Interface

Instrument access via the LAN socket protocol can be operated with or without the VISA library. See also Chapter 12.2.1.4, "Socket Communication", on page 462.

For more information about VISA library, refer to the user documentation.

12.3.2 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. The involved parts are **highlighted**. For more information, see the application note 1GP72: Connectivity of Rohde&Schwarz Signal Generators.

- Remote control (application) program using VISA

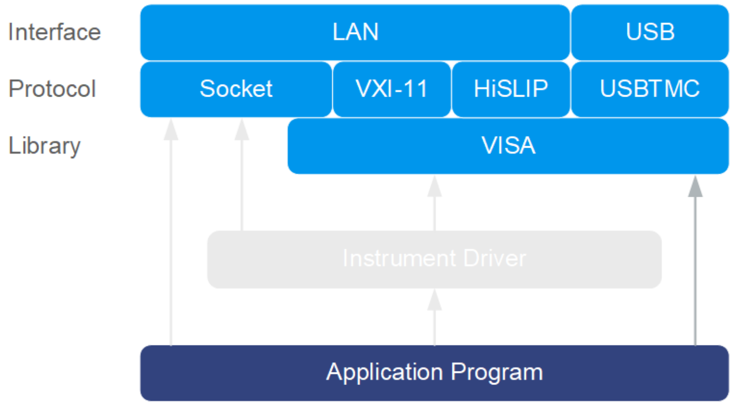


Figure 12-3: Application program using VISA

Protocol	Remote control program
Socket	`viOpen (..., "TCPIP:SMCV100B-102030::5025::SOCKET", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
VXI-11	`viOpen (..., "TCPIP:SMCV100B-102030::inst0::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
HiSLIP	`viOpen (..., "TCPIP:SMCV100B-102030::hislip0::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
USBTMC	`viOpen (..., "USB::0x0AAD::0x01df::100001::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`

- Remote control program using instrument driver (VISA available)

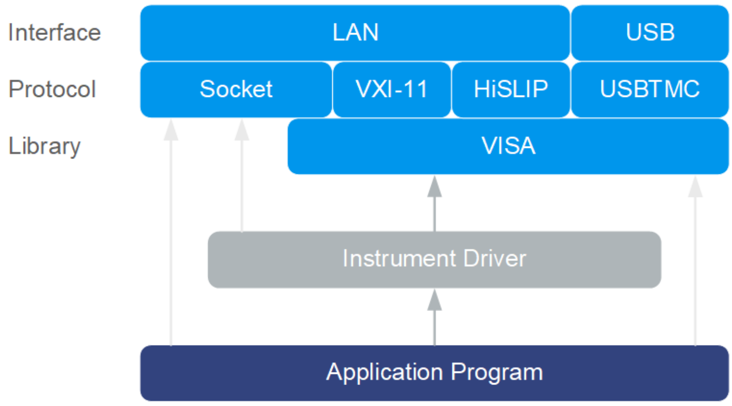


Figure 12-4: Application using instrument driver (VISA available)

Protocol	Remote control program
Socket	`rssmcv_init ("TCPIP:SMCV100B-102030::5025::SOCKET", ...)` `rssmcv_SetFrequency (..., 2e9)`
VXI-11	`rssmcv_init ("TCPIP:SMCV100B-102030::inst0::INSTR", ...)` `rssmcv_SetFrequency (..., 2e9)`
HiSLIP	`rssmcv_init ("TCPIP:SMCV100B-102030::hislip0::INSTR", ...)` `rssmcv_SetFrequency (..., 2e9)`
USBTMC	`rssmcv_init ("USB::0x0AAD::0x01df::100001::INSTR", ...)` `rssmcv_SetFrequency (..., 2e9)`

- Remote control program using instrument driver (VISA **not** available)

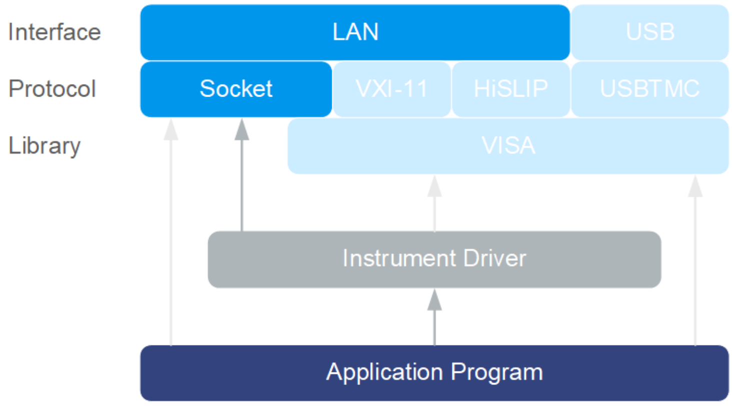


Figure 12-5: Remote control program using instrument driver (VISA not available)

Protocol	Remote control program
Socket	`rssmcv_init ("TCPIP:SMCV100B-102030::5025::SOCKET", ...)` `rssmcv_SetFrequency (..., 2e9)`

12.4 Remote Access Settings

This section outlines 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 via smart devices.

About instrument emulations

You can also remotely control the R&S SMCV100B via the command set of another signal generator. With this function you can, for example, replace a signal generator with an R&S SMCV100B in an automated test setup, without adjusting the command scripts used.

The R&S SMCV100B also covers command sets of Rohde & Schwarz signal generators, such as the R&S SFE and R&S SFE100. To achieve optimal compatibility when replacing an instrument, we recommend that you select the emulation command set for the corresponding signal generator.

You find all the remote control command sets supported by the R&S SMCV100B 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 SMCV100B specific command set is disabled and the SCPI command `:SYSTem:LANGuage` is discarded.

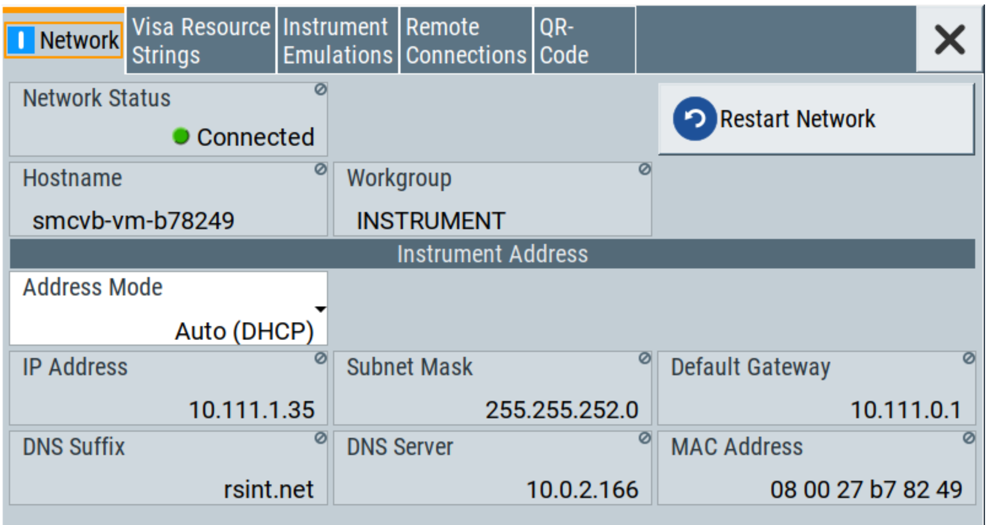
To return to the SCPI command set of the R&S SMCV100B, use the appropriate command of the selected command set.

If for example the R&S SFE/R&S SFE100 is emulated, the R&S SFE/R&S SFE100 command returns the corresponding R&S SMCV100B-specific command.

12.4.1 Network Settings

Access:

► Select "System Config > Remote Access > Network".



In the "Network" dialog, you can configure the settings of the general network environment and specific identification parameters of the instrument in the network.

The remote commands required to configure the network remotely are described in Chapter 13.16, "SYSTem Subsystem", on page 732.

How to: see Chapter 12.6.3, "How To Connect to LAN", on page 482.

Network Status

Indicates that the instrument is connected to the network.

Remote command:
`:SYSTem:COMMunicate:NETWork:STATus?` on page 742

Restart Network

Terminates the network connection of the instrument and subsequently 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 742

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 host-name 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 743

Workgroup

Sets the individual windows workgroup name of the R&S SMCV100B. 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 743

Address Mode

Selects the mode for assigning the IP address.

How to: see Chapter 12.6.4, "How to Assign the IP Address", on page 482.

"Auto (DCHP)"
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 741

IP Address

Displays the IP address of the instrument in the network.

By default, the R&S SMCV100B is configured to use dynamic TCP/IP configuration and to obtain the whole address information automatically.

If the network does not support DHCP or the attempt does not succeed, the instrument tries to obtain the IP address via Zeroconf (APIPA) protocol. IP addresses assigned via Zeroconf start with the number blocks `169.254.*.*`.

Note: An IP address that is assigned via the Zeroconf protocol although the network requires an IP address assigned via the DHCP server can cause network connection failures.

How to:
- "To assign the IP address manually on the instrument" on page 482.
- Chapter 12.6.2, "How To Activate LAN Services", on page 481.

Remote command:
`:SYSTem:COMMunicate:NETWork:IPADdress` on page 741

Subnet Mask

Displays the bit group of the subnet in the host identifier.

To assign the subnet mask manually, select Address Mode > "Static".

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK` on page 744

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 744

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 743

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 743

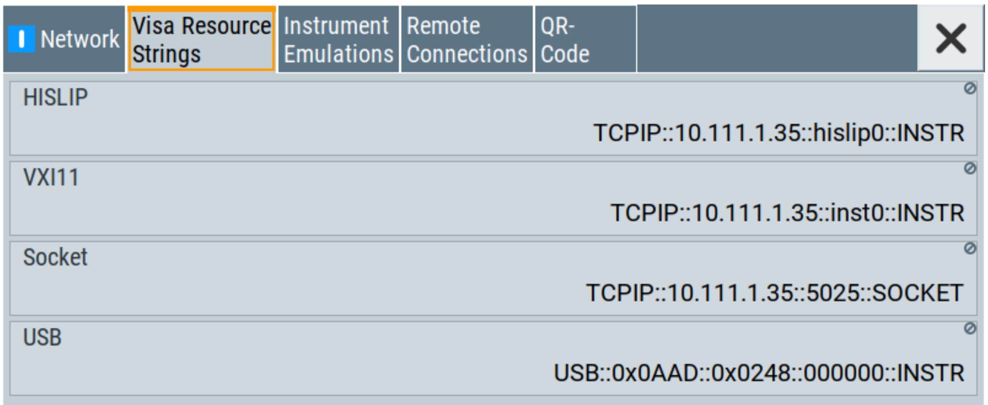
MAC Address
Indicates the MAC (Media Access Control) address, a unique identifier of the network adapter in the R&S SMCV100B.

Remote command:
`:SYSTem:COMMunicate:NETWork:MACaddress` on page 742

12.4.2 VISA Resource Strings

Access:

► Select "System Config > Remote Access > Visa Resource Strings".



The "Visa Resource String" dialog displays the VISA resource strings provided for remote control via the different interfaces.

Remote command:

`:SYSTem:COMMunicate:HISLip:RESource?` on page 741

`:SYSTem:COMMunicate:NETWork:RESource?` on page 742

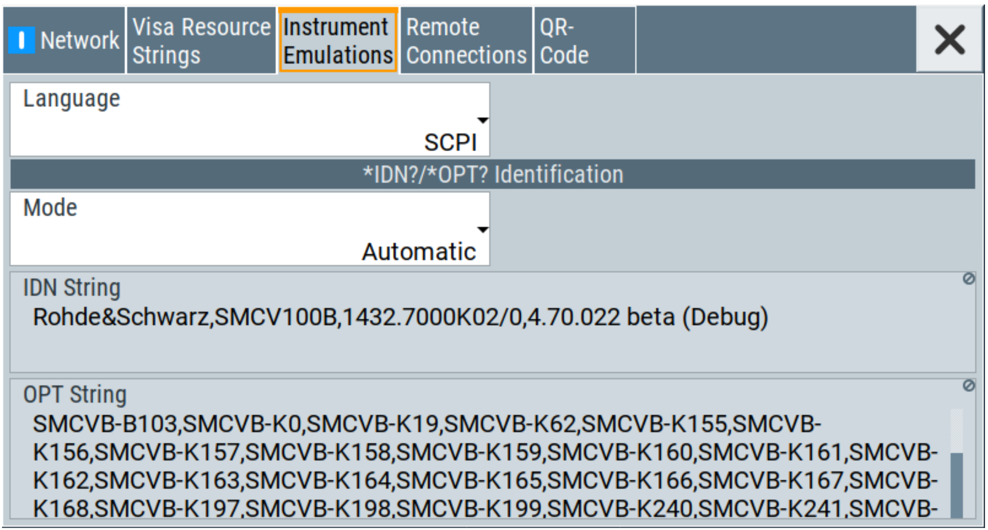
`:SYSTem:COMMunicate:SOCKet:RESource?` on page 744

`:SYSTem:COMMunicate:USB:RESource?` on page 744

12.4.3 Instrument Emulations Settings

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 Chapter 13.16, "SYSTem Subsystem", on page 732.

Language
Selects the instrument whose remote command set is emulated by the R&S SMCV100B.

Remote command:
`:SYSTem:LANGuage` on page 746

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 745

Set to Default
In "Mode > User Defined", resets the `*IDN` and `*OPT` strings.

Remote command:
`:SYSTem:IDENtification:PRESet` on page 745

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 514
`:SYSTem:IRESponse` on page 745

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, additionally to the automatically created one.

Remote command:
`*OPT?` on page 515
`:SYSTem:ORESponse` on page 746

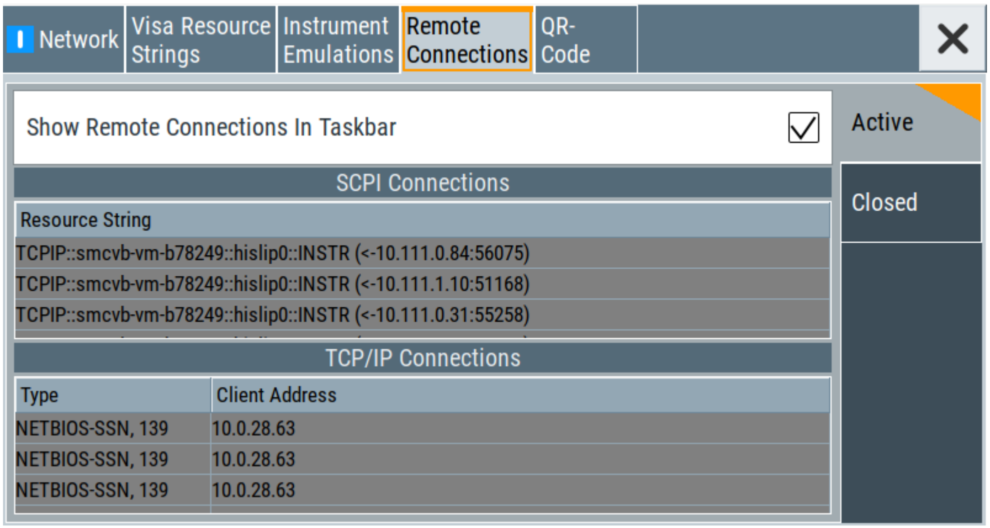
12.4.4 Remote Connections Settings

The "Remote Connections" dialog covers the active SCPI and TCP/IP connections, and a history list of the connections that have accessed the instrument before.

12.4.4.1 Active Connections

Access:

► Select "System Config > Remote Access > Remote Connections > Active".



The "Active " tab shows the currently active remote connections, and you can enable the display of the active connections in the task bar.

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.

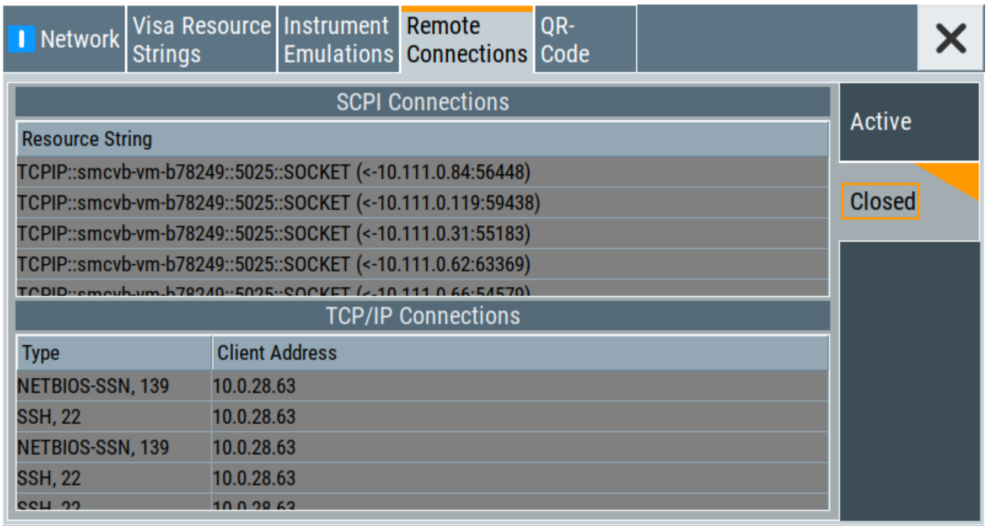
TCP/IP Connections
Displays the types and client addresses of the remote connections curently controlling the instrument via the LAN interface.

Remote command:
n.a.

12.4.4.2 Closed Connections

Access:

► Select "System Config > Remote Access > Remote Connections > Closed".



The "Closed" tab shows the currently active remote connections, and you can enable the display of the active connections in the task bar.

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.

12.4.5 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 Chapter 12.9.3, "How To Set Up a Remote Operation from a Smart Device", on page 505.

12.5 LXI Settings

On the R&S SMCV100B the LXI functionality is already installed and enabled, see LXI Status Settings. Thus, the instrument can be accessed via any web browser (like the Microsoft Internet Explorer) to perform the following tasks:

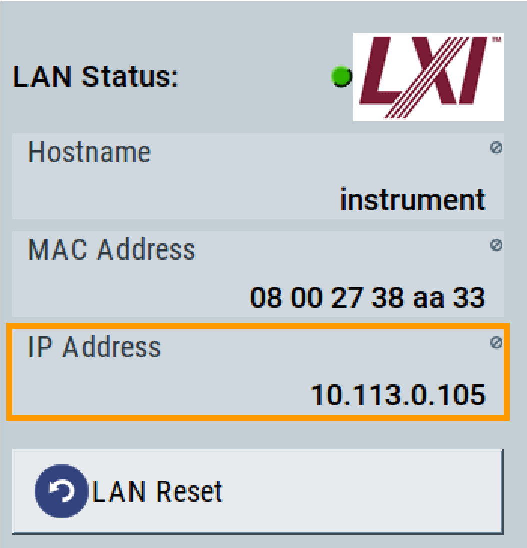
- Modifying network configurations
- Remote control the instrument
- Performing SCPI remote diagnostics

The LAN settings are configured using the instrument's LXI browser interface described in Chapter 12.5.2.1, "LAN Configuration", on page 477.

12.5.1 LXI Status Settings

Access:

► Select "System Config > Setup > Remote Access > LXI Status...".



The "LXI - Status" dialog shows the parameters of the LAN connection.

Alternatively, you can change the LAN settings using the LXI web browser interface, see Chapter 12.5.2.1, "LAN Configuration", on page 477.

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 468.

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 place the following network settings 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 vector signal generator:

Parameter	
Hostname	`Instrument-specific hostname`
Description	
Negotiation	Auto detect
VXI-11 discovery	Enabled

12.5.2 LXI Browser Settings

To access the instrument via the web browser:

► In the address field of the browser on your PC, type the instrument's host name or IP address, 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 LEDs flash, both in the browser dialog and in the LXI dialog of the connected instrument, see LAN Status. 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 "Ping Client" on page 479.
  - "Status" displays information about the LXI status of the instrument.
  - "Utilities" provides access to the LXI event log functionality required by the LXI standard.
- "Instrument Control"
  - "Web Control" provides remote access to the instrument, see "Starting a remote control via the LXI web browser" on page 485.
- "Diagnostics"
  - "SCPI Remote Trace" records messages exchanged via the remote control interface, see "SCPI Remote Trace" on page 479.
- "Help"
  - "Glossary" explains terms related to the LXI standard.

– www.rohde-schwarz.com opens the Rohde & Schwarz homepage.

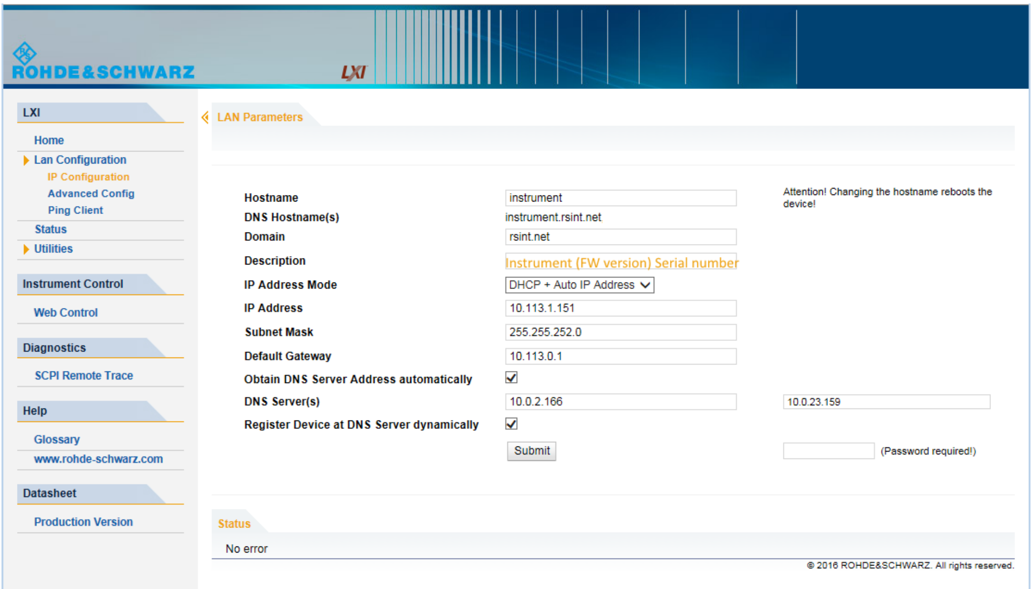
12.5.2.1 LAN Configuration

The "LAN Configuration" web page displays all mandatory LAN parameters and allows their modification.

It comprises the following navigation entries.

IP Configuration

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.

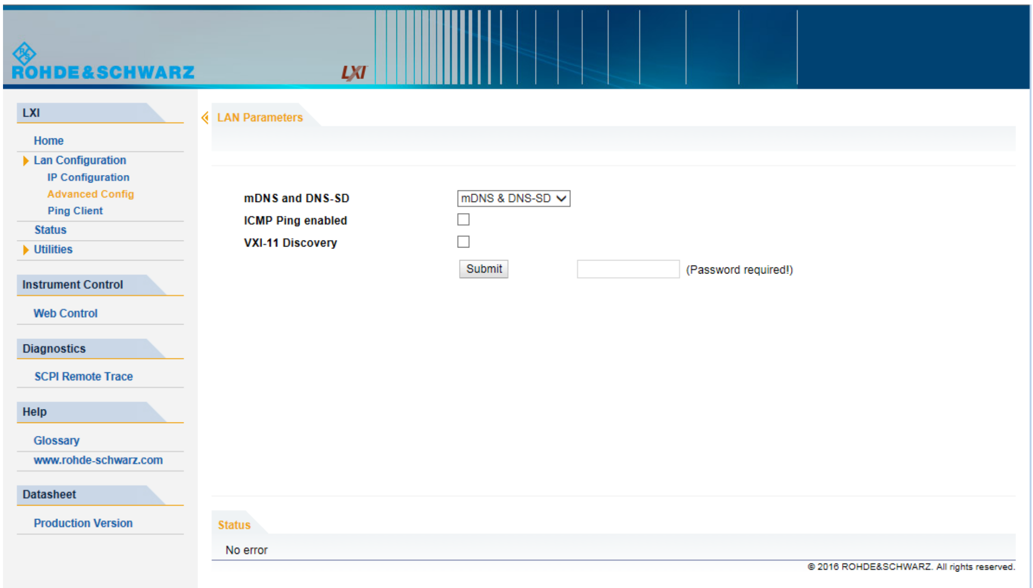
How to:

- "Changing the default user password of the instrument" on page 452.
- "Changing the default security password" on page 452.

See Chapter 11.5.4, "Password Management", on page 449.

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:

- "Changing the default user password of the instrument" on page 452.
- "Changing the default security password" on page 452.

See Chapter 11.5.4, "Password Management", on page 449.

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".

SCPI Remote Trace

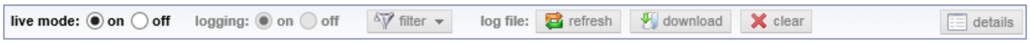
The remote trace functionality allows you to trace input and output strings at the remote control interface of the R&S SMCV100B, see Chapter 12.7.6, "How to Trace Messages with the LXI Web Browser Interface", on page 492.

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
- **I**: number of the subinstrument
- "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.
- "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

12.6 Connecting the Instrument to the Network (LAN)

The R&S SMCV100B is equipped with a network interface and can be connected to an Ethernet LAN (local area network).

There are two methods to establish a LAN connection to the instrument:

- A non-dedicated network (Ethernet) connection from the instrument to an existing network
- A dedicated network connection (Point-to-point connection) between the instrument and a single computer

For addressing, both the instrument and the computer require an IP address. The address information is usually assigned to the devices automatically, see Chapter 12.6.4, "How to Assign the IP Address", on page 482.

12.6.1 How To Enable Access via LAN

Per default, the LAN interfaces on the instrument are enabled.

If they have been disabled because of security reasons, enable them as follows:

1. Select "Setup > Security > LAN Services > LAN Interface = On".
2. Enter the Security Password.
3. Select "Accept".

12.6.2 How To Activate LAN Services

Per default, the LAN interfaces and all LAN services are enabled.

If they have been disabled because of security reasons, enable them as follows:

1. Select "Setup > Security > LAN Services".
2. Enable the required service, e.g. "LAN Services > FTP > On".
3. Enter the Security Password.
4. Select "Accept".

   See Chapter 11.5.5, "How to Prevent Unauthorized Access", on page 451.

12.6.3 How To Connect to LAN

1. **NOTICE!** 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. Connect the LAN socket on the rear panel via an RJ-45 cable to the LAN.

   The R&S SMCV100B displays its IP address on the screen.

12.6.4 How to Assign the IP Address

Depending on the network capacities, the TCP/IP address information for the instrument can be obtained in different ways.

- If the network supports DHCP (dynamic host configuration protocol), the address information is assigned automatically.
- If the network does not support DHCP, the instrument tries to obtain the IP address via Zeroconf (APIPA) protocol. If this attempt does not succeed or if the instrument is set to use alternate TCP/IP configuration, the addresses must be set manually.

Since the dynamic TCP/IP configuration assigns the address information automatically, it is safe to establish a physical connection to the LAN without any previous instrument configuration.

To assign the IP address manually on the instrument

1. **NOTICE!** 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. 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. Every block contains 3 numbers in maximum.
6. Select the "Subnet Mask" and enter the subnet mask, for example *255.255.255.0*.

   The subnet mask consists of four number blocks separated by dots. Every block contains 3 numbers in maximum.

To assign the IP address manually on the computer

► Obtain the necessary information from your network administrator. If you use more than one LAN connector, you need separate address information for each connector.
For information on how to perform the configurations, refer to the documentation of the operating system the computer uses.

12.6.5 How to Use Computer Names (Hostnames)

In a LAN that uses a DNS server, each PC or instrument connected in the LAN can be accessed via an unambiguous computer name (*hostname*) instead of the IP address. The DNS server translates the hostname to the IP address. It is especially useful when a DHCP server is used, as a new IP address can be assigned each time the instrument is restarted.

Each instrument is delivered with an assigned computer name, that remains permanent as long as it is not explicitly changed.

The default computer 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 .

Example:

The default hostname of an R&S SMCV100B with a serial number 102030 is `SMCV100B-102030`.

To query and change a computer name

1. Select "System Config > Remote Access > Network".

   The computer name is displayed under "Hostname".

2. Select "System Config > Setup > Security > Protection".

3. Enable the "Protection Level 1".
   The default password is *123456*.

   The parameter "Hostname" in the "Network" tab is now enabled for configuration.

4. Change the "Hostname".

12.7 Controlling the R&S SMCV100B Remotely

This section shows you how to set up remote control connections over the available interfaces.

The following general prerequisites must be fulfilled:

- The instrument and the controller have to be connected with the suitable cable and switched on.
  See Chapter 12.6, "Connecting the Instrument to the Network (LAN)", on page 481.
- To operate the instrument via remote control, it must be addressed using the defined interface address.

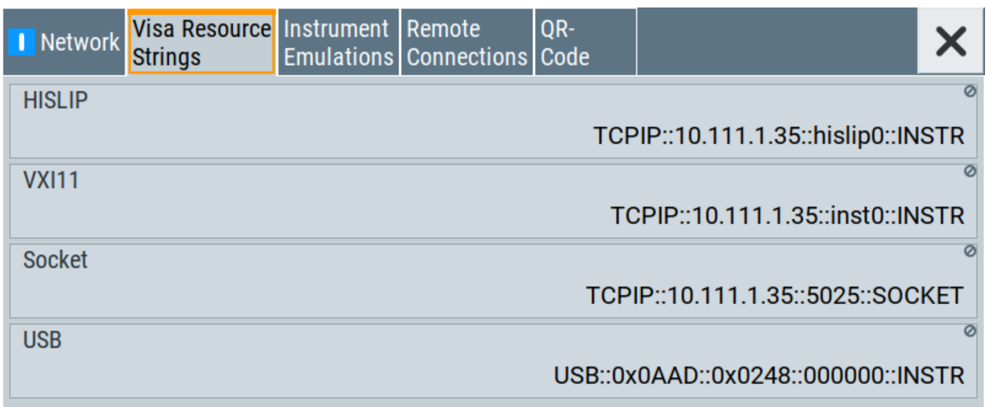
  See:
  - Chapter 12.2.1, "LAN Interface", on page 460
  - Chapter 12.2.2, "USB Interface", on page 463
  - Chapter 12.7.1, "How to Find the VISA Resource String", on page 484
- A remote control program must open a connection to the instrument, before it can send commands to and receive device responses from the instrument.

If security is a concern, see:

- Document instrument security procedures.
- Chapter 11.5.5, "How to Prevent Unauthorized Access", on page 451.

12.7.1 How to Find the VISA Resource String

► Select "System Config > Remote Access > VISA Resource Strings".



The dialog shows all specified resource strings of the supported remote control interfaces.

Note: Using the RS232 serial interface via USB requires the USB serial adapter R&S TS-USB1.

12.7.2 Establishing a Remote Control Connection over the LXI Browser Interface

Via the LXI browser interface to the R&S SMCV100B one or more users can control the instrument remotely from another PC without additional installation. Most instrument controls are available via the front panel simulation. File upload and download between the instrument and the remote PC is also available.

Starting a remote control via the LXI web browser

1. On the instrument, enable the LAN interface.
   See Chapter 12.6.1, "How To Enable Access via LAN", on page 481.
2. Connect the remote PC and the instrument in the same network.
   See Chapter 12.6.3, "How To Connect to LAN", on page 482.
3. On the remote PC, start a web browser that supports HTML5 (W3C compliant).
4. Enter the IP address of the R&S SMCV100B in the browser's address bar.
   The R&S SMCV100B's welcome page is displayed.
5. In the navigation pane, select "Instrument Control" > "Web Control".
   Remote access to the instrument requires the password. The default password is *instrument*.
6. Enter the password and confirm with the [Enter] key.
   After the connection is established, the current screen of the R&S SMCV100B is displayed in the browser window.
7. Use the mouse cursor and keyboard to access the functionality of the instrument as you would directly perform on the instruments touchscreen and front panel.

12.7.3 Establishing a Remote Control Connection over LAN Using VXI-11 Protocol

In this example, the I/O software library R&S VISA from Rohde & Schwarz is used to set up a LAN remote control link and remotely control the R&S SMCV100B. R&S VISA is running on a controller PC with Windows operating system. When the connection is set up, you can send commands to the instrument and receive the responses.

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) is used to replace the complete resource string. The host address is the R&S SMCV100B's hostname or its IP address.

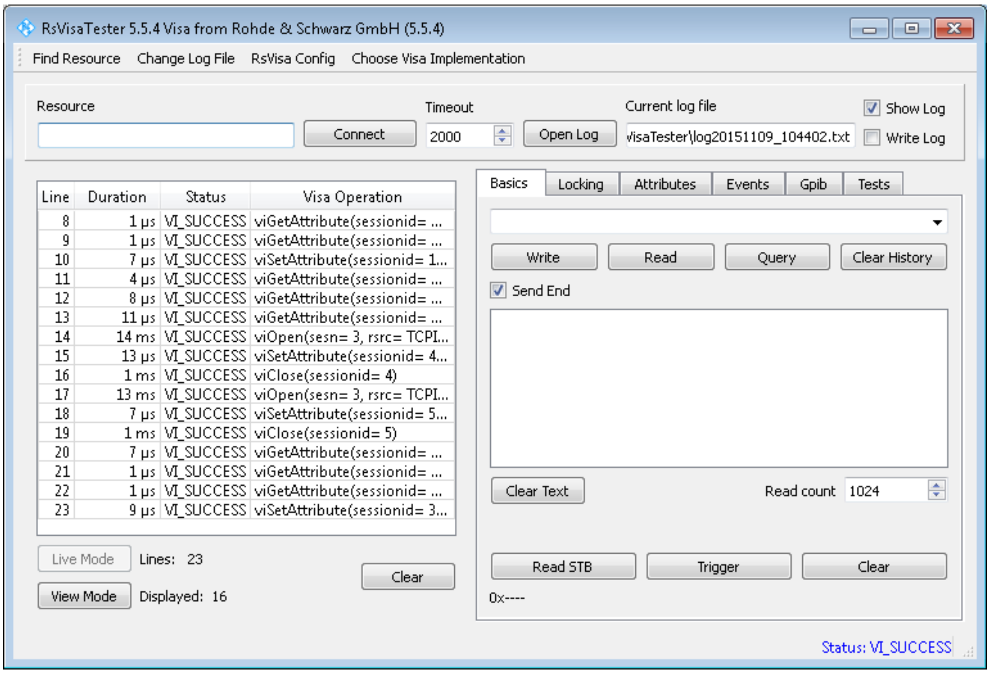
See also Chapter 12.2.1, "LAN Interface", on page 460.

Setting up the controller with R&S VISA

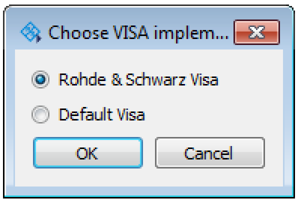
To remote control the R&S SMCV100B, we use the R&S VISA Tester application. The application communicates via TCP/IP protocol.

The instrument is preconfigured for networks using DHCP (dynamic host configuration protocol). If this configuration is used, enter the computer name in the position of the IP address.

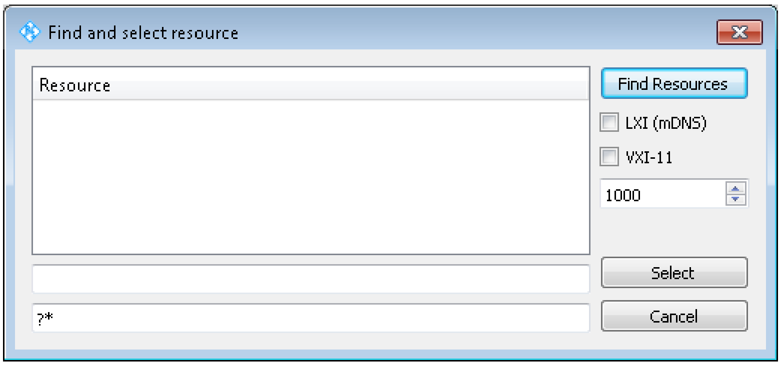
1. On the instrument:
   a) Enable the LAN interface.
      See Chapter 12.6.1, "How To Enable Access via LAN", on page 481.
   b) Enable "SCPI over LAN".
      See Chapter 12.6.2, "How To Activate LAN Services", on page 481.
2. On the controller (remote PC), install the R&S VISA program.
   See http://www.rohde-schwarz.com/rsvisa > "RS VISA Release Notes".
3. Connect the controller and the instrument in the same network (network cable). Switch them on.
   See also Chapter 12.6.3, "How To Connect to LAN", on page 482.
4. On the controller, start "R&S VISA > Tester 32bit" or "R&S VISA > Tester 64bit".



5. In the menu bar, select "Choose VISA Implementation > Rohde & Schwarz Visa" and confirm with "OK".



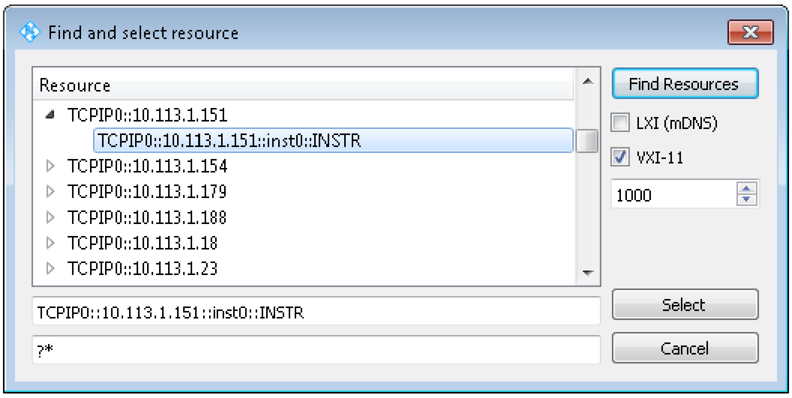
6. In the menu bar, select "Find Resource" to search for the instrument in the LAN.



7. Select "VXI-11" and "Find Resources".

   R&S VISA scans the network for connected instruments and lists all detected instruments in the "Resource" list.
   Note: The search may take some time, particularly in large networks.

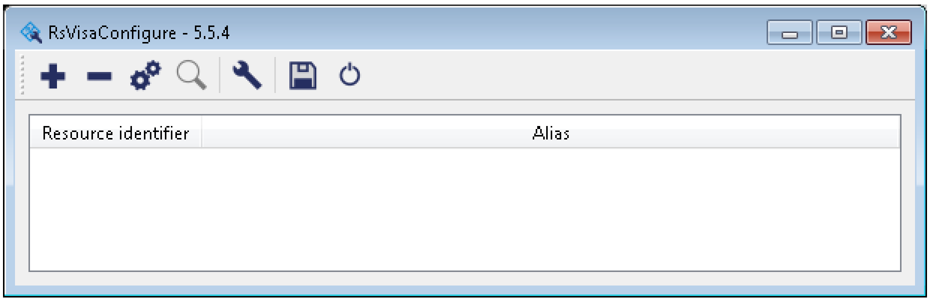
8. Select the required instrument and confirm with "Select".



   The "Find and select resource" dialog closes and R&S VISA indicates the IP address in the "Resource" field of the main application window.

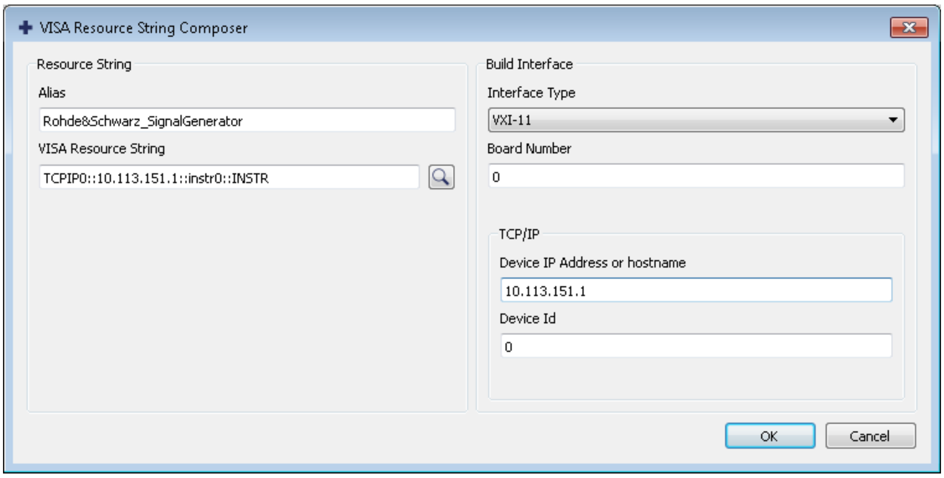
9. As an alternative to the IP address, you can assign an alias name to the R&S SMCV100B:

a) In the menu bar, select "RsVisaConfig".

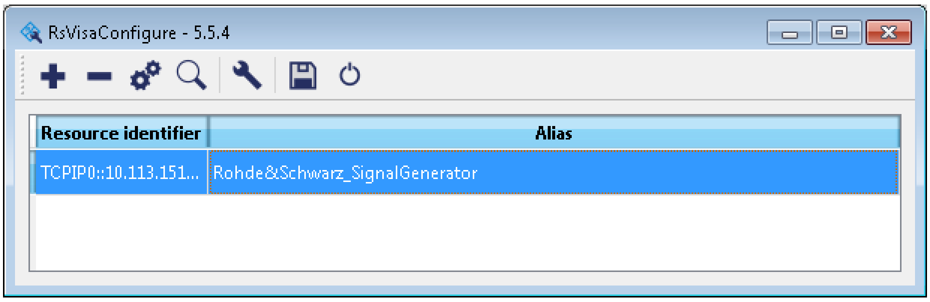


b) In the toolbar, select "+" to access the "VISA Resource String Composer".

c) Fill in the "Alias" name, the "VISA Resource String" and the "Device IP Address or host name" as shown in the figure, and confirm with "OK".



The "Alias" name is assigned.



d) Close the dialog.
The R&S SMCV100B is registered in the program. It can be addressed via the resource string or alias name.

10. In the main window, select "Connect".

R&S VISA establishes the connection to the R&S SMCV100B.

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 Chapter 14.5, "Resolving Network Connection Failures", on page 766.

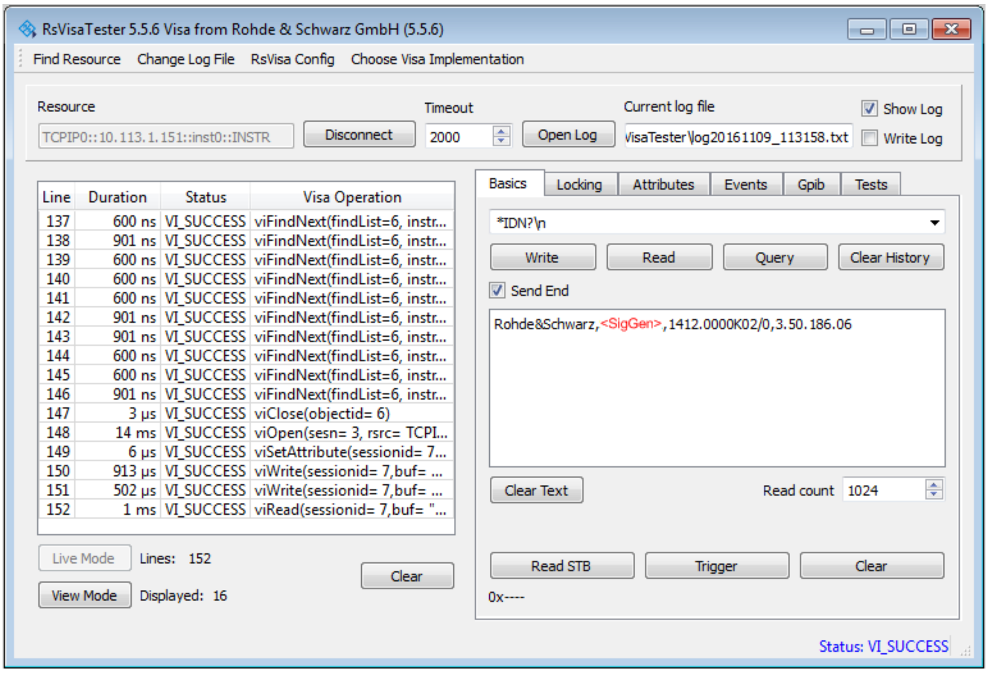
For further information on the functions to read and write to an open session, and the utility applications the software provides, see the R&S VISA user manual.

Starting a remote control session over LAN with R&S VISA

To set the instrument to remote control, you can use the addressed command `&GTR` or send any command from the controller.

1. Start the R&S VISA Tester.
   Establish the connection to the R&S SMCV100B.
   See "Setting up the controller with R&S VISA" on page 486.
2. In the R&S VISA "Basics" tab, enter an SCPI command, e.g. "*IDN?". Confirm with "Query".

   The instrument is switched to remote control when it receives a command from the controller.
3. Select "Read" to obtain the instrument response.



Tip: If the "Show Log" checkbox is checked, R&S VISA displays each VISA function call in the log-view on the left. If you check the "Write Log" checkbox, the log-view entry is written to the log file as well. You can operate the log-view in two modes: the "Live Mode" shows only the most recent messages whereas the "View Mode" allows you to scroll the history.

4. To check the performed setting, `SOUR1:FREQ?` and select "Query".

   While remote control is active, the "Remote" icon in the status bar indicates that the instrument is in remote control mode. Currently ongoing communication (data transfer) is indicated by green colored arrows in the icon.

Operating via the front and touch panel or via mouse and keyboard are locked, allowing a remote control program to be performed without interruption. On the display, keys and entry fields are grayed out and cannot be activated or modified, but you can still open dialogs, for example to verify settings.

5. To disable the access to the dialogs, use the command `SYST:KLOC ON`.
6. To prevent unintentional return to manual operation, use the command `&LLO`. See also Chapter A.1.2, "LAN Interface Messages", on page 787.

   The instrument switches to "Remote LLO" state. The [Setup] key is disabled.
7. To enable the [Setup] key, use the command `&GTR`.
8. To return to manual operation, see Chapter 12.7.7, "How to Return to Manual Operation", on page 492.

   Tip: Switching from manual operation to remote control and vice versa does not affect the other instrument settings.

12.7.4 Establishing a Remote Control Connection over LAN Using 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.

In the following example, we assume basic knowledge of programming and operation of the controller. You can find information on the interface commands in the corresponding manuals.

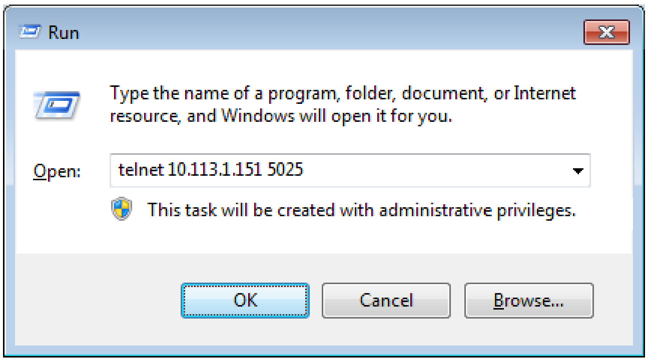
Setting up a Telnet connection

To control the software, only a Telnet program is required. The Telnet program is part of every operating system.

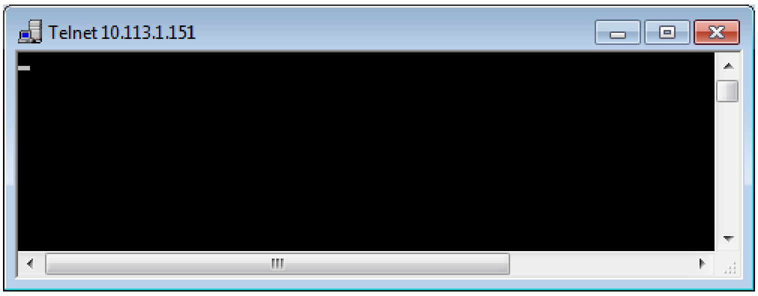
1. On the instrument:
   a) Enable the LAN interface.
      See Chapter 12.6.1, "How To Enable Access via LAN", on page 481.
   b) Enable "SCPI over LAN".
      See Chapter 12.6.2, "How To Activate LAN Services", on page 481.
2. Connect the remote PC and the instrument in the same network.
   See also Chapter 12.6.3, "How To Connect to LAN", on page 482.
3. On the remote PC, start the Telnet program.
   Enter the socket address.

The socket address is a combination of the IP address or the hostname of the R&S SMCV100B and the number of the port configured for remote-control via Telnet.

Tip: The R&S SMCV100B 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, blindly enter a remote-control command. Confirm with Enter.

12.7.5 Setting Up a Remote Control Connection over USB

For remote control via the USB connection, the PC and the instrument must be connected via 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.

Starting a remote control session over USB

1. Connect instrument and controller using USB cable. Switch them on.
2. To return to manual operation, press the [Local] key.

12.7.6 How to Trace Messages with the LXI Web Browser Interface

The remote trace functionality allows you to trace commands and messages exchanged via a remote control interface of the R&S SMCV100B.

Activating the SCPI remote trace

1. On the instrument:
   a) Enable the LAN interface.
   See Chapter 12.6.1, "How To Enable Access via LAN", on page 481.
   b) Enable "SCPI over LAN".
   See Chapter 12.6.2, "How To Activate LAN Services", on page 481.
2. Connect the remote PC and the instrument in the same network.
   See also Chapter 12.6.3, "How To Connect to LAN", on page 482.
3. Start a web browser that supports HTML5 (W3C compliant).
4. Enter the IP address of the R&S SMCV100B in the browser's address bar.

   The welcome page is displayed.
5. In the navigation pane, select "Diagnostics > SCPI Remote Trace".
6. In the toolbar bar of the "SCPI Remote Trace" page, select "live mode > on" and "logging > on".

   "live mode > on" displays all commands and responses, and "logging > on" also traces messages.

   If you now control the R&S SMCV100B with SCPI commands, using an appropriate tool, the LXI function records the information sent and received.
   The 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 upon request, using the "refresh" button. You can also save the log in a file.
   Note: The diagnostics functionality will be extended in later releases, e.g. to download or upload SCPI command files from / to the instrument.

12.7.7 How to Return to Manual Operation

Before returning to manual control, command processing must be completed. Otherwise, the instrument switches back to remote control immediately.

1. To return from "Remote" state to manual state, perform one of the following:
   - On the controller, use the command `&GTL`
     Note: If `&NREN` has been set before `&GTL` is locked. Use `&GTR` instead.
   - In the status bar, select the "Remote" icon.
   - On the front panel, press the [Local] key.
   - In the block diagram, select "Context sensitive menu > Key Emulation > Local"
2. To return from "Remote LLO" state to manual or to "Remote" state, perform one of the following:
   Note: In the local lockout state, the command `&GTL` and the [Local] key are locked. You can unlock this state only via remote control.
   - On the controller, use the command `&LOCS`.
     This command switches directly to manual operation.
   - Send the command `&REMS`.
     This command changes the remote control state from "Remote LLO" to "Remote".
   - Use the Visual Basic command `CALL IBLOC (generator%)`.
     The command switches directly to manual operation.
   - VISA function `viGpibControlREN()`
     This function switches directly to manual operation.

12.8 Automating Tasks with Remote Command Scripts

To achieve fast configuration, make complex test setups or repeating measurements reproducible, you can automate the required settings with scripts. A script contains a series of SCPI commands corresponding to the settings. When completed, it is converted to an executable format, saved in a file and can be run whenever needed.

If you frequently need to load and run a script, assign the script to the [★ (User)], and you can quickly and easily perform the task.

See Chapter 11.3.4, "How to Assign Actions to the [★ (User)] Key", on page 435.

In contrast to "Recall Setup" via the [★ (User)] key, an assigned script execution does not close active dialogs and windows. On the contrary, even active window control (open / close) is possible.

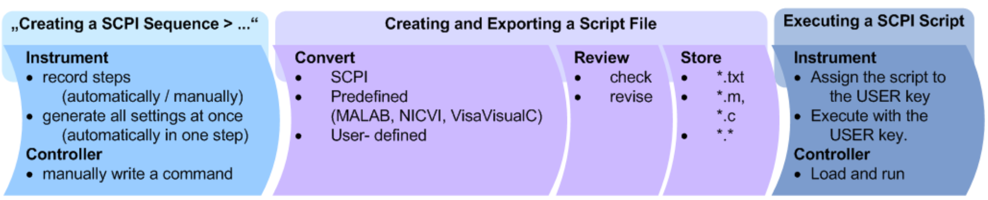


Figure 12-6: Steps for performing SCPI Scripts

In the graph, you can see the main steps required to work with an SCPI script.

Creating a SCPI list

With the SCPI record functions, you can create a SCPI command list directly in the instrument and then export the list to the controller. If you want to edit or write a script manually, use a suitable editor on the controller. Even for manually creating, the instrument supports you by showing the corresponding command syntax and the current settings value.

Directly in the instrument, you can create a SCPI list at any time of operation, in the following ways:

- Recording steps
  Both, automatic and manual SCPI recording of settings is possible. You can start, stop and resume automatic recording, and also record individual commands manually.
  – Manually record the steps selectively
    In manual recording mode, you can deliberately record a SCPI command with the "Add CPI Command to Recording List" function, see How to record SCPI lists manually.
  – Automatically record all performed steps
    The instrument records the SCPI command and settings value of each step you perform, and then writes the commands to the file system, see How to record SCPI lists automatically.
    You can also add a SCPI command manually to the recording list during automatic SCPI recording.

  Note: The vector signal generator clears the SCPI list after booting automatically.
- Generating all settings at once
  Generates the SCPI commands of the current instrument settings in one step, and writes the command list in a temporary list, see How to create a SCPI list with the current instrument settings in one step.
  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. Using this function can slow down the runtime or cause errors during execution. Therefore, always check and revise a script if necessary, see "How to check an SCPI list" on page 500.
- Manually create a command script with "Copy" and paste
  Enables you to copy the SCPI command and the current setting, see Chapter 12.8.1, "Show SCPI Command", on page 496.

Some parameters cannot be set by an SCPI command.

If so, *no SCPI command found* is entered instead of a command when you record or generate all settings at once.

The difference between Show SCPI Command and the provided cross-reference

If you want to enter your settings in a script, or use a remote control program, you must know the corresponding SCPI command and the exact syntax.

If you need to look up the SCPI command, the instrument offers two ways to figure it out quickly.

- "Show SCPI command" (context-sensitive menu)
  Displays the SCPI command syntax of a selected parameter including the current setting value, see "Findig out the SCPI command using "Show SCPI Command"" on page 502.
  The "Copy" function enables you to write an SCPI script conveniently by hand.
- Instrument help ([Help] key)
  Opens a help topic that describes the selected parameter or instrument function, including a cross-reference to the corresponding SCPI command. The reference leads you to the description of the SCPI command comprising the complete SCPI syntax, all available setting values, value ranges, etc.
  See "Findig out the SCPI command using the online help" on page 502.

Creating and exporting a script file

When the script list is completed, a code generator translates the SCPI commands into the source code of a proprietary programming language, using a code template. Therefore, each language requires an appropriate code template. When converted, you can save the script in a file with an extension corresponding to the programming language.

The R&S SMCV100B 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: MATLAB Toolkit for R&S Signal Generators.
- 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`.

For information on how to select the code template and save the script in a file, see Chapter 12.8.3, "SCPI Recording Export Settings", on page 497.

Executing an SCPI script

An SCPI script primarily runs on the controller PC. In addition, you can execute a script directly on the instrument, by assigning the script to the [★ (User)] key.

See Chapter 11.3.4, "How to Assign Actions to the [★ (User)] Key", on page 435.

12.8.1 Show SCPI Command

Access:

1. Select the parameter.
2. Open the context-sensitive menu (tap and hold).
3. Select "Show SCPI Command".

This function provides the syntax of the remote command with the current setting.

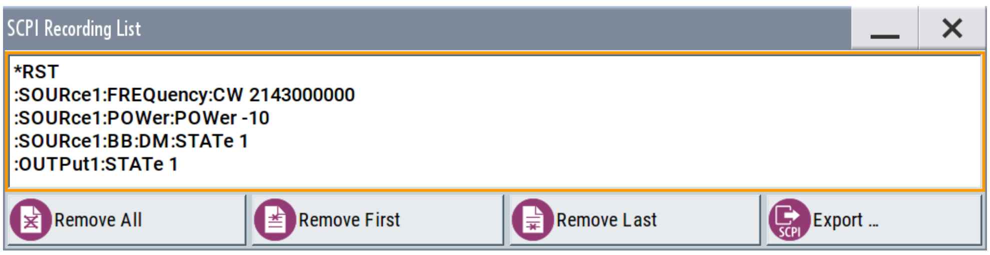
Copy
Copies the command and the current setting.

Close
Exits the "SCPI Command" dialog.

12.8.2 Displaying an SCPI List

The instrument displays a recorded SCPI list and thus provides viewing the recorded results before exporting.

► Depending on the starting point, you can access the "SCPI Recording List" dialog as follows:
   - During recording
     Select "Show SCPI Recording List" in the context-sensitive menu.
   - At any time outside recording
     Select "Show SCPI Recording List" in the context-sensitive menu.
     This function assumes that at least one recording has been executed after power-on.
   - At the end of the recording
     Select "Stop automatic SCPI recording". The dialog opens automatically.
   - After you have exported the script to a file.
     Select "SCPI Recording Export > Show file content"
     See Chapter 12.8.3, "SCPI Recording Export Settings", on page 497.



The "SCPI Recording List" shows the last recorded and exported commands.

SCPI Recording List
Lists the automatically or manually recorded recorded SCPI commands.

Export
Opens the SCPI Recording Export dialog for configuring the file parameters for export.

Remove All, Remove First, Remove Last
Deletes either the first, the last or all recorded SCPI commands.

To remove several recorded commands, repeat the removing.

For post processing, export the SCPI command list in a file, see Chapter 12.8.5, "How to Convert and Save SCPI Lists", on page 501.

12.8.3 SCPI Recording Export Settings

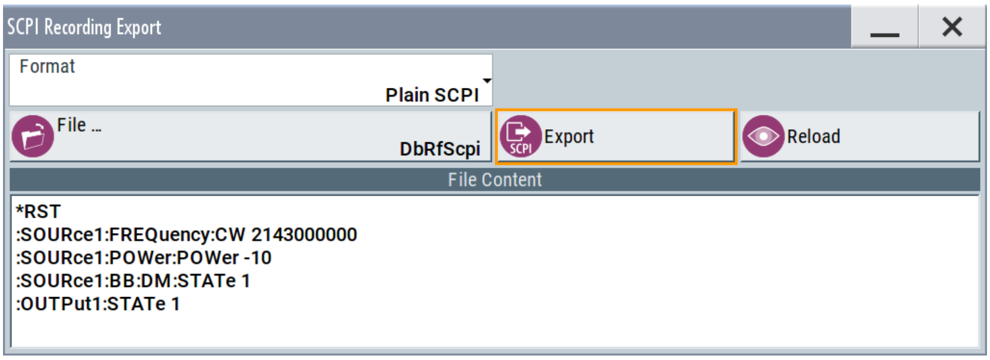
Scripts are configured and saved in the "SCPI Recording Export" dialog. This dialog opens automatically, when you stop recording.

Access:

1. Select "Show SCPI Recording List" in the context-sensitive menu.

   The "SCPI Recording List" dialog opens.

2. 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.

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.

Select Code Template
Opens the standard "File Select" dialog and lists the predefined or user-defined code templates.

File
Opens the standard file select dialog "Select Output File".

Export
Executes data export.

The SCPI list is saved in as file with the selected filename and in the selected directory, see File.

Reload
Reloads a SCPI list from a file.

You can export recorded SCPI lists to files (see File and Export), that can be modified.

File content
Displays the content of the script in the selected format and code template.

12.8.4 How to Record / Create SCPI Lists

How to record SCPI lists automatically

The following example briefly explains how to proceed when you want to record SCPI lists.

For comprehensive description, see 1GP98: SCPI Recorder Test Automation on a Fingertip.

1. On the screen, open the context-sensitive menu (touch and hold, or right mouse click) and select "Start SCPI recording".

   Starting from now, all steps you perform are recorded.
2. To stop SCPI recording, select "context-sensitive menu > Stop SCPI recording".

   The "SCPI Recording List" dialog opens automatically.
3. Proceed with How to check an SCPI list.

How to record SCPI lists manually

1. To retrace your settings, open the context-sensitive menu and select "Mark all Parameters Changed from Preset".

   This function identifies and highlights all settings you have changed, both in the block diagram, and in the dialogs.
2. For selectively recording your steps:
   a) Set the parameter.
   b) Open the context-sensitive menu.
   c) Select "Add SCPI Command to Recording List"

      Tip: You cannot see "Add SCPI ..." in the menu?
      A possible reason is opening the menu outside of a dialog or input field, for example in a block diagram. Open the context-sensitive menu within the corresponding dialog or input field, and the feature is available.
   d) Continue with the next setting, and repeat steps *a to b* whenever needed.

   Each time you select "Add SCPI ...", the SCPI command is appended to a temporary list.
3. To check the progress of the recording, select "Context-Sensitive > Show SCPI Recording List".

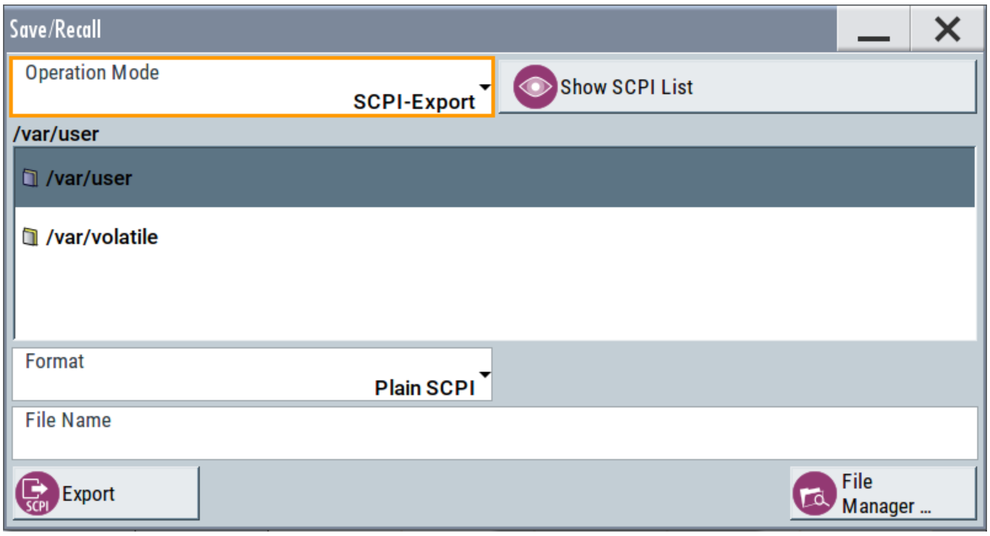
   The "SCPI Recording List" dialog opens, displaying all recorded settings so far.
4. Proceed with How to check an SCPI list.

How to create a SCPI list with the current instrument settings in one step

You can also generate a SCPI list from a manually created instrument state at any time, in only one step.

To generate an SCPI list with commands for all settings performed:

1. Select "Save/Recall > SCPI Export".



The instrument opens the standard file select dialog, see Chapter 10.4.1, "Save/ Recall Settings", on page 396.

2. In the "Format" entry field, select the source code.
3. Depending on the selected format, convert the script as described in Chapter 12.8.5, "How to Convert and Save SCPI Lists", on page 501
4. Enter a filename.
5. Select "Export".
   The instrument writes all SCPI commands of the key parameters and the modified settings in the file. Also assigns the file extension automatically according to the source code format.
6. To preview the content of the SCPI list:
   a) Select Save/Rcl.
   b) Select "Operation Mode > SCPI-Export".
   c) In the `/var/user/` directory, select a previously saved file.
   d) Select "Show SCPI List".

   The list of all SCPI commands is displayed, for example, for a final check.

Exporting the SCPI list of the instrument state in one step is a fast and convenient method. Nevertheless, it usually requires postprocessing on an external PC.

How to check an SCPI list

The easiest way to check a list, is to execute it. The generator returns a warning if a setting could not be performed.

However, we recommend that you check the list and possibly rework. It can be that ...

- A parameter has not assigned an 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 an error message.

- A preset has been executed, but several standards subsequently perform some internal settings that are also assigned to the list with "SCPI Export".
- After a preset still some settings are defined, which are then written to the list generated with "SCPI Export."

Some suggestions on how you can check and revise a list:

1. Search and remove missing command entries.
2. Remove unnecessary content written after a preset.
3. Rearrange the commands to a reasonable order. If you, for example, set a `STATe` command to the last position of a list, you can avoid intermediate calculations of the signal.
4. Preview the list for completeness by comparing it with the modified settings in the manual mode.
   a) To retrace your settings in manual operation, open the context-sensitive menu and select "Mark all parameters changed from preset".
   The function identifies all settings you have changed, both in the block diagram, and in the dialogs. They appear orange.
   b) Check whether there is a command in the list for all modified settings.
5. To perform modifications, export the list to a PC, using for example a USB flash drive.

12.8.5 How to Convert and Save SCPI Lists

After completing the recording, the "SCPI Recording Export" dialog opens.

1. Select the "Format" for the command syntax in which you want to save the list.
2. "Select Code Template"
   Depending on the selected format, proceed accordingly:
   Note: Select the code template **before** exporting.
   a) Plain SCPI
   Continue with the next step.
   b) Predefined code generator
   The "SCPI Recording Export - Select Predefined Code Template" dialog opens.
   Select one of the predefined code templates.
   c) User code generator
   A file system ("SCPI Recording Export - Select User Code Template") dialog opens.
   Select your user-defined code template. The code template must have file extension `*.expcodetmpl`.
3. Select "File..."

The "SCPI Recording Export - Select Output File" dialog opens.

4. Select "New" and assign a filename for saving the recorded list.
5. In the "SCPI Recording Export" dialog, select "Export".
   Saves the recorded data either in ASCII format (plain SCPI), or in the corresponding format of the used code template, and shows the SCPI list in the "File Content" section.

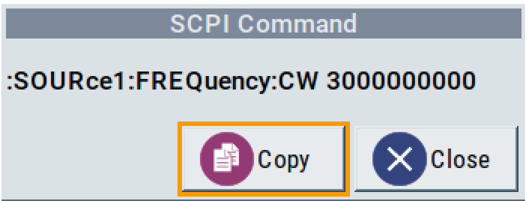
12.8.6 How to Find Out the SCPI Commands for GUI Functions

Findig out the SCPI command using "Show SCPI Command"

1. To find out the SCPI command of a parameter in manual operation, select the respective parameter.
2. Open the context-sensitive menu and select "Show SCPI command"

   You get the detailed command syntax, including the currently set value.

   With the "Copy" function, you can conveniently paste the command including the current setting, e.g., in a command script.

Findig out the SCPI command using the online help

If you are looking for the remote command to a function in manual operation, you find it in the description of the online help.

1. To find out the SCPI command of a parameter in manual operation, select the respective parameter.
2. To open the corresponding help topic, select one of the following:
   - In the display, select "context-sensitive menu > Help".

   - On the front panel, press the [Help] key.

   The help topic opens. Apart from the function description, it contains the SCPI command in detailed syntax.

How to find the corresponding GUI function to a command
Conversely, if you are looking for a function in the GUI, which belongs to a SCPI, you find it via a cross-reference in the online help and in the user manual.

12.9 Operating the R&S SMCV100B Remotely via VNC

This section shows you some examples of the various possibilities to set up remote operation.

- Using a desktop system
  - Chapter 12.9.2.1, "Using a Web Browser", on page 503
  - Chapter 12.9.2.2, "Using a VNC Client Software", on page 504
- Using a smart device
  - Chapter 12.9.3.1, "Using a VNC App", on page 507
  - Chapter 12.9.3.2, "Using a Web Browser with HTML5", on page 507
  - Chapter 12.9.3.3, "Special Mode QR Code ", on page 508

12.9.1 How To Enable the VNC Service

1. **NOTICE!** Enabled VNC service can lead to unauthorized access.
   Change the computer name and password of the instrument.
   See Chapter 11.5.5, "How to Prevent Unauthorized Access", on page 451.
2. Select "System Config > Setup > Security > Security > LAN Services".
3. Select "VNC > On".
4. Enter the Security Password.
5. Select "Accept".

12.9.2 How To Set Up a Remote Operation from a Desktop System

12.9.2.1 Using a Web Browser

The R&S SMCV100B supports remote operation via VNC with any web browser, like Windows Internet Explorer or Mozilla Firefox for instance, or alternatively, an HTML5 web browser.

To operate the instrument via a web browser remotely:

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. Type the instruments' IP address in the address field of the web browser on your PC, e.g. *http://10.113.1.151*

   The VNC authentication screen appears.
3. Enter the password and confirm with "OK".
   The default password is *instrument*.

   After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated from the remote computer.

12.9.2.2 Using a VNC Client Software

A VNC client software is an application which can be used to access and control the instrument from a remote computer through a LAN connection.

The VNC client software for setting up the connection is included in the operating system Linux/Unix per default. For Windows operating systems, 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.

Setting up the VNC connection on a Linux/Unix desktop client

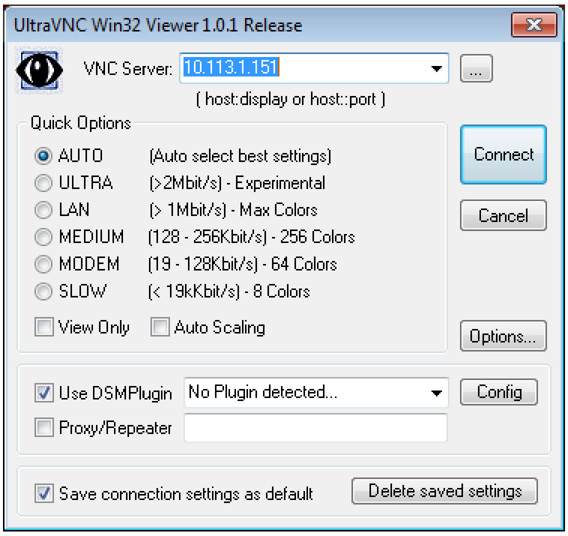
1. Start a web browser on the remote computer. Enter the IP address of the instrument.
2. Enter the following address:
   `vnc://<IP-address of the instrument>`, for example *vnc://10.113.1.151*.

   A dialog opens requesting the password for the remote VNC connection.
3. Enter the password and confirm with "OK".
   The default password is *instrument*.

   After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated from the remote computer.

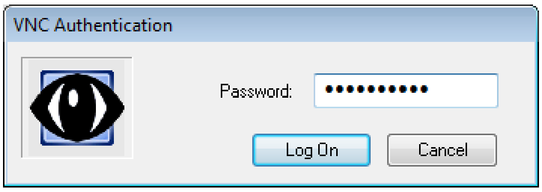
Setting up the VNC connection on a Windows desktop client

1. Install the VNC viewer program component on the remote computer.
   a) On the Internet, select a VNC client program and download it onto your PC.
   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" and enter the IP address of the instrument.
4. To initialize the connection, select "Connect".

   A dialog opens requesting the password.



5. Enter the password and confirm with "OK".
   The default password is *instrument*.

   After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated from the remote computer.

Terminating VNC connection

► Perform one of the following:
   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.

   The connection is terminated but not disabled. It can be established again any time.
   In the "Active Connections" tab, the displayed TCP/IP connection disappears.
   See Chapter 11.5.5, "How to Prevent Unauthorized Access", on page 451.

12.9.3 How To Set Up a Remote Operation from a Smart Device

The R&S SMCV100B supports remote operation via VNC from a smart device (remote client), like a tablet (tablet computer) or a smartphone. The smart device accesses the instrument via WLAN, either by a suitable App, or an HTML5 web browser, that means with embedded *javascript*.

There are several possibilities to establish a WLAN connection between the smart device and the R&S SMCV100B. 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:

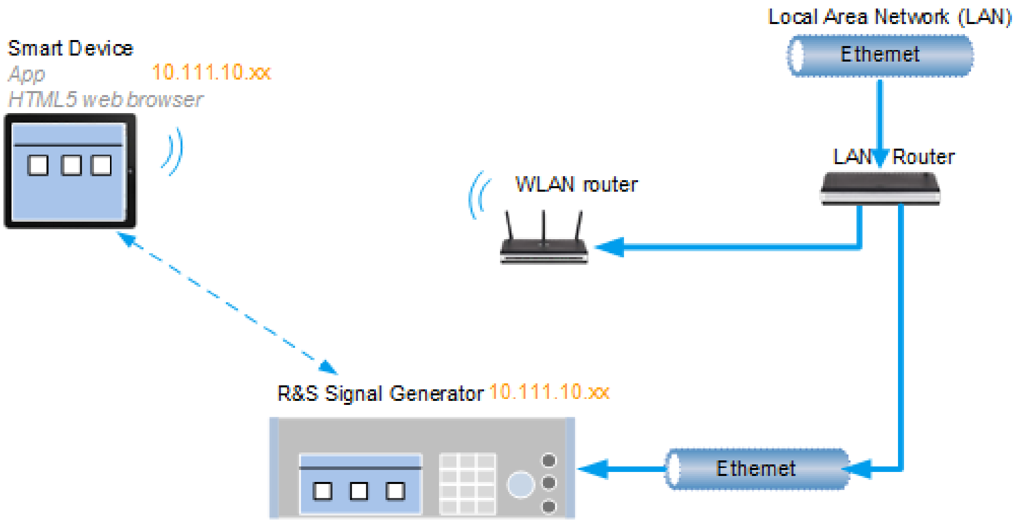


Figure 12-7: Example of a network configuration for remote operation with a smart device

As shown in the figure, the R&S SMCV100B and the WLAN router are connected to the LAN router. The smart device accesses the Rohde & Schwarz instrument via the WLAN router.

Prerequisites

For this network configuration, the following prerequisites must be met:

- The required equipment is:
  – A LAN router
  – A WLAN router (hot spot)
    Required for accessing the R&S SMCV100B
- The smart device must be known and accepted in the network of the R&S SMCV100B.
- The *App* or web browser implements the VNC functionality on the smart device for remote operation.

It is recommended that all components in the network use DHCP, which automatically assigns the relevant address information.

With the configuration in the example, you can reach the instrument from a great distance, since the WLAN router acts as an additional access point.

12.9.3.1 Using a VNC App

Using a *VNC App* enables the smart device to access the R&S SMCV100B via WLAN.

The VNC Apps are available from various manufacturers of the smart devices.

The list of supported devices is different according to the smart device.

1. Refer to the manufacturer's website to find out whether a VNC App is available for your device, and how it is installed.
2. In the network, establish the connection of the WLAN router to the LAN router.
   We assume the connection of the LAN router and the R&S SMCV100B and their configuration in the LAN.
3. Configure the WLAN router according to the manufacturer's instructions.
4. Install the required *VNC App* on your smart device.
5. On the smart device, start the *VNC App*.
6. In the address field, enter the IP address of the instrument.
   A log-on dialog opens and requests the password for the VNC connection.
7. Enter the password to establish the remote access.
   The default user name and password is *instrument*.
   See Chapter 11.5.5, "How to Prevent Unauthorized Access", on page 451.
   After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated.

12.9.3.2 Using a Web Browser with HTML5

The R&S SMCV100B supports remote operation from a smart device via VNC with any HTML5 compliant web browser, like Internet Explorer, Firefox, Google Chrome, or Safari for instance.

To operate the instrument remotely via a web browser, proceed as follows:

1. In the web browser enter the IP address of the instrument, e.g. *http://10.113.1.151*.
2. Type the instrument IP address in the address field of the web browser on your PC, e.g. *http://10.113.1.151*
   The VNC authentication screen appears.
3. Enter the password and confirm with "OK".
   The default password is *instrument*.

See Chapter 11.5.5, "How to Prevent Unauthorized Access", on page 451.

After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated.

12.9.3.3 Special Mode 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.

QR code readers are available from various manufacturers of the smart devices.

The list of supported devices is different according to the smart device.

1. Refer to the manufacturer's website of your smart device to find out whether a reader is available for your device, and how it is installed.
2. Install the required QR code reader software on your device.
3. Start the reader.
4. On the R&S SMCV100B, select "System Config > Remote Access".
5. In the "Remote Access" dialog, select the "QR-Code" tab.
6. Scan the QR code of the instrument with your smart device.
7. On the device, decode the scanned QR code and pass it to the web browser.

   A dialog opens requesting the password for the VNC connection.
8. Enter the password and confirm with "OK".
   The default password is *instrument*.

   After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated.

12.10 References

12.10.1 LXI Functionality

LAN Extensions for Instrumentation (LXI) is an instrumentation platform for measuring instruments and test systems that is based on standard Ethernet technology.

The LXI implementation in the R&S SMCV100B 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 http://www.lxistandard.org.

See also "News from Rohde & Schwarz, article 2006/II - 190".

The LXI functionality in the R&S SMCV100B is characterized by a common LAN implementation, including an ICMP ping responder for diagnostics. The instrument can be configured via a web browser. 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 SMCV100B provides the following LXI-related functionality:

- Integrated "LXI Status" dialog for LXI status indication and reset of the LAN configuration, see Chapter 12.5.1, "LXI Status Settings", on page 475.
- "LXI Browser Interface", as described in Chapter 12.5.2.1, "LAN Configuration", on page 477.
- "SCPI Remote Trace" utility, see "SCPI Remote Trace" on page 479.

Firmware update

To enable the full LXI functionality after a firmware update, shut down and restart the instrument.

12.10.2 Code Generator Templates

This section describes the main structure of the code generator templates, and shows the method by means of 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 an 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
```

12.10.3 Remote Control States

How to recognize if there is an active remote connection to the instrument

► Observe the indication on the taskbar.

A softkey in the taskbar indicates if and what kind of remote connections are currently set up.
See also Chapter 12.4.4, "Remote Connections Settings", on page 472.

The following table shows the different remote control states and the associated commands or actions to return to manual control.

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, refer to:
- Chapter 12, "Network Operation and Remote Control", on page 457
- Chapter A.1, "Additional Basics on Remote Control", on page 786

13.1 Conventions Used in SCPI Command Descriptions

Note the following conventions 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 SMCV100B 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 SMCV100B. The purpose of the examples is to present **all** commands for a given task. In real applications, one would rather reduce the examples to an appropriate subset of commands.

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 (for example comments) start with two // characters.

At the beginning of the most remote control program, an instrument (p)reset is recommended to set the R&S SMCV100B 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 that:

- 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**

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 471

***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 data sheet.

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 472

***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 "Recall Immediate x" on page 398

***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 391

***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 `:MMEMory:STORe:STATe`.

Manual operation: See "Save Immediate x" on page 397

***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.

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 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 516). 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 519)
- Activating the preset state of all parameters that are not related to the signal path (`:DEVice:PRESet` on page 518)
- Activating the original state of delivery (factory reset, `:SYSTem:FPReset` on page 519). 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

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

Manual operation: See "Connect/Disconnect All Remote" on page 247

: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. It 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

Manual operation: See "Preset" on page 391

: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 392

13.5 MMEMory Subsystem

The `MMEMory` subsystem (Mass MEMory) contains the commands for managing files and directories as well as for loading and storing complete instrument settings in files.

Mass storage location

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 SMCV100B 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 Chapter 10.7, "Using the File Manager", on page 402. 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.

13.5.1 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 SMCV100B distinguishes the files according to their extensions; each type of file is assigned a specific file content and hence a specific file extension. Refer to Chapter A.2, "Extensions for User Files", on page 808 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.

13.5.2 Accessing Files in the Default or in a Specified Directory

For better overview and easy file handling, you may not save all user files in the user directory `/var/user` but rater 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 stored list files, files with user data or save/recall files.
  (See Example "Store the user settings in a file in a specific directory" on page 521).
  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 SMCV100B filters out the relevant files.
- Define the **absolute file path**, including the user directory `/var/user`, created subdirectories and filename (see Example "Load file with user data from a specific directory" on page 522).
  As a rule, whenever an absolute 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 Chapter 13.5.3, "Programming Examples", on page 522 explains the general working principle with the commands for mass memory storage.

The same rule applies to the `/var/volatile` directory, see Example "Working with files in the volatile memory" on page 524.

Example: Store the user settings in a file in a specific directory

This example uses the commands for storing 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"
```

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"
```

13.5.3 Programming Examples

Example: Storing and loading current settings

This example shows two ways of how to store the current instrument setting in the file `settings.savrcltxt` in the directory `/var/user/savrcl`.

Before the instrument settings can be stored in a file, they have to be stored 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>`.

```
// Store the current settings in an intermediate memory with number 4
*SAV 4

// store the settings in a file in a specific directory;
// the complete path has to be specyfied
MMEMory:STORe:STATe 4,"/var/user/savrcl/settings.savrcltxt"

// store the settings in a file in the default directory;
// set the default directory; specify only the file name
MMEMory:CDIRectory  "/var/user/savrcl"
*SAV 4
MMEMory:STORe:STATe 4,"settings.savrcltxt"

// Load the stored settings in the intermediate memory 4 and activate them
```

```
MMEMory:LOAD:STATe 4,"/var/user/settings.savrcltxt"
*RCL 4
```

Example: Working with files and directories

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 the "test" directory
MMEMory:RDIRectory "/var/user/test"
```

Example: Working 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 and play a file with the ARB
MMEMory:CDIRectory "/var/volatile"
MMEMory:CDIRectory?
// "/var/volatile"
MMEMory:CATalog?
//13928,525352960,".,DIR,60","..,DIR,4096","list.lst,BIN,9772"

:SOURce1:LIST:SELect "/var/volatile/list"
:SOURce1:FREQuency:MODE LIST
:OUTPut1:STATe 1
```

13.5.4 Remote Control Commands

:MMEMory:CATalog? <path>

Returns the content of a particular directory.

Query parameters:

<path> 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 may be relative or absolute.

Return values:

<UsedDiskSpace> Byte size of all files in the directory.

<FreeDiskSpace> Remaining disk space in bytes.

<FileInfo> <NameFileN>,<SuffixFileN>,<SizeFileN>

List of files, separated by commas

<NameFileN>
Name of the file.

<SuffixFileN>
Type of the file. Possible suffixes are: ASCii, BINary, DIRectory

<SizeFileN>
Size of the file in bytes.

Usage: Query only

Manual operation: See "Directory, File List and Filename" on page 396

: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.

Usage: Query only

:MMEMory:CDIRectory <Directory>

Changes the default directory for mass memory storage. The directory is used for all subsequent `MMEM` commands if no path is specified with them.

Parameters:

<Directory> <directory_name>

String containing the path to another directory. The path can be relative or absolute.
To change to a higher directory, use two dots '..' .

Usage: SCPI confirmed

Manual operation: See "Directory, File List and Filename" on page 396

: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

String containing the path and file name of the source file

<DestinationFile> string

String containing the path and name of the target file. The path can be relative or absolute.
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.

Usage: Setting only
SCPI confirmed

Manual operation: See "Cut, Copy&Paste and Delete" on page 403

:MMEMory:DATA <Filename>, <BinaryBlock>
: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:

<BinaryBlock> #<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.

Parameters for setting and query:

<Filename> string

String parameter to specify the name of the file.

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`

Usage: SCPI confirmed

:MMEMory:DCATalog? <path>

Returns the subdirectories of a particular directory.

Query parameters:

<path> 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:

<Catalog> <file_entry>

Names of the subdirectories separated by colons. The first two strings are related to the parent directory.

Usage: Query only

:MMEMory:DCATalog:LENGth? [<Path>]

Returns the number of subdirectories in the current or specified directory.

Query parameters:

<Path> 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 parent and subdirectories.

Usage: Query only

:MMEMory:DELete <Filename>

Removes a file from the specified directory.

Setting parameters:

<Filename> string

String parameter to specify the name and directory of the file to be removed.

Usage: Event

SCPI confirmed

Manual operation: See "Cut, Copy&Paste and Delete" on page 403

: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`.

<file_name> String parameter to specify the file name with extension `*.savrcltxt`.

Usage: Setting only

Manual operation: See "Recall" on page 398

: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

String parameter to specify the new directory.

Usage: Event

Manual operation: See "Create New Directory" on page 403

: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

String parameter to specify the name of the file to be moved.

<DestinationFile> string

String parameters to specify the name of the new file.

Usage: Event
SCPI confirmed

Manual operation: See "Rename " on page 403

:MMEMory:MSIS <Msis>

Defines the drive or network resource (in the case of networks) for instruments with windows operating system, using `msis` (MSIS = Mass Storage Identification String).

Note: Instruments with Linux operating system ignore this command, since Linux does not use drive letter assignment.

Usage: SCPI confirmed

:MMEMory:RDIRectory <Directory>

Removes an existing 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

String parameter to specify the directory to be deleted.

Usage: Event

:MMEMory:STORe:STATe <savrcl_state_nr>, <file_name>

Stores the current instrument setting in the specified file.

The instrument setting must first be stored in an 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`.

<file_name> String parameter to specify the file name with extension `*.savrcltxt`.

Usage: Event

Manual operation: See "Save" on page 397

: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

13.6 CALibration Subsystem

The `CALibration` subsystem contains the commands needed for performing internal adjustments. This procedure is triggered by the query commands.

Suffix <hw>

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

---

:CALibration:ALL[:MEASure]? [<Force>]

Starts all internal adjustments that do not need external measuring equipment.

Query parameters:
<Force> string

Return values:
<Measure> 0 | 1 | OFF | ON

Example:
```
CAL:ALL:MEAS?
// 0
// Executes the adjustments of all instrument functions.
// When completed, it indicates that the adjustment
// has been performed successfully.
```

Usage: Query only

:CALibration<hw>:ALL:DATE?

Queries the date of the most recently executed full adjustment.

Suffix:
<hw> [1]
Optional suffix

Return values:
<Date> string

Example:
```
CAL:ALL:DATE?
// "2016-01-01"
```

Usage: Query only

:CALibration<hw>:ALL:INFormation?

Queries the current state of the internal adjustment.

Return values:

<CalInfoText> string

Example:
```
CAL:ALL:INF?
```
"Instrument is calibrated, no adjustment required."
"UNCAL, instrument is warming up."
"UNCAL, Please perform full adjustment after warming up."
"UNCAL, Please perform full adjustment."

Usage: Query only

:CALibration<hw>:ALL:TEMP?

Queries the temperature deviation compared to the calibration temperature.

Suffix:

<hw> [1]
Optional suffix

Return values:

<Temperature> string

Example:
```
CALibration:ALL:TEMP?
// "+12.00 K"
```

Usage: Query only

:CALibration<hw>:ALL:TIME?

Queries the time elapsed since the last full adjustment.

Return values:

<Time> string

Example:
```
CAL:ALL:TIME?
// "22 days"
```

Usage: Query only

: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 Factory Calibration" on page 768

: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> 0 | 1 | OFF | ON

*RST: n.a. (factory preset: 0)

Example:
```
CAL:CONT ON
// Continues calibration after an error
```

13.7 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 SMCV100B 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?
// IPS3,BIOS,RFCV,BBCV, ...
DIAGnostic1:BGINfo? "RFCV"
// RFCV 1432.8207.02 01.00 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,...
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
```


: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 533.

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 533.

Usage: Query only

Manual operation: See "Assembly" on page 768

: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 533.

Usage: Query only

Manual operation: See "Operation Time / h" on page 768

: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 533.

Usage: Query only

Manual operation: See "Power On Count" on page 768

:DIAGnostic<hw>:POINt:CATalog?

Queries the test points available in the instrument.

For more information, see R&S SMCV100B Service Manual.

Return values:

<Catalog>	string List of comma-separated values, each representing a test point
Example:	See Example "Programming example" on page 533.
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 SMCV100B Service Manual.

Query parameters:

<Name>	<test point identifier> Test point name, as queried with the command `:DIAGnostic<hw>:POINt:CATalog?`

Return values:

<Value>	<value><unit>
Example:	See Example "Programming example" on page 533.
Usage:	Query only

13.8 DISPlay Subsystem

The `DISPlay` system contains the commands to set the power-save mode of the instrument.

Programming Examples

Example: Activating screen saver mode 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 current frequency and level values in remote control
:DISPlay:ANNotation:ALL ON
```

```
// :DISPlay:ANNotation:FREQuency ON
// :DISPlay:ANNotation:AMPLitude ON

// Enable automatic update of the display at defined time intervals
:DISPlay:UPDate ON
```

Example: Querying the dialog IDs, opening and closing 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 Chapter 11.3.4, "How to Assign Actions to the [★ (User)] Key", on page 435.

```
// 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
```


: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 "Activating screen saver mode and display update" on page 535

Manual operation: See "Wait Time" on page 418

: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> 0 | 1 | OFF | ON

*RST: n.a. (factory preset: 0)

Example: See Example "Activating screen saver mode and display update" on page 535

Manual operation: See "Screen Saver" on page 417

:DISPlay:UPDate <Update>

Activates the refresh mode of the display.

Parameters:

<Update> 0 | 1 | OFF | ON

*RST: n.a. (factory preset: 1)

Example: See Example "Activating screen saver mode and display update" on page 535

Manual operation: See "Display Update is" on page 418

:DISPlay:ANNotation:AMPLitude <State>

Indicates asterisks instead of the level values in the status bar.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: n.a. (factory preset: 1)

Example: See Example "Activating screen saver mode and display update" on page 535

Manual operation: See "Annotation Amplitude" on page 445

:DISPlay:ANNotation:FREQuency <State>

Indicates asterisks instead of the frequency values in the status bar.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: n.a. (factory preset: 1)

Example: See Example "Activating screen saver mode and display update" on page 535

Manual operation: See "Annotation Frequency" on page 445

:DISPlay:ANNotation[:ALL] <State>

Displays asterisks instead of the level and frequency values in the status bar of the instrument.

We recommend that you use this mode if you operate the instrument in remote control.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 1

Example: See Example "Activating screen saver mode and display update" on page 535

: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 539

`:DISPlay:DIALog:CLOSe` on page 539

<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 "Querying the dialog IDs, opening and closing dialogs" on page 536

Usage: Query only

Manual operation: See "SCPI" on page 435

: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 "Querying the dialog IDs, opening and closing dialogs" on page 536

Usage: Setting only

Manual operation: See "SCPI" on page 435

: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 "Querying the dialog IDs, opening and closing dialogs" on page 536

Usage: Setting only

:DISPlay:DIALog:CLOSe:ALL

Closes all open dialogs.

Example: See Example "Querying the dialog IDs, opening and closing dialogs" on page 536

Usage: Event

13.9 FORMat Subsystem

The commands in the FORMat subsystem determine the format of data returned by the R&S SMCV100B 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.

: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.

13.10 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"
```

13.10.1 Hard Copy Settings

With the following commands, you can configure the settings of a hard copy.

: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 541

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 541

Manual operation: See "Format" on page 413

: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 541

Manual operation: See "Region" on page 413

: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 Chapter 13.10.2, "Automatic Naming", on page 543.

Parameters:

<Name> string

Example: See Example "Store a hard copy of the display" on page 541

Manual operation: See "File..." on page 412

: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 541

Usage: Event

Manual operation: See "Save" on page 413

13.10.2 Automatic Naming

Use the following commands to automatically assign a file name.

: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 541
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 541
Manual operation:	See "Path..." on page 413

: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 541
Usage:	Event
Manual operation:	See "Clear Path" on page 414

: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 541.
Usage:	Query only

:HCOPy:FILE[:NAME]:AUTO:STATe <State>

Activates automatic naming of the hard copy files.

Parameters:

<State>	0 | 1 | OFF | ON	
	*RST:	1

Example: See Example "Store a hard copy of the display" on page 541

Manual operation: See "Automatic Naming" on page 412

: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>	0 | 1 | OFF | ON	
	*RST:	1

Example: See Example "Store a hard copy of the display" on page 541

Manual operation: See "Prefix, Year, Month, Day" on page 414

: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 SMCV100B 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 541

Usage: Query only

Manual operation: See "Current Auto Number" on page 414

: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> 0 | 1 | OFF | ON

*RST: 1

Example: See Example "Store a hard copy of the display" on page 541

Manual operation: See "Prefix, Year, Month, Day" on page 414

13.11 KBOard Subsystem

The `KBOard` subsystem contains the commands to set a connected keyboard.

:KBOard:LAYout <Layout>

Selects the language for an external keyboard and assigns the keys acccordingly.

Parameters:

<Layout> CHINese | DANish | DUTCh | DUTBe | 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 "USB Keyboard > Layout" on page 418

13.12 OUTPut Subsystem

In the `OUTPut` subsystem, you can configure the output signals.

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
`OUTPut<hw>`	[1]	Optional suffix

:OUTPut:ALL[:STATe] <State>

Activates the RF output signal of the instrument.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: n.a. (factory preset: 0)

Example: `OUTPut:ALL:STATe 0`

:OUTPut<hw>[:STATe] <State>

Activates the RF output signal.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `OUTP ON`

Activates the RF output.

Manual operation: See "RF State/RF ON" on page 292

: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: `OUTP:PON OFF`

The RF output is deactivated when the instrument is switched on.

Manual operation: See " Power-On State " on page 419

:OUTPut<hw>:AMODe <AMode>

Sets the step attenuator mode at the RF output.

Parameters:

<AMode> AUTO | FIXed

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:
```
SOURce:POWer:ALC:STATe 1
OUTPut:AMODe FIXed
```

Manual operation: See " Mode " on page 342

:OUTPut<hw>:IMPedance?

Queries the impedance of the RF outputs.

Return values:

<Impedance> G1K | G50 | G10K

*RST: G50

Example: `OUTP: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 292

: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 342

: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: `OUTP:PROT:CLE`
Resets the protective circuit of the RF output.

Usage: Event

Manual operation: See "Overload" on page 342

:OUTPut<hw>:PROTection:TRIPped?

Queries the state of the protective circuit.

Return values:

<Tripped> 0 | 1 | OFF | ON
*RST: 0

Example: `OUTP: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 342

13.13 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 SMCV100B.

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"
// list of 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 'NRQ6',11.123.1.123, 101624 //IP address, serial number
// add sensor connected in the LAN to the list


: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
// add sensor connected at the USB interface to the list


SLISt:LIST?
// Response:
// "NRP33SN-V-900007-USB Legacy","NRP-Z211-900001-USB Legacy",
// "NRP33SN-V-900005-USBTMC","NRP33SN-V-900011-LAN"
// list of automatically detected sensors
// the list can contain more entries

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 directly to channel 3


:SLISt:CLEar[ALL] // remove all sensors from the list
:SLISt:CLEar:LAN  // remove sensors connected in the LAN from the list
:SLISt:CLEar:USB  // remove sensors connected over USB from the list
// remove all sensors from the list
```

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]?

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 551.

Usage: Query only

Manual operation: See " Sensor Mapping List " on page 356

:SLISt:SCAN[:STATe] <State>

Starts the search for R&S NRP power sensors, connected in the LAN or via the USBTMC protocol.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Detecting and assigning a power sensor" on page 551.

Manual operation: See " Scan " on page 357

: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 551.
Usage:	Setting only
Manual operation:	See " Add LAN Sensor settings" on page 357

: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 551.
Usage:	Setting only
Manual operation:	See " Add USB Sensor settings " on page 357

:SLISt:CLEar:LAN

Removes all R&S NRP power sensors connected in the LAN from the list.

Example:	See Example "Detecting and assigning a power sensor" on page 551.
Usage:	Event

:SLISt:CLEar:USB

Removes all R&S NRP power sensors connected over USB from the list.

Example:	See Example "Detecting and assigning a power sensor" on page 551.
Usage:	Event

:SLISt:CLEar[:ALL]

Removes all R&S NRP power sensors from the list.

Example: See Example "Detecting and assigning a power sensor" on page 551.

Usage: Event

: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 551.

Manual operation: See " Sensor Mapping List " on page 356

: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 551.

Usage: Setting only

Manual operation: See " Sensor Mapping List " on page 356

: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> 0 | 1 | OFF | ON

*RST: 0

Example: `INIT1:CONT ON`
Switches local state of continuous power measurement on.

Manual operation: See " State " on page 361

: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 " Level (Peak) / Level (Average) " on page 360

: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 " Level (Peak) / Level (Average) " on page 360

: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 557.

Parameters:

<UseDefAp> 0 | 1 | OFF | ON
*RST: 1

Example: See Example "Performing a power measurement with a fixed filter" on page 552.

Manual operation: See "Default Aperture Time" on page 363

: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 552.

Manual operation: See "Aperture Time" on page 363

: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 363

: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> 0 | 1 | OFF | ON

*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 363

: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 363

: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 65536

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 362

: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 358).

The R&S NRP power sensors provide different resolutions for setting the filter length, depending on the used sensor type:

- Resolution = 1 for R&S NRPxx power sensors
- Resolution = 2^n for sensors of the R&S NRP-Zxx family, with n = 1 to 16

Parameters:

<User> float

Range: 1 to 65536
*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 362

: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 552.

Manual operation: See "Noise/Signal Ratio" on page 363

:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe <MTime>

Sets an upper limit for the settling time of the auto-averaging filter in the NSRatio mode and thus limits the length of the filter. The filter type is set with command :SENSe<ch>[:POWer]:FILTer:TYPE.

Parameters:

<MTime> float

Range: 1 to 999.99
Increment: 0.01
*RST: 4

Example: See Example "Performing a power measurement with a fixed filter" on page 552.

Manual operation: See "Timeout" on page 363

: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 362

: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.

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`.
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`).
*RST: AUTO

Example: See Example "Performing a power measurement with a fixed filter" on page 552.

Manual operation: See " Filter" on page 362

:SENSe<ch>[:POWer]:FREQuency <Frequency>

Sets the RF frequency of the signal, if signal source "USER" is selected (`:SENSe<ch>[:POWer]:SOURce`).

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 361

:SENSe<ch>[:POWer]:LOGGing:STATe <State>

Activates the recording of the power values, measured by a connected R&S NRP power sensor.

Parameters:
<State> 0 | 1 | OFF | ON
*RST: 0

Example:
`SENS:LOGG:STAT ON`
Activates recording of the power measurement of the first sensor.

Manual operation: See "Enable Logging" on page 363

: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 362

: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> 0 | 1 | OFF | ON

*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 362

: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 360

: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 552.

Manual operation: See " Use Frequency Of" on page 361

:SENSe<ch>[:POWer]:STATus[:DEVice]?

Queries if a sensor is connected to the instrument.

Return values:

<Status> 0 | 1 | OFF | ON

*RST: 0

Example:
```
SENS1:STAT?
Response: 1
```
A sensor is connected.

Usage: Query only

Manual operation: See " State " on page 361

: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 360

: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 361

13.14 SCONfiguration Subsystem

The `SCONfiguration` subsystem contains the commands for defining the system configuration setting, like stream mapping and used baseband configuration.

Required options

See "Required options" on page 244.

Suffix	Value range	Description
HSDigital<ch>	1 to 2	"Dig. IQ HS x" connectors

Example: Distributing the I/Q 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:HSDigital1:CHANnel0:STReam1:STATe ON
```

Example: Connecting and configuring external instrument

The following example lists the commands necessary to fulfill this task.

```
SCONfiguration:EXTernal:DISPlay ALL
SCONfiguration:EXTernal:REMote:CLEan
SCONfiguration:EXTernal:REMote:SCAN
SCONfiguration:EXTernal:REMote:SCAN:STATe?
// 0

SCONfiguration:EXTernal::HSDigital2:DIRection?
// Response: OUT
SCONfiguration:EXTernal::HSDigital2:IQConnection:STATe?
// Response: ON

SCONfiguration:EXTernal:REMote:LIST?
// Response: SMBV100A,SGS_2,SGT100A,SMBV_1
```

```
SCONfiguration:EXTernal:REMote:ADD "SGS_1","USB","100007"
SCONfiguration:EXTernal:REMote:ADD "SGT100A","LAN","10.112.11.125","1"
SCONfiguration:EXTernal:REMote:LIST?

SCONfiguration:EXTernal:REMote:REName "SGS_2","SGS (102030)"
SCONfiguration:EXTernal:REMote:LIST?
// Response:
// SMBV100A,SGS (102030),SGT100A,SMBV_1

// Detecting a connected external instrument and connecting it
// SCONfiguration:EXTernal:DIGital:REMote:DETect?
// Response: "SMBV100A"

SCONfiguration:EXTernal:HSDigital2:REMote:ISELect?
// Response: "SGT100A","A"
SCONfiguration:EXTernal:HSDigital2:REMote:CONNect

// Manually defining the externa instrument
SCONfiguration:EXTernal:HSDigital2:REMote:ISELect "SGS_1","A"
SCONfiguration:EXTernal:HSDigital2:REMote:CONNect
SCONfiguration:EXTernal:HSDigital2:RCONnection:STATe?
// Response: 1
SCONfiguration:EXTernal:HSDigital2:INAMe?
// Response: "SGS_1 [A]"
SCONfiguration:EXTernal:HSDigital2:RF:COUPling OFF
SCONfiguration:EXTernal:HSDigital2:RF:FREQuency 2143000000
SCONfiguration:EXTernal:HSDigital2:RF:POWer \-20
SCONfiguration:EXTernal:HSDigital2:RF:STATe ON

// Use an user defined initialization file
// MMEMory:CDIRectory "/var/user/RcExtInstr"
// SCONfiguration:EXTernal:REMote:INITialization:CATalog?
// Response: init_seq_sgs
// SCONfiguration:EXTernal:HSDigital2:REMote:INITialization:FILE "init_seq_sgs.iec"

SCONfiguration:EXTernal:ACONnect 1
*RST

SCONfiguration:EXTernal:REMote:PURGe
// Disabling remote control of the external instruments
SCONfiguration:EXTernal:REMote:DISConnect[:ALL]
```

13.14.1 I/Q Stream Mapping

Commands

:SCONfiguration:OUTPut:MAPPing:RF:STReam<st>:STATe <State>
:SCONfiguration:OUTPut:MAPPing:HSDigital:CHANnel<di>:STReam<st>:STATe <State>

Maps the I/Q output streams to the output connectors.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Manual operation: See "Map Stream X to Connector" on page 245

:SCONfiguration:OUTPut:MAPPing:STReam<st>:FOFFset <SmFreqOffset>

Sets an absolute frequency offset.

Parameters:

<SmFreqOffset> float
Range: depends on the installed options, e.g. -60E6 to +60E6 (base unit)
Increment: 0.01
*RST: 0

Example: See Example "Distributing the I/Q streams to the output connectors" on page 564.

:SCONfiguration:OUTPut:MAPPing:STReam<st>:POFFset <SmPhasOffset>

Sets the phase offset of the corresponding stream.

Parameters:

<SmPhasOffset> float
Range: -999.99 to 999.99
Increment: 0.01
*RST: 0

Example: See Example "Distributing the I/Q streams to the output connectors" on page 564.

13.14.2 External RF and I/Q Instruments

: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 instrument" on page 564.

Manual operation: See "Display" on page 246

:SCONfiguration:EXTernal:ACONnect <State>

Enables automatic detection and connection setup of connected external instruments.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Distributing the I/Q streams to the output connectors" on page 564.

Manual operation: See "Auto Connect" on page 247

:SCONfiguration:EXTernal:REMote:CONNect[:ALL]
:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]

Triggers the instrument to establish the connections to all configured external RF and I/Q instruments or to disconnect all existing connections.

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Event

Manual operation: See "Connect/Disconnect All Remote" on page 247

:SCONfiguration:EXTernal:PBEHaviour <State>

If enabled, the connection to the external instruments is retained on instrument's preset (`*RST`).

Parameters:

<State> 0 | 1 | OFF | ON

*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:OUTPup:ANALog:TYPE?
// SING
```

Manual operation: See "Preset behavior: Keep connections to external instruments" on page 247

:SCONfiguration:EXTernal:HSDigital<ch>:DIRection?

Queries the connector direction.

Return values:

<Direction> NONE | IN | OUT

*RST: IN

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Query only

Manual operation: See "Direction" on page 248

:SCONfiguration:EXTernal:HSDigital<ch>:IQConnection:STATe?

Queries the status of the I/Q connection of the digital interfaces.

Return values:

<IQConnState> 0 | 1 | OFF | ON

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Query only

Manual operation: See "I/Q Connection" on page 248

:SCONfiguration:EXTernal:HSDigital<ch>:RCONnection:STATe?

Return values:

<State> 0 | 1 | OFF | ON

Usage: Query only

:SCONfiguration:EXTernal:HSDigital: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> (Serial-Number)
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 instrument" on page 564.

Usage: Query only

Manual operation: See "Instrument Name" on page 249

:SCONfiguration:EXTernal:HSDigital: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 SMCV100B.

Parameters:

<RfCouplingState> 0 | 1 | OFF | ON

*RST: 1

Example: See Example "Connecting and configuring external instrument" on page 564.

Manual operation: See "RF Couple" on page 249

:SCONfiguration:EXTernal:HSDigital<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: See Example "Connecting and configuring external instrument" on page 564.

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 249

:SCONfiguration:EXTernal:HSDigital: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: See Example "Connecting and configuring external instrument" on page 564.

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 249

:SCONfiguration:EXTernal:HSDigital: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: See Example "Connecting and configuring external instrument" on page 564.

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 249

:SCONfiguration:EXTernal:HSDigital<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: See Example "Connecting and configuring external instrument" on page 564.

Manual operation: See "(Delta) RF Frequency/ RF Level" on page 249

:SCONfiguration:EXTernal:HSDigital<ch>:RF:STATe <RemConnState>

Queries/sets the RF output state of the connected external instrument.

Parameters:

<RemConnState> 0 | 1 | OFF | ON

Example: See Example "Connecting and configuring external instrument" on page 564.

Manual operation: See "RF State" on page 250

:SCONfiguration:EXTernal:REMote:SCAN

Scans the network for connected instruments.

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Event

Manual operation: See "Detect/Scan" on page 251

: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 572.

Return values:

<ScanState> 0 | 1 | OFF | ON

1
Scanning process running

0
Not scanning

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Query only

Manual operation: See "Detect/Scan" on page 251

:SCONfiguration:EXTernal:REMote:LIST?

Lists all available instruments, found 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 instrument" on page 564.

Usage: Query only

Manual operation: See "External Instrument" on page 252

: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 instrument" on page 564.

Usage: Setting only

Manual operation: See "External Instrument" on page 252

:SCONfiguration:EXTernal:REMote:REName

Changes the symbolic name of the instrument.

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Setting only

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:DETect?

Searches for external instruments connected to the particular digital interfaces.

Return values:

<DetectedInstr> string

If the detection fails, the query returns "None".

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Query only

Manual operation: See "Detect/Scan" on page 251

:SCONfiguration:EXTernal:HSDigital:REMote:ISELect <InstrName>[, <RfPath>]

Select an external instrument for the selected connector.

Parameters:

<InstrName> String

Instrument alias name, as retrieved with the command `:SCONfiguration:EXTernal:REMote:LIST?` or defined with the command `:SCONfiguration:EXTernal:REMote:ADD`.

<RfPath> String

Determines the used RF output of the external instrument.

Example: See Example "Connecting and configuring external instrument" on page 564.

Manual operation: See "External Instrument" on page 252

:SCONfiguration:EXTernal:HSDigital:REMote:CONNect

Usage: Event

Manual operation: See "Apply and Connect" on page 253

:SCONfiguration:EXTernal:HSDigital<ch>:REMote:INFO?

Queries information on the external instrument.

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Query only

Manual operation: See "Remote Connection Status" on page 249

:SCONfiguration:EXTernal:HSDigital: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 instrument" on page 564.

Usage: Event

Manual operation: See "Remote Connection Status" on page 249

:SCONfiguration:EXTernal:REMote:INITialization:CATalog?

Queries the names of the existing initialization files in the default directory.

Per default, the instrument stores 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 instrument" on page 564.

Usage: Query only

Manual operation: See "Initialization Sequence" on page 253

:SCONfiguration:EXTernal:HSDigital: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 instrument" on page 564.

Manual operation: See "Initialization Sequence" on page 253

:SCONfiguration:EXTernal:REMote:PURGe

Removes unused instruments from the pool of external instruments.

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Event

Manual operation: See "Clean Unused/Clean All" on page 252

:SCONfiguration:EXTernal:REMote:CLEan

Removes all instruments from the pool of external instruments.

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Event

Manual operation: See "Clean Unused/Clean All" on page 252

:SCONfiguration:EXTernal:HSDigital:REMote:SEND <SendScpiCommand>

Allows you to send SCPI commands to the RF instruments connected to the R&S SMCV100B.

Setting parameters:
<SendScpiCommand>"<SCPI syntax>"

String containing a SCPI command (query or setting)

Example: See Example "Connecting and configuring external instrument" on page 564.

Usage: Setting only

Manual operation: See "Command, Send Command" on page 254

13.15 SOURce Subsystem

The `SOURce` subsystem contains the commands for configuring the digital and analog 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)

13.15.1 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.

Refer to Chapter 13.15.6, "SOURce:INPut Subsystem", on page 692 for description of the commands for configuring the inputs for external modulation signals.

Required options

See also Chapter 11.2, "Configuring the Global Connectors", on page 420.

Example: Global connectors settings configuration

```
SOURce1:INPut:USER1:DIRection?
// Response: "UNUS"
SOURce1:INPut:USER1:SIGnal?
// Response: "NONE"
// No direction is specified, no input signal is expected.

SOURce1:INPut:USER1:DIRection INP
SOURce1:INPut:USER1:SIGNal TRIG1
SOURce1:INPut:USER:TRIGger:LEVel 1.5
SOURce1:INPut:USER:TRIGger:IMPedance G1K

// The signal threshold at USER 1-2 is 1.5 V.
// This applies to all input signal, i.e. TRIG1, TS, ETI, SDIF and PPS.

SOURce1:INPut:USER2:DIRection OUTP
OUTput:USER2:SIGNal?
// Response: "MARKA1"
// The ouput signal is the baseband marker 1 signal.
:OUTPut:USER2:DIRection
```

[:SOURce]:INPut:USER<ch>:DIRection <Direction>
:OUTPut:USER<ch>:DIRection <Direction>

Determines whether the connector is used as an input or an output.

Suffix:

USER<ch>	1 to 2

Parameters:

<Direction>	INPut | OUTPut | UNUSed `UNUSed` = the connector is not defined
Example:	See Example "Global connectors settings configuration" on page 577.
Manual operation:	See "User x Connector Direction" on page 427

[: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 2

Parameters:

<Signal> TRIG1 | NSEGM1 | INST | TS | ETI | SDIF | PPS

TRIG1
Global trigger input signal available at "User 1/2" connector

NSEGM1
Input global next segment for triggering of multi-segment waveform files. The signal is available at "User 1/2" connector.

INST
Internal instrument trigger signal available at "User 1/2" connector.

TS
Transport stream (TS) input signal available at "User 1" connector only

ETI
Ensemble transport interface input signal compatible with DAB/T-DMB ETSI standard. The signal is available at "User 1" connector only.

SDIF
S/PDIF input signal available at "User 1" connector only

PPS
1PPS (one pulse per second) input signal available at "User 2" connector only

Example: See Example "Global connectors settings configuration" on page 577.

Manual operation: See "Signal" on page 427

: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`.

Parameters:

<Signal> MARKA1 | NONE

*RST: MARKA1

Example: See Example "Global connectors settings configuration" on page 577.

Manual operation: See "Signal" on page 427

[:SOURce]:INPut:USER:CLOCk:LEVel <Level>
[:SOURce]:INPut:USER:TRIGger:LEVel <Level>

Sets the threshold for any input signal at the "User"1-2 connectors.

Parameters:

<Level> float

Range: 0.1 to 2
Increment: 0.1
*RST: 1

Example: See Example "Global connectors settings configuration" on page 577.

Manual operation: See "Threshold User1-2 Input" on page 428

[:SOURce]:INPut:USER:CLOCk:IMPedance <Impedance>
[:SOURce]:INPut:USER:TRIGger:IMPedance <Impedance>

Selects the input impedance for the external trigger inputs.

Parameters:

<Impedance> G1K | G50

*RST: G1K

Example: See Example "Global connectors settings configuration" on page 577.

Manual operation: See "Impedance Clock/Trigger Input" on page 428

[: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 "Global connectors settings configuration" on page 577.

Manual operation: See "Clock Input Slope" on page 429

[:SOURce]:INPut:USER:TRIGger:SLOPe <Slope>

Sets the polarity of the active slope of an applied instrument trigger.

Parameters:

<Slope> NEGative | POSitive

*RST: POSitive

Example: See Example "Global connectors settings configuration" on page 577.

Manual operation: See "Trigger Input Slope" on page 429

13.15.2 SOURce:BBIN Subsystem

The `SOURce:BBIN` subsystem contains the commands for setting the external digital baseband signal.

Suffix	Value range	Description
`CHANnel<ch0>`	0 to 7	Channel number Up to 8 channels per "Dig. IQ HS x" interface and max. 8 channels for both interfaces.

Required options

See "Required options" on page 256.

See also Chapter 5.1, "Overview of the Input and Output Signals and Interfaces", on page 239.

Example: Applying an external digital baseband signal (Dig. IQ HS x)

An external digital signal must be applied at the "Dig. IQ HS x" 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

// to 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 <State>

Switches the feeding of an external analog signal into the signal path on/off.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 580.

Manual operation: See "State" on page 258

[:SOURce<hw>]:BBIN:DIGital:INTerface <BBinDigInterfac>

Selects the input connector at that the signal is fed.

Parameters:

<BBinDigInterfac> DIGital | HSDin | HSDin

HSDin

"Dig. IQ HS 1"

*RST: HSDin

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 580.

Manual operation: See "Interface" on page 258

[: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 259

[:SOURce<hw>]:BBIN:CHANnel<ch0>:BB:STATe <BbinIqHsChanSta>

Activates the channel.

Parameters:

<BbinIqHsChanSta> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 580.

Manual operation: See "BB" on page 260

[:SOURce<hw>]:BBIN:CHANnel<ch0>:NAME <BbinIqHsChanNam>

Queries the channel name.

Parameters:

<BbinIqHsChanNam> string

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 580.

Manual operation: See "Name" on page 260

[: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 (Dig. IQ HS x)" on page 580.

Manual operation: See "Crest Factor" on page 260

[: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 (Dig. IQ HS x)" on page 580.

Manual operation: See "Peak Level" on page 260

[: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 (Dig. IQ HS x)" on page 580.

Manual operation: See "Level" on page 260

[:SOURce<hw>]:BBIN:CHANnel<ch0>:SRATe <BbinIqHsChSaRat>

Sets 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 (Dig. IQ HS x)" on page 580.

Manual operation: See "Sample Rate" on page 260

[: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. IQ HS x)" on page 580.

[:SOURce<hw>]:BBIN:SRATe:SOURce <Source>

Queries the digital interface used to estimate the sample rate.

Parameters:

<Source> HSDin

HSDin
Queried for `[:SOURce<hw>]:BBIN:DIGital:INTerface HSDin`.

*RST: HSDin

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 580.

Manual operation: See "Sample Rate Source" on page 258

[: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 (Dig. IQ HS x)" on page 580.

Usage: Query only

Options: R&S SMCVB-K521/-K522/-K523

Manual operation: See "Aggregated Link Sample Rate" on page 260

[:SOURce<hw>]:BBIN:SRATe:MAX?

Queries the maximum sample rate.

Return values:

<DigIqHsOutSRMax> integer

Range: 400 to 600E6
*RST: 600E6

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 580.

Usage: Query only

Manual operation: See "Aggregated Link Sample Rate" on page 260

[:SOURce<hw>]:BBIN:SRATe[:ACTual]?

Queries the sample rate of the external digital baseband signal.

Return values:

<Actual> float

Range: 400 to 100E6
Increment: 0.001
*RST: 100E6

Usage: Query only

[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe <State>

Activates automatic adjustment of the baseband input signal.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 1

Example: See Example "Applying an external digital baseband signal (Dig. IQ HS x)" on page 580.

Manual operation: See "DIG IQ Auto Setting" on page 261

[: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. IQ HS x)" on page 580.

Manual operation: See "Measurement Period" on page 261

[: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. IQ HS x)" on page 580.

Usage: Event

Manual operation: See "Auto Level Set" on page 261

[: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. IQ HS x)" on page 580.

[: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. IQ HS x)" on page 580.

[: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. IQ HS x)" on page 580.

Usage: Query only

13.15.3 SOURce:BB Subsystem

This subsystem contains all commands for digital signal generation. It is divided into several subsystems which are described separately.

13.15.3.1 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.

The following commands are available:

[:SOURce<hw>]:BBIN:FOFFset <FOffset>
[:SOURce<hw>]:BB:FOFFset <FOffset>

Sets a frequency offset for the internal/external baseband signal. The offset affects the generated baseband signal.

Parameters:

<FOffset> float

Range: depends on the installed options
Increment: 0.01
*RST: 0
Default unit: Hz

Example: `SOURce1:BB:FOFFset 2MHZ`

Manual operation: See "Frequency Offset" on page 237

[: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 237

[: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 237

[: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

13.15.3.2 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 Chapter 4.5.1, "Required Options", on page 102

The commands are grouped in the following sections:

Programming Examples

Example: Performing general tasks

This example shows how to enable custom digital modulation 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 instrument first
// ******************************************************************
*RST; *CLS

SOURce:BB:DM:PRESet
SOURce:BB:DM:STANDard W3GPp
SOURce:BB:DM:SRATe?
```

```
// 3840000
SOURce:BB:DM:CODing?
// WCDMA
SOURce:BB:DM:FORMat?
// QPSK45
SOURce:BB:DM:STATe ON
SOURce:BB:DM:SETTing:STORe "/var/user/ digMod/CustDM3GPP"

// *****************************************************************
// Recall settings
// *****************************************************************
MMEM:CDIR "/var/user/digMod"
SOURce:BB:DM:SETTing:CATalog?
// CusDigMod,cdm3gpp, CustDM3GPP
SOURce:BB:DM:SETTing:DELete "cdm3gpp"
SOURce:BB:DM:SETTing:LOAD "CusDigMod"

// *****************************************************************
// Change the data source
// *****************************************************************
SOURce:BB:DM:SOURce?
// PRBS
SOURce:BB:DM:PRBS:LENGth?
// 9
SOURce:BB:DM:SOURce DLISt
// Set the default directory and query the existing data lists
MMEM:CDIR "/var/user/DLists"
SOURce:BB:DM:DLISt:CATalog?
// "DList1","DList2"
// delete a list and create a new data list
SOURce:BB:DM:DLISt:DELete "DList1"
SOURce:BB:DM:DLISt:SELect "DList2"
// copy the content of an existing data list to the new data list
SOURce:BB:DM:DLISt:COPY "DList3"
// query the content of the new data list and modify it (append data to it)
FORM ASCI
SOURce:BB:DM:DLISt:DATA? 2048,1024
// 1,1,0,0,0, ...
SOURce:BB:DM:DLISt:DATA:APPend 1,1,1,0,0,0,1,1,0,1...
SOURce:BB:DM:DLISt:SELect "DList3"
// query the free memory and number of bits to be utilized
SOURce:BB:DM:DLISt:FREE?
SOURce:BB:DM:DLISt:POINts?
```

Example: Adjusting clock, marker and trigger settings

The following example lists the provided commands

```
// *****************************************************************
// Clock settings
// *****************************************************************
SOURce:BB:DM:CLOCk:SOURce INTernal
```

```
// ******************************************************************
// Configure and enable standard marker signals
// ******************************************************************
SOURce:BB:DM:TRIGger:OUTPut2:MODE PULSe
SOURce:BB:DM:TRIGger:OUTPut2:PULSe:DIVider 5
SOURce:BB:DM:TRIGger:OUTPut2:PULSe:FREQuency?
SOURce:BB:DM:TRIGger:OUTPut3:MODE PATTern
SOURce:BB:DM:TRIGger:OUTPut3:PATTern #HE0F52,20
SOURce:BB:DM:TRIGger:OUTPut1:MODE RATio
SOURce:BB:DM:TRIGger:OUTPut1:ONTime 40
SOURce:BB:DM:TRIGger:OUTPut1:OFFTime 20

SOURce:BB:DM:TRIGger:OUTPut2:DELay 16

// ******************************************************************
// Configure and enable signal generation
// ******************************************************************
SOURce:BB:DM:TRIGger:SEQuence SINGle
SOURce:BB:DM:TRIGger:SLENgth 200
// the first 200 samples will be output after the next trigger event
SOURce:BB:DM:TRIGger:SEQuence ARETrigger
SOURce:BB:DM:TRIGger:SOURce EGT1
// external trigger signal must be provided at the connector
// configured for the external global trigger 1 signal
SOURce:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut ON
SOURce:BB:DM:TRIGger:EXTernal:DELay 200
SOURce:BB:DM:TRIGger:EXTernal:INHibit 100

// with internal trigger source
SOURce:BB:DM:TRIGger:SEQuence AAUTo
SOURce:BB:DM:TRIGger:SOURce INTernal
SOURce:BB:DM:STAT ON
SOURce:BB:DM:TRIGger:EXEC
```

Example: Enable power ramping

The following example lists the provided commands

```
SOURce:BB:DM:PRAMp:SOURce INTernal
SOURce:BB:DM:PRAM:SHAP COS
SOURce:BB:DM:PRAMp:TIME 5
SOURce:BB:DM:PRAMp:RDELay 0
SOURce:BB:DM:PRAMp:FDELay -1
SOURce:BB:DM:PRAMp:ATTenuation 10
SOURce:BB:DM:PRAMp:BBONly:STATe ON
SOURce:BB:DM:PRAMp:STATe ON
```

General Commands

[:SOURce<hw>]:BB:DM:STATe <State>

Enables/disables digital modulation. Switching on digital modulation turns off all the other digital standards in the same signal path.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Performing general tasks" on page 590

Manual operation: See "State" on page 104

[: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 command `SOURce<hw>:BB:DM:STATe`

Example: See Example "Performing general tasks" on page 590

Usage: Event

Manual operation: See "Set To Default" on page 104

[: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: 400 to depends on the installed options
Increment: 0.001
*RST: 270833.333
Default unit: Hz or sym/s

Example: See Example "Performing general tasks" on page 590.

Manual operation: See "Symbol Rate" on page 105

[:SOURce<hw>]:BB:DM:STANdard <Standard>

Selects predefined set of settings according to the selected standard, see Table 4-5.

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

A query returns the value `USER` if one the following is true:
• A user-defined custom digital modulation setting was loaded
• One of the associated settings was changed subsequent to the selection of a standard.

*RST: GSM

Example: See Example "Performing general tasks" on page 590

Manual operation: See "Set according to Standard" on page 105

[:SOURce<hw>]:BB:DM:SOURce <Source>

Selects the data source.

Parameters:

<Source> ZERO | ONE | PRBS | PATTern | DLISt

*RST: PRBS

Example: See Example "Performing general tasks" on page 590

Manual operation: See "Data Source" on page 106

[: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 106

[: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 "Performing general tasks" on page 590

Manual operation: See "Data Source" on page 106

Save/Recall Settings

[: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`.

Refer to Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 for general information on file handling in the default and a specific directory.

Return values:

<Catalog> "<filename1>,<filename2>,..."

Returns a string of file names separated by commas.

Example: See Example "Performing general tasks" on page 590

Usage: Query only

Manual operation: See "Save/Recall" on page 104

[:SOURce<hw>]:BB:DM:STANdard:ULISt:STORe <Filename>
[:SOURce<hw>]:BB:DM:SETTing:STORe <Filename>

Stores the current settings into the selected file; the file extension (`*.dm` respectively `*.dm_stu`) is assigned automatically.

Refer to Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 for general information on file handling in the default and a specific directory.

Setting parameters:

<Filename> string

Example: See Example "Performing general tasks" on page 590

Usage: Setting only

Manual operation: See "Save/Recall" on page 104

[: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`.

Refer to Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 for general information on file handling in the default and a specific directory.

Setting parameters:

<Filename> string

Example: See Example "Performing general tasks" on page 590

Usage: Setting only

Manual operation: See "Save/Recall" on page 104

[: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`.

Refer to Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 for general information on file handling in the default and a specific directory.

Setting parameters:

<Filename> string

Example: See Example "Performing general tasks" on page 590

Usage: Setting only

Manual operation: See "Save/Recall" on page 104

Filter Settings

[:SOURce<hw>]:BB:DM:FILTer:TYPE <Type>

The command selects the filter type.

When a standard is selected (`:BB:DM:STAN`), the filter type and filter parameter are set to the default value.

Parameters:

<Type> RCOSine | COSine | GAUSs | LGAuss | CONE | COF705 | COEQualizer | COFequalizer | C2K3x | APCO25 | SPHase | RECTangle | USER | PGAuss | LPASs | DIRac | ENPShape | EWPShape | LTEFilter | LPASSEVM | APCO25Hcpm | APCO25Lsm

*RST: GAUSs

Example: See [:SOURce<hw>]:BB:DM:FILTer:PARameter:SPHase on page 597

Manual operation: See "Filter" on page 111

[: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	Roll-off factor	<Apco25>	0.05	0.99	0.01	0.2
APCO25Lsm	Cut off frequency for the lowpass/gauss filter (:LOWPass/:GAUSs)	<Cosine>	400	25E6	1E-3	270833.333
COSine	Bandwidth	<FiltParm>	400	depends on the installed options*)	1E-3	270833.333
COSine	Roll-off factor	<Cosine>	0.05	1	0.01	0.35
GAUSs	Roll-off factor	<Gauss>	0.15	100000	0.01	0.3
LPASs	Cut-off frequency	<LPass>	0.05	2	0.01	0.5
LPASSEVM	Cut-off frequency	<LPassEvm>	0.05	2	0.01	0.5
PGAuss	Roll-off factor	<PGauss>	0.15	2.5	0.01	0.3
RCOSine	Roll-off factor	<RCosine>	0.05	1	0.001	0.35
SPHase	B x T	<SPhase>	0.15	2.5	0.01	2

*)120E6 (R&S SMCVB-K521) / 160E6 (R&S SMCVB-K522) / 240E6 (R&S SMCVB-K522)

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
```

Manual operation: See "Filter Parameter" on page 111

[: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 596.

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 597

Modulation and Coding Settings

[: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 "Performing general tasks" on page 590

Manual operation: See "Coding" on page 105

[: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 "Performing general tasks" on page 590

Manual operation: See "Modulation Type" on page 108

[: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 109

[: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 109

[: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 109

[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEViation <Deviation>

Sets the deviation of the selected symbol for variable FSK modulation mode.

Parameters:

<Deviation> float

The value range depends on the selected symbol rate (see data sheet).

Range: -40E6 to 40E6
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 110

[: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 600

Manual operation: See "FSK Type" on page 109

[: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 110

[: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 110

[:SOURce<hw>]:BB:DM:SWITching:STATe <State>

Enables switching between a modulated and an unmodulated signal.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Manual operation: See "State Modulation CW Switching" on page 110

Power Ramping

[: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 592

Manual operation: See "Source" on page 113

[: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 592

Manual operation: See "Ramp Function" on page 113

[: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 592

Manual operation: See "Ramp Time" on page 113

[: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 592

Manual operation: See "Rise Delay" on page 113

[:SOURce<hw>]:BB:DM:PRAMp:ATTenuation <Attenuation>

Sets the level attenuation for signal ranges that are flagged with 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 592

Manual operation: See "Attenuation" on page 114

[: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> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Enable power ramping" on page 592.

Manual operation: See "In Baseband Only" on page 114

[:SOURce<hw>]:BB:DM:PRAMp[:STATe] <State>

Enables or disables power ramping.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Enable power ramping" on page 592

Manual operation: See "State" on page 113

Trigger Settings

[:SOURce<hw>]:BB:DM[:TRIGger]:SEQuence <Sequence>

Selects the trigger mode. For detailed description of the trigger modes, refer to "Impact of the Trigger Modes on the Signal Generation" on page 83.

Parameters:

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGle

*RST: AUTO

Example: See Example "Adjusting clock, marker and trigger settings" on page 591

Manual operation: See "Mode" on page 97

[:SOURce<hw>]:BB:DM:TRIGger:SOURce <Source>

Selects the trigger signal source and determines the way the triggering is executed. Provided are:

- Internal triggering by a command (`INTernal`)

Parameters:

<Source> INTernal|EXTernal

*RST: INTernal

Example: See Example "Adjusting clock, marker and trigger settings" on page 591

Manual operation: See "Source" on page 98

[: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 "Adjusting clock, marker and trigger settings" on page 591

Manual operation: See "Signal Duration" on page 98

[: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 98

[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut <Output>

Enables signal output synchronous to the trigger event.

Parameters:

<Output> 0 | 1 | OFF | ON

*RST: 1

Example: See Example "Adjusting clock, marker and trigger settings" on page 591

Manual operation: See "Sync. Output to External Trigger/Sync. Output to Trigger" on page 99

[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute

Stops signal generation; a subsequent internal or external trigger event restart signal generation.

Example: See also Example "Adjusting clock, marker and trigger settings" on page 591

Usage: Event

Manual operation: See "Arm" on page 98

[:SOURce<hw>]:BB:DM:TRIGger:EXECute

Executes a trigger.

Example: See Example "Adjusting clock, marker and trigger settings" on page 591

Usage: Event

Manual operation: See "Execute Trigger" on page 98

[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT <TrigDelUnit>

Determines the units the trigger delay is expressed in.

Parameters:

<TrigDelUnit> SAMPle | TIME

*RST: SAMPle

Example: See Example "Specifying delay and inhibit values in time units" on page 617

Manual operation: See "(External) Delay Unit" on page 99

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay <Delay>

Specifies the trigger delay in symbols.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "Specifying delay and inhibit values" on page 89.

Parameters:

<Delay> float

Range: 0 to depends on the symbol rate
Increment: 0.01
*RST: 0
Default unit: symbol

Example: See Example "Adjusting clock, marker and trigger settings" on page 591.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 99

[:SOURce<hw>]:BB:DM: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 "Specifying delay and inhibit values" on page 89.

Parameters:

<ExtTimeDelay> float

Range: 0 to 7929.170398682
Increment: 0.25E-9
*RST: 0
Default unit: s

Example: See Example "Specifying delay and inhibit values in time units" on page 617.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 99

[: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 "Specifying delay and inhibit values in time units" on page 617

Usage: Query only

Manual operation: See "Actual Trigger Delay/Actual External Delay" on page 100

[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit <Inhibit>

Specifies the number of symbols, by which a restart is inhibited.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "Specifying delay and inhibit values" on page 89.

Parameters:

<Inhibit> integer

Range: 0 to 21.47 * (symbol rate)
*RST: 0
Default unit: symbol

Example: See Example "Adjusting clock, marker and trigger settings" on page 591.

Manual operation: See "External / Trigger Inhibit" on page 99

Marker Settings

[: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 81.

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 "Adjusting clock, marker and trigger settings" on page 591

Manual operation: See "Marker Mode" on page 100

[: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 "Adjusting clock, marker and trigger settings" on page 591

Manual operation: See "Marker Mode" on page 100

[: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 "Adjusting clock, marker and trigger settings" on page 591.

Manual operation: See "Marker Mode" on page 100

[: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 "Adjusting clock, marker and trigger settings" on page 591

Manual operation: See "Marker Mode" on page 100

[: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 "Adjusting clock, marker and trigger settings" on page 591

Usage: Query only

Manual operation: See "Marker Mode" on page 100

[: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: 0.001
*RST: 0

Example: See Example "Adjusting clock, marker and trigger settings" on page 591.

Manual operation: See "Marker x Delay" on page 101

Clock Settings

[:SOURce<hw>]:BB:DM:CLOCk:SOURce <Source>

Selects the clock source:

- `INTernal`: Internal clock reference

Parameters:

<Source> INTernal

*RST: INTernal

Example: See Example "Adjusting clock, marker and trigger settings" on page 591.

Manual operation: See "Clock Source" on page 101

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 files present in the default directory (see `:MMEMory:CDIRectory`).

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`

Refer to Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 for general information on file handling in the default and a specific directory.

Return values:

<Catalog> "<filename1>,<filename2>,..."

Returns a string of file names separated by commas.

Example: See Example "Performing general tasks" on page 590.

Usage: Query only

Manual operation: See "Data Source" on page 106

[: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 (see `:MMEMory:CDIRectory`) or in the directory specified with the absolute file path.

If a list with the specified name does not yet exist, it is created. The file extension can be omitted.

Refer to Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 for general information on file handling in the default and a specific directory.

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 "Performing general tasks" on page 590

Manual operation: See "Data Source" on page 106

[: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 (see `:MMEMory:CDIRectory`) or from the directory specified with the absolute file path.

Refer to Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 for general information on file handling in the default and a specific directory.

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 "Performing general tasks" on page 590

Usage: Setting only

Manual operation: See "Select Data List" on page 107

[: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 "Performing general tasks" on page 590

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 `:MMEMory:CDIRectory`).

Refer to Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 for general information on file handling in the default and a specific directory.

Setting parameters:

<Filename> string

Example: See Example "Performing general tasks" on page 590

Usage: Setting only

Manual operation: See "Select Data List" on page 107

[: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 being a 2-byte value in which the 16 bits represent the binary values (16-bit unsigned integer, 2 bytes, LSB first).

Tip: Control lists are created in binary format. You may however need the control list in an ASCII format, e.g for creating a waveform file with R&S WinIQSIM2. Refer to the examples in Chapter 4.6.4.6, "How to Create a Control List Using Tag File Format", on page 157 for description on how to create a control list file in ASCII format manually.

`*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 0,0,0,0,8,8,8,0,0,0,0...
// 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 118

[: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.

The **query** 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.

`*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 "Performing general tasks" on page 590

[: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 piece-meal.

The command cannot be used with an empty data list, like for example data lists that has just been created. Use the command `[:SOURce<hw>]:BB:DM:DLISt:DATA` first and enter modulation data in the list.

`*RST` has no effect on data lists.

Setting parameters:

<Bits> 0 | 1 {,0 | 1 } | block data

Example: See Example "Performing general tasks" on page 590

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>

Refer to Chapter 4.6.6, "Tags for Waveforms, Data and Control Lists", on page 162 for description of the available tag formats.

Example: `SOURce1:BB:DM:DLISt:TAG? "D_list","date"`
Queries the `Date` tag in list `D_list`.

Usage: Query only

13.15.3.3 SOURce:BB:ARBitrary Subsystem

This section list the commands of the `SOURce:BB:ARBitrary` subsystem.

Required options

See Chapter 4.6.1, "Required Options", on page 130.

The commands are grouped in the following sections:

Programming Examples

Example: Creating test signals

The following example lists commands necessary to configure the different test signals.

```
// ******************************************************************
// Reset instrument first
// ******************************************************************
*RST; *CLS
SOURce:BB:ARBitrary:PRESet

// ******************************************************************
// Create test signals
// ******************************************************************
SOURce:BB:ARBitrary:SIGNal:TYPE CIQ
SOURce:BB:ARBitrary:TSIGnal:CIQ:I -0.5
SOURce:BB:ARBitrary:TSIGnal:CIQ:Q -0.33
SOURce:BB:ARBitrary:TSIGnal:CIQ:CREate

SOURce:BB:ARBitrary:TSIGnal:SINE:FREQuency 1MHz
SOURce:BB:ARBitrary:TSIGnal:SINE:SAMPles 100
SOURce:BB:ARBitrary:TSIGnal:SINE:PHASe -90
SOURce:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed "/var/user/ARBtestSignals/sineTest"

SOURce:BB:ARBitrary:TSIGnal:RECTangle:FREQuency 100KHz
SOURce:BB:ARBitrary:TSIGnal:RECTangle:SAMPles 1000
SOURce:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude 0.5
SOURce:BB:ARBitrary:TSIGnal:RECTangle:OFFSet -0.3
SOURce:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed "/var/user/ARBtestSignals/rectTest"

SOURce:ARBitrary:STATe ON
```

Example: Managing waveform files

The following example lists the commands provided for handling of waveform files.

```
// *******************************************************************
// Reset instrument first
// *******************************************************************
*RST; *CLS
SOURce:BB:ARBitrary:PRESet

// *******************************************************************
// Set the default directory and list the available waveform files
// *******************************************************************
MMEM:CDIR "/var/user/ARBtestSigs"
SOURce:BB:ARBitrary:WAVeform:CATalog?
// sineTest,rectTest,ciqTestSignal,waveformTest,test2
SOURce:BB:ARBitrary:WAVeform:CATalog:LENGth?
// 5
// SOURce:BB:ARBitrary:WAVeform:FREE?

// *******************************************************************
// Select a waveform and querry information
// *******************************************************************
// SOURce:BB:ARBitrary:WAVeform:DELete "/var/user/ARBtestSigs/test2"
SOURce:BB:ARBitrary:WAVeform:SELect "/var/user/ARBtestSigs/wvTest"
SOURce:BB:ARBitrary:WAVeform:POINts?
// 100
SOURce:BB:ARBitrary:WAVeform:TAG? "TYPE"
// "SMU-WV"
SOURce:BB:ARBitrary:WAVeform:TAG? "COMMENT"
// "Waveform for test purposes"
// alternatively: query the comment tag of the current waveform file
// SOURce:BB:ARBitrary:WAVeform:DATA? "comment"
// "Waveform for test purposes"

// to query the date tag of a specific waveform file
// SOURce:BB:ARBitrary:WAVeform:DATA? "/var/user/ARBtestSigs/waveformTest","date"
// #2192014-04-15;16:19:30

// *******************************************************************
// Clock settings
// *******************************************************************
SOURce:BB:ARBitrary:CLOCk:SOURce INTernal
SOURce:BB:ARBitrary:CLOCk?
// 100000000
// or alternativelly use SOURce:BB:ARBitrary:WAVeform:TAG? "CLOCK"

// *******************************************************************
// Configure and enable standard marker signals
// *******************************************************************
SOURce:BB:ARBitrary:TRIGger:OUTPut1:MODE RESTart
```

```
SOURce:BB:ARBitrary:TRIGger:OUTPut2:MODE PULSe
SOURce:BB:ARBitrary:TRIGger:OUTPut2:PULSe:DIVider 5
SOURce:BB:ARBitrary:TRIGger:OUTPut2:PULSe:FREQuency?
// 20000000
SOURce:BB:ARBitrary:TRIGger:OUTPut3:MODE PATTern
SOURce:BB:ARBitrary:TRIGger:OUTPut3:PATTern #HE0F52,20
SOURce:BB:ARBitrary:TRIGger:OUTPut1:MODE RATio
SOURce:BB:ARBitrary:TRIGger:OUTPut1:ONTime 40
SOURce:BB:ARBitrary:TRIGger:OUTPut1:OFFTime 20

SOURce:BB:ARBitrary:TRIGger:OUTPut2:DELay 16

// ******************************************************************
// Configure and enable signal triggering; start ARB generator
// ******************************************************************
SOURce:BB:ARBitrary:TRIGger:SEQuence SINGle
SOURce:BB:ARBitrary:TRIGger:SLENgth 200
// the first 200 samples of the current waveform will be output after
// the next trigger event
// SOURce:BB:ARBitrary:TRIGger:SEQuence ARETrigger
// SOURce:BB:ARBitrary:TRIGger:SOURce EGT1
// external trigger signal must be provided at the USER connector
SOURce:BB:ARBitrary:TRIGger:EXTernal:SYNChronize:OUTPut ON
SOURce:BB:ARBitrary:TRIGger:EXTernal:DELay 200
SOURce:BB:ARBitrary:TRIGger:EXTernal:INHibit 100

// with internal trigger source
SOURce:BB:ARBitrary:TRIGger:SEQuence AAUTo
SOURce:BB:ARBitrary:TRIGger:SOURce INTernal
SOURce:BB:ARBitrary:STAT ON
SOURce:BB:ARBitrary:TRIGger:EXEC

// ******************************************************************
// Enable streaming for large waveforms
// ******************************************************************
SOURce:BB:ARBitrary:WAVeform:HDDStreaming:STATe ON
SOURce:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel?
// 94%
```

Example: Specifying delay and inhibit values in time units

The following example lists the commands necessary to configure the instrument as described in "Specifying delay and inhibit values" on page 89.

```
SOURce1:BB:ARBitrary:CLOCk 1000000
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: 100
```

```
SOURce1:BB:ARBitrary:TRIGger:DELay:UNIT TIME
SOURce1:BB:ARBitrary:TRIGger:EXTernal:TDELay 0.00001
SOURce1:BB:ARBitrary:TRIGger:EXTernal:RDELay?
// Response: 0.00001

SOURce1:BB:ARBitrary:TRIGger:DELay:UNIT SAMP
SOURce1:BB:ARBitrary:TRIGger:EXTernal:DELay 10
```

Example: Creating a multi-segment waveform

The following example lists the commands necessary to create a multi-segment waveform.

```
// *******************************************************************
// Reset instrument first
// *******************************************************************
*RST; *CLS
// SOURce:BB:ARBitrary:PRESet

// *******************************************************************
// Set the default directory and list the available waveform files
// *******************************************************************
MMEM:CDIR "/var/user/ARB/multi_segment"
SOURce:BB:ARBitrary:WAVeform:CATalog:LENGth?
// 4
SOURce:BB:ARBitrary:WAVeform:CATalog?
// Seg_0, Seg_1, Seg_2, Seg_3
// *******************************************************************
// List the available configuration files and select/create file
// *******************************************************************
SOURce:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// multi_segment,ms_waveform
// the directory contains the configuration files multi_segment.inf_mswv
and ms_waveform.inf_mswv
SOURce:BB:ARBitrary:WSEGment:CONFigure:DELete "ms_waveform.inf_mswv"
SOURce:BB:ARBitrary:WSEGment:CONFigure:SELect
"/var/user/ARB/multi_segment/config.inf_mswv"
// creates new empty configuration file config.inf_mswv

// *******************************************************************
// Append waveforms to the multi segment sequence
// *******************************************************************
SOURce: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
SOURce:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_1"
SOURce:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_2"
SOURce:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend "Seg_3"

SOURce:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend 1000,100000000
```

```
// adds a blank segment with 1000 samples and 100 MHz clock rate

SOURce:BB:ARBitrary:WSEGment:CONFigure:LEVel:MODE ERMS
SOURce:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE HIGHest
// SOURce:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE USER
// SOURce:BB:ARBitrary:WSEGment:CONFigure:CLOCk 30000000
SOURce:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE TAKE

SOURce:BB:ARBitrary:WSEGment:CONFigure:SELect
"/var/user/ARB/multi_segment/config.inf_mswv"
SOURce:BB:ARBitrary:WSEGment:CONFigure:COMMent "Multi Segment File"
SOURce:BB:ARBitrary:WSEGment:CONFigure:OFILe "ms_0to3"
SOURce: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 waveforms into the ARB generator; the ARB is activated
// the first segment is output deppending on the trigger settings
// ******************************************************************
// SOURce:BB:ARBitrary:WSEGment:CREate "/var/user/ARB/multi_segment/config.inf_mswv"
SOURce:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"

SOURce:BB:ARBitrary:TRIGger:SEQuence AAUTo
SOURce:BB:ARBitrary:TRIGger:SOURce INTernal
SOURce:BB:ARBitrary:STAT ON
SOURce:BB:ARBitrary:TRIGger:EXEC
```

Example: Configuring the output order of the segments

The following example lists the commands necessary to trigger the output of the segments in 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 618). 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"
SOURce:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// config
SOURce:BB:ARBitrary:WSEGment:CONFigure:SELect "config"
SOURce:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3"
SOURce:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"

// ******************************************************************
// Adjust trigger settings and enable the ARB
```

```
// ******************************************************************
SOURce:BB:ARBitrary:TRIGger:SEQuence AAUTo
SOURce:BB:ARBitrary:TRIGger:SOURce INTernal
SOURce:BB:ARBitrary:STATe ON

// ******************************************************************
// Select the next segment trigger mode and source
// ******************************************************************
SOURce:BB:ARBitrary:TRIGger:SMODe NEXT
// SOURce:BB:ARBitrary:TRIGger:SMODe NSEam
SOURce:BB:ARBitrary:WSEGment:NEXT:SOURce INTernal

SOURce:BB:ARBitrary:WSEGment?
// 0
SOURce: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
// ******************************************************************
SOURce:BB:ARBitrary:WSEGment:NEXT 3
// stops Seg_0 and starts immediatly Seg_3; Seg_3 is output continuously
SOURce:BB:ARBitrary:TRIGger:EXECute
//restarts Seg_3
SOURce:BB:ARBitrary:WSEGment:NEXT 2
SOURce:BB:ARBitrary:WSEGment:NEXT 0

// ******************************************************************
// Scrolling trough the segments, i.e. shwitch over in incremental order
// ******************************************************************
SOURce:BB:ARBitrary:WSEGment:NEXT:EXECute
SOURce:BB:ARBitrary:WSEGment?
// 1
SOURce:BB:ARBitrary:WSEGment:NEXT:EXECute
SOURce:BB:ARBitrary:WSEGment?
// 2
```

Refer to "To apply a manual segment switch to the output segments in the required order" on page 202 for description of the steps necessary to achieve a similar task via manual operation of the instrument.

Example: Using the ARB sequencer

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 618). 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 composed from waveforms with equal clock rates
// ******************************************************************
MMEM:CDIR "/var/user/ARB/multi_segment"
SOURce:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// config
SOURce:BB:ARBitrary:WSEGment:CONFigure:SELect "config"
SOURce:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"
SOURce:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3.wv"

// ******************************************************************
// Select a sequencing list (*.wvs)
// ******************************************************************
SOURce:BB:ARBitrary:WSEGment:SEQuence:SELect "play_list"
SOURce: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
SOURce:BB:ARBitrary:WSEGment:SEQuence:APPend ON,3,2,NEXT
SOURce:BB:ARBitrary:WSEGment:SEQuence:APPend ON,2,1,SEG0

SOURce:BB:ARBitrary:TRIGger:SMODe SEQuencer
SOURce:BB:ARBitrary:TRIGger:SEQuence AAUTo
SOURce:BB:ARBitrary:TRIGger:SOURce INTernal
SOURce:BB:ARBitrary:STAT ON
SOURce:BB:ARBitrary:TRIGger:EXEC
```

Refer to "To apply a manual segment switch to the output segments in the required order" on page 202 for description of the steps necessary to achieve a similar task via manual operation of the instrument.

Example: Adding extra marker signals

The following example lists the commands necessary 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"
SOURce:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// config
SOURce:BB:ARBitrary:WSEGment:CONFigure:SELect "config"
SOURce:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"
SOURce:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3.wv"

// ******************************************************************
// Enable restart markers on marker trace 1 and 2
// ******************************************************************
SOURce:BB:ARBitrary:WSEGment:CONFigure:MARKer:MODE IGNore
SOURce:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment MRK1
SOURce:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment MRK2

SOURce:BB:ARBitrary:TRIGger:OUTPut1:MODE UNCHanged
SOURce:BB:ARBitrary:TRIGger:OUTPut2:MODE UNCHanged
```

Example: Generating a multi carrier signal

The following example lists the commands necessary to generate a multi carrier signal.

```
// ******************************************************************
// Generating a multi carrier 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"
// store the waveform in the default directory ("/var/user")
SOURce1:BB:W3GPp:WAVeform:CREate "3gpp_arb"

// ******************************************************************
// Configure a multi carrier scenario with 4 carriers
// and carrier spacing of 5 MHz
// Activate the carriers
// ******************************************************************
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)
// ******************************************************************
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 multi carrier waveform file in the ARB generator
SOURce1:BB:ARBitrary:MCARrier:CLOad
// Alternatively: create the multi carrier waveform and
// load it subsequently in the ARB generator
// SOURce1:BB:ARBitrary:MCARrier:CREate
// SOURce1:BB:ARBitrary:WAVeform:SELect"3gpp_mc"

// Activate the ARB generator
SOURce1:BB:ARBitrary:STATe ON

// ******************************************************************
// Use the save/recall function to store the settings
// ******************************************************************
// 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 settings files mcar1.arb_multcarr and mcar2.arb_multcarr
SOURce1:BB:ARBitrary:MCARrier:SETTing:STORe "3gpp_mc"
```

General Commands

[:SOURce<hw>]:BB:ARBitrary:PRESet

Sets all ARB generator parameters to their default values.

Example: See "Programming Examples" on page 615

Usage: Event

Manual operation: See "Set To Default" on page 138

[:SOURce<hw>]:BB:ARBitrary:STATe <State>

Enables the ARB generator.

A waveform must be selected before the ARB generator is activated.

Parameters:

<State>	0 | 1 | OFF | ON *RST: 0

Example: See "Programming Examples" on page 615

Manual operation: See "State" on page 137

Test Signal Commands

[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE <ArbSignalType>

Selects the type of test signal.

Parameters:

<ArbSignalType>	SINE | RECT | CIQ *RST: SINE

Example: See Example "Creating test signals" on page 615.

Manual operation: See "Test Signal Form" on page 140

[: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 "Creating test signals" on page 615

Manual operation: See "I Value, Q Value" on page 143

[: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 "Creating test signals" on page 615

Manual operation: See "Amplitude" on page 142

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency <Frequency>

Sets the frequency of the test signal.

Parameters:

<Frequency> float

Range: 100 to depends on the installed options
Increment: 0.01
*RST: 1000
Default unit: Hz

Example: See Example "Creating test signals" on page 615.

Manual operation: See "Frequency" on page 142

[: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 "Creating test signals" on page 615

Manual operation: See "Offset DC" on page 143

[: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 "Creating test signals" on page 615

Manual operation: See "Samples per Period" on page 142

[: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 the installed options
Increment: 0.01
*RST: 1000
Default unit: Hz

Example: See Example "Creating test signals" on page 615.

Manual operation: See "Frequency" on page 141

[: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 "Creating test signals" on page 615

Manual operation: See "Phase Offset Q" on page 141

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles <Samples>

Sets the sample rate for the sine signal in samples per period.

The resulting clock rate must not exceed the maximum ARB clock rate (see data sheet).

The maximum value is automatically restricted by reference to the set frequency and has to fulfill the rule *Frequency * Samples <= ARB clock rate*.

Parameters:

<Samples> integer

Range: 4 to 1000
*RST: 100

Example: see Example "Creating test signals" on page 615

Manual operation: See "Samples per Period" on page 141

[: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 "Creating test signals" on page 615

Usage: Setting only

Manual operation: See "Generate Signal File" on page 141

[: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 "Creating test signals" on page 615

Usage: Event

Manual operation: See "Generate Signal RAM" on page 141

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 file name 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 file name are required.

[: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 "Managing waveform files" on page 616

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 "Managing waveform files" on page 616

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect <Filename>

Selects an existing waveform file, i.e. file with extension `*.wv`.

Parameters:

<Filename> string

Example: See Example "Managing waveform files" on page 616

Manual operation: See "Load Waveform/File" on page 138

[: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 "Managing waveform files" on page 616

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 "Managing waveform files" on page 616

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 "Managing waveform files" on page 616

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 Chapter 4.6.6, "Tags for Waveforms, Data and Control Lists", on page 162.

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 "Managing waveform files" on page 616

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 Chapter 4.6.6, "Tags for Waveforms, Data and Control Lists", on page 162).

Return values:

<Tag> 'comment' | 'copyright' | 'date' | 'lacpfilter' | 'marker name' | 'poweroffset' | 'samples'

Example: see Example "Managing waveform files" on page 616

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 data sheet for value range.

Parameters:

<Clock> float

Range: depends on the installed options
Increment: 0.001
*RST: 1E6
Default unit: Hz
E.g. 400 Hz to 300 MHz

Example: See Example "Managing waveform files" on page 616.

Manual operation: See "Clock Frequency" on page 139

[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:STATe <State>

By processing large files, enables the streaming of modulation data directly from the hard drive (HDD).

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Managing waveform files" on page 616.

Manual operation: See "HDD Streaming" on page 139

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CLOCk <Filename>, <Clock>

Appends information on the ARB clock rate to specified waveform file. The file must contain I/Q and/or marker data and have been created.

Parameters:

<Filename> string

Complete file path and file name 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

Multi-Segment Commands

Required options

See Chapter 4.8.1, "Required Options", on page 180.

[: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 "Configuring the output order of the segments" on page 619

Usage: Query only

Manual operation: See "Current Segment/Current Segment Index" on page 198

[: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 "Configuring the output order of the segments" on page 619

Usage: Query only

Manual operation: See "Current Segment/Current Segment Index" on page 198

[: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 "Configuring the output order of the segments" on page 619

Manual operation: See "Segment" on page 198

[: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 "Configuring the output order of the segments" on page 619

Usage: Event

Manual operation: See "Execute Next Segment" on page 200

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce <Source>

Selects the next segment source.

Parameters:

<Source> INTernal | NSEGM1 | INTernal | NSEGM1

*RST: INTernal

Example: See Example "Configuring the output order of the segments" on page 619.

Manual operation: See "Next Segment Source" on page 200

[: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 200

[: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 618.

Usage: Query only

Manual operation: See "Multi Segment Table" on page 189

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect <Filename>

Selects the sequencing list (files with extension `*.wvs`)

Parameters:

<Filename> string

Example: see Example "Using the ARB sequencer" on page 621

Manual operation: See "New/Load Sequencing List" on page 195

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend <State>, <Segment>, <Count>, <Next>

Appends a new segment to the selected sequencing play list.

Setting parameters:

<State> ON | OFF

Activates/deactivates the appended segment

*RST: ON

<Segment> 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 "Using the ARB sequencer" on page 621

Usage: Setting only

Manual operation: See "Append" on page 197

[: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> Absolute file path, file name of the configuration file and file extension (*.inf_mswv)

Example: See Example "Creating a multi-segment waveform" on page 618

Usage: Setting only

Manual operation: See "Save List/Save List As..." on page 188

[: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

Absolute file path, file name of the configuration file and file extension (`*.inf_mswv`)

Example: See Example "Creating a multi-segment waveform" on page 618

Usage: Setting only

Manual operation: See "Save List/Save List As..." on page 188

[: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 621

Manual operation: See "Segment Marker" on page 192

[: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 621

Manual operation: See "Sequence Restart" on page 193

[: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 "Configuring the output order of the segments" on page 619.

Manual operation: See "Next Segment Mode" on page 199

Multi-Segment Sequencing Commands

Required options

See Chapter 4.8.1, "Required Options", on page 180.

[: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 the installed options Increment: 0.001 *RST: 1E8
Example:	See Example "Creating a multi-segment waveform" on page 618
Usage:	Setting only
Manual operation:	See "Blank Segment" on page 190

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?

Queries the available configuration files in the default directory. See also Chapter 4.8.2.3, "File Concept", on page 181.

Return values:

<Catalog>	string
Example:	see Example "Creating a multi-segment waveform" on page 618
Usage:	Query only
Manual operation:	See "Load List" on page 187

[: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: max SampleRate
Example:	See Example "Creating a multi-segment waveform" on page 618
Manual operation:	See "User Clock Rate" on page 192

[: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 618.
Manual operation:	See "Clock" on page 192

[: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 618.

Manual operation: See "Level" on page 191

[: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 618

Manual operation: See "Comment" on page 188

[: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 618.

Usage: Setting only

Manual operation: See "Append/Delete/Shift Seg. Up/Down" on page 190

[: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 618

Manual operation: See "Save List/Save List As..." on page 188

[: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 618

Usage: Setting only

Manual operation: See "Append/Delete/Shift Seg. Up/Down" on page 190

[: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 618

Manual operation: See "New List" on page 187

Multi-Carrier Commands

Required options

See Chapter 4.9.1, "Required Options", on page 210.

Suffixes

Suffix	Value range
CARRier<ch>	1 to 512

[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet

Sets all the multi-carrier parameters to their default values.

Example: `SOURce1:BB:ARBitrary:MCARrier:PRESet`

Usage: Event

Manual operation: See "Set to Default" on page 213

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog?

Queries the available settings files in the specified default directory. Only files with the file extension `*.arb_multcarr` are listed.

Return values:

<Catalog> string

Example: See Example "Generating a multi carrier signal" on page 622

Usage: Query only

Manual operation: See "Save/Recall Frame" on page 214

[: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 "Generating a multi carrier signal" on page 622.

Usage: Setting only

Manual operation: See "Save/Recall Frame" on page 214

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe <Filename>

Stores 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 "Generating a multi carrier signal" on page 622

Usage: Setting only

Manual operation: See "Save/Recall Frame" on page 214

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt <Count>

Sets the number of carriers in the ARB multi-carrier waveform.

Parameters:

<Count> integer

Range: 1 to 512
*RST: 1

Example: See Example "Generating a multi carrier signal" on page 622

Manual operation: See "Number of Carriers" on page 214

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE <Mode>

The command sets the carrier frequency mode.

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 214

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing <Spacing>

Sets the frequency spacing between adjacent carriers of the multi-carrier waveform (see Chapter 4.9.2.1, "Defining the Carrier Frequency", on page 211).

Parameters:

<Spacing> float

Range: 0.0 to depends on the installed options, e.g. 120E6
Increment: 0.01
*RST: 0
Default unit: Hz

Example: See Example "Generating a multi carrier signal" on page 622

Manual operation: See "Carrier Spacing" on page 214

[: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 218

[: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" on page 216

[: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 215

[: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 643.

Manual operation: See "Target Crest Factor" on page 215

[: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 250E6
Increment: 0.01
*RST: 75E6

Example: See `[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe]` on page 643.

Manual operation: See "Filter Cutoff Frequency" on page 215

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] <State>

Switches baseband clipping on and off.

Parameters:

<State> 0 | 1 | OFF | ON

*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 215

[: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 215

[: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 216

[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe <OFile>

Defines the output file name for the multi-carrier waveform (file extension `*.wv`).

This file name 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 "Generating a multi carrier signal" on page 622

Manual operation: See "Output File" on page 218

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad

Creates a multi-carrier waveform using the current entries of the carrier table and activates the ARB generator.

Use the command [:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe to define the multi-carrier waveform file name. The file extension is *.wv.

Example: See Example "Generating a multi carrier signal" on page 622

Usage: Event

Manual operation: See "Create/Create and Load" on page 218

[: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 218

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate

Creates a multi-carrier waveform using the current settings of the carrier table.

Use the command [:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe to define the multi-carrier waveform file name. The file extension is *.wv.

Example: See Example "Generating a multi carrier signal" on page 622

Usage: Event

Manual operation: See "Create/Create and Load" on page 218

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe <State>

Enables/diasbled the selected carrier.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Generating a multi carrier signal" on page 622

Manual operation: See "State" on page 220

[: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 the installed 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 [MHz]" on page 220

[: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" on page 220

[: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" on page 220

[: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" on page 220

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE <File>

Selects the file with I/Q data to be modulated onto the selected carrier.

Parameters:

<File> <file name>

Example: See Example "Generating a multi carrier signal" on page 622

Manual operation: See "File" on page 220

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?

Queries carrier conflicts. A conflict arises when the carriers overlap.

Return values:

<Conflict> 0 | 1 | OFF | ON

0
No conflict

*RST: 0

Example: `BB:ARB:MCAR:CARR:CONF?`

Usage: Query only

Manual operation: See "!!!" on page 221

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe <State>

Switches all the carriers in the selected carrier range on or off.

Parameters:

<State> 0 | 1 | OFF | ON

*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 222

[: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/Start" on page 222

[: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 222

[: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 222

[: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.

[: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 222

[: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 223

[: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 223

[: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 223

[: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 223

Trigger Commands

[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence <Sequence>

The command selects the trigger mode.

Parameters:

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGle
*RST: AUTO

Example: See Example "Managing waveform files" on page 616

Manual operation: See "Mode" on page 97

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce <Source>

Selects the trigger signal source and determines the way the triggering is executed. Provided are:

- Internal triggering by a command (`INTernal`)

Parameters:

<Source> INTernal|EXTernal
*RST: INTernal

Example: See Example "Managing waveform files" on page 616

Manual operation: See "Source" on page 98

[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe?

Queries the status of waveform output.

Return values:

<RMode> STOP | RUN

Example: see Example "Managing waveform files" on page 616

Usage: Query only

Manual operation: See "Running/Stopped" on page 98

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth <SLength>

Defines the length of the signal sequence that is output in the `SINGle` trigger mode.

Parameters:

<SLength> integer

Maximun value dependents 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 "Managing waveform files" on page 616

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit <SLUnit>

Defines 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 "Managing waveform files" on page 616

Manual operation: See "Signal Duration" on page 98

[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute

Stops (arms) waveform output.

Example: See Example "Managing waveform files" on page 616

Usage: Event

Manual operation: See "Arm" on page 98

[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute

Executes an internal trigger event.

Example: See Example "Managing waveform files" on page 616

Usage: Event

Manual operation: See "Execute Trigger" on page 98

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut <Output>

Enables signal output synchronous to the trigger event.

Parameters:

<Output> 0 | 1 | OFF | ON

*RST: 1

Example: See Example "Managing waveform files" on page 616

Manual operation: See "Sync. Output to External Trigger/Sync. Output to Trigger" on page 99

[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT <TrigDelUnit>

Sets the units the trigger delay is expressed in.

Parameters:

<TrigDelUnit> SAMPle | TIME

*RST: SAMPle

Example: See Example "Specifying delay and inhibit values in time units" on page 617

Manual operation: See "(External) Delay Unit" on page 99

[: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 "Specifying delay and inhibit values" on page 89.

Parameters:

<Delay> float

Range: 0 to depends on the sample rate
Increment: 0.01
*RST: 0
Default unit: sample

Example: see Example "Managing waveform files" on page 616

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 99

[: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 "Specifying delay and inhibit values" on page 89.

Parameters:

<ExtTimeDelay> float

Range: 0 to 2147483647 / (clock frequency)
Increment: 1E-9
*RST: 0
Default unit: s

Example: See Example "Specifying delay and inhibit values in time units" on page 617.

Manual operation: See "(Specified) External Delay/(Specified) Trigger Delay" on page 99

[: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 "Specifying delay and inhibit values in time units" on page 617

Usage: Query only

Manual operation: See "Actual Trigger Delay/Actual External Delay" on page 100

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:INHibit <Inhibit>

Specifies the number of samples, by which a restart is inhibited.

Maximum trigger delay and trigger inhibit values depend on the installed options. See "Specifying delay and inhibit values" on page 89.

Parameters:

<Inhibit> integer

Range: 0 to 21.47 * (clock frequency)
*RST: 0
Default unit: samples

Example: See Example "Managing waveform files" on page 616.

Manual operation: See "External / Trigger Inhibit" on page 99

Marker Commands

[:SOURce<hw>]:BB:ARBitrary: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 81.

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 "Managing waveform files" on page 616

Manual operation: See "Marker Mode" on page 144

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime <OnTime>
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime <OffTime>

Sets the number of samples in the ON and OFF periods.

Parameters:

<OffTime> integer

Range: 1 to 14913079
*RST: 1

Example: see Example "Managing waveform files" on page 616

Manual operation: See "Marker Mode" on page 144

[:SOURce<hw>]:BB:ARBitrary: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 "Managing waveform files" on page 616.

Manual operation: See "Marker Mode" on page 144

[: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 "Managing waveform files" on page 616

Manual operation: See "Marker Mode" on page 144

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?

Queries the pulse frequency of the pulsed marker signal. The pulse frequency is derived by dividing the symbol rate by the divider.

Return values:

<Frequency> float

Increment: 0.001

Example: see Example "Managing waveform files" on page 616

Usage: Query only

Manual operation: See "Marker Mode" on page 144

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay <Delay>

Defines the delay between the signal on the marker outputs and the start of the signals.

Parameters:

<Delay> integer

Range: 0 to depends on other values
Increment: 0.001
*RST: 0
Default unit: Symbol

Example: See Example "Managing waveform files" on page 616.

Manual operation: See "Marker x Delay" on page 101

Clock Commands

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce <Source>

Selects the clock source:

- `INTernal`: Internal clock reference

Parameters:

<Source>	INTernal	
	*RST:	INTernal

Example: See Example "Managing waveform files" on page 616.

Manual operation: See "Clock Source" on page 101

13.15.3.4 :SOURce:BB:General Subsystem

The `:SOURce:BB:GENeral` subsystem contains the commands for configuring basic frequency (FM), phase (PhiM), amplitude (AM) and pulse modulation (PULM) digital baseband signals.

Required options

See "Required options" on page 227.

Modulation states

You can modulate frequency and phase in parallel. But activating another baseband signal, e.g. for amplitude or pulse generation, deactivates the previous baseband modultaion signal:

```
:SOURce:BB:GENeral:FM:STATe 1
:SOURce:BB:GENeral:PM:STATe 1
:SOURce:BB:GENeral:FM:STATe? 1
:SOURce:BB:GENeral:AM:STATe? 0
```

Programming examples

Example: Activate basic FM

```
:SOURce:BB:GENeral:FM:FREQuency 2000
:SOURce:BB:GENeral:FM:DEViation 1250
:SOURce:BB:GENeral:FM:PERiod? 0.0005
:SOURce:BB:GENeral:FM:SHAPe? SINE
:SOURce:BB:GENeral:FM:STATe 1
```

Example: Activate basic PM

```
:SOURce:BB:GENeral:PM:FREQuency 100000
:SOURce:BB:GENeral:PM:DEViation 286.4789 // degrees
:SOURce:BB:GENeral:PM:PERiod? 0.00001
:SOURce:BB:GENeral:PM:SHAPe? SINE
:SOURce:BB:GENeral:PM:STATe 1
```

Example: Activate basic AM

```
:SOURce:BB:GENeral:AM:DEPTh 100
:SOURce:BB:GENeral:AM:FREQuency 20000
:SOURce:BB:GENeral:AM:PERiod? 0.0005
:SOURce:BB:GENeral:AM:SHAPe? SINE
:SOURce:BB:GENeral:AM:STATe 1
```

Example: Activate PULM

```
:SOURce:BB:GENeral:PULM:MODE DOUB
:SOURce:BB:GENeral:PULM:PERiod 0.00005
:SOURce:BB:GENeral:PULM:WIDTh 0.000001
:SOURce:BB:GENeral:PULM:DOUBle:DELay 0.000002
:SOURce:BB:GENeral:PULM:DOUBle:WIDTh 0.000006
:SOURce:BB:GENeral:PULM:TRANsition:TYPE SMO
:SOURce:BB:GENeral:PULM:POLarity INV
:SOURce:BB:GENeral:PULM:STATe 1
```

FM Commands

[:SOURce<hw>]:BB:GENeral:FM:DEViation <FmDeviation>

Sets the frequency modulation deviation in Hz.

Parameters:

<FmDeviation> float

Range: 0 to 4E6
Increment: 0.01
*RST: 1E3

Example: See Example "Activate basic FM" on page 657.

Manual operation: See "FM Deviation" on page 229

[:SOURce<hw>]:BB:GENeral:FM:FREQuency <FreqModFreq>

Sets the frequency of the modulation signal.

Parameters:

<FreqModFreq> float

Range: 0.1 to 100E3
Increment: 0.1
*RST: 1E3

Example: See Example "Activate basic FM" on page 657.

Manual operation: See "Modulation Frequency" on page 228

[:SOURce<hw>]:BB:GENeral:FM:PERiod <FmPer>

Queries the period of the modulation signal.

Parameters:

<FmPer>	float Range: 100E-9 to 100 Increment: 5E-9 *RST: 10E-6
Example:	See Example "Activate basic FM" on page 657.
Manual operation:	See "Modulation Period" on page 228

[:SOURce<hw>]:BB:GENeral:FM:SHAPe <FmShape>

Queries the shape of the modulation signal.

Parameters:

<FmShape>	SINE *RST: SINE
Example:	See Example "Activate basic FM" on page 657.
Manual operation:	See "Modulation Shape" on page 228

[:SOURce<hw>]:BB:GENeral:FM[:STATe] <FmModState>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:

<FmModState>	0 | 1 | OFF | ON *RST: 0
Example:	See Example "Activate basic FM" on page 657.
Manual operation:	See "State" on page 228

AM Commands

[:SOURce<hw>]:BB:GENeral:AM:DEPTh <AmDepth>

Sets the depth of the modulation signal in percent.

The depth is limited by the maximum peak envelope power (PEP).

Parameters:

<AmDepth> float

Range: 0 to 100
Increment: 0.1
*RST: 30

Example: See Example "Activate basic AM" on page 657.

Manual operation: See "AM Depth" on page 231

[:SOURce<hw>]:BB:GENeral:AM:FREQuency <AmFreq>

Sets the frequency of the modulation signal.

Parameters:

<AmFreq> float

Range: 0.1 to 100E3
Increment: 0.1
*RST: 1E3

Example: See Example "Activate basic AM" on page 657.

Manual operation: See "Modulation Frequency" on page 231

[:SOURce<hw>]:BB:GENeral:AM:PERiod <AmPer>

Queries the period of the modulation signal.

Parameters:

<AmPer> float

Range: 100E-9 to 100
Increment: 5E-9
*RST: 10E-6

Example: See Example "Activate basic AM" on page 657.

Manual operation: See "Modulation Period" on page 231

[:SOURce<hw>]:BB:GENeral:AM:SHAPe <AmShape>

Queries the shape of the modulation signal.

Parameters:

<AmShape> SINE

*RST: SINE

Example: See Example "Activate basic AM" on page 657.

Manual operation: See "Modulation Shape" on page 231

[:SOURce<hw>]:BB:GENeral:AM[:STATe] <AmModState>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:

<AmModState> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Activate basic AM" on page 657 .

Manual operation: See "State" on page 231

PhiM Commands

[:SOURce<hw>]:BB:GENeral:PM:DEViation <PmDeviation>

Sets the phase modulation deviation in radians or degrees.

Parameters:

<PmDeviation> float

Range: 0 to 6
Increment: 0.000001
*RST: 1
Default unit: rad

Example: See Example "Activate basic PM" on page 657.

Manual operation: See "PhiM Deviation" on page 230

[:SOURce<hw>]:BB:GENeral:PM:FREQuency <PhaseFreq>

Sets the frequency of the modulation signal.

Parameters:

<PhaseFreq> float

Range: 0.1 to 100E3
Increment: 0.1
*RST: 1E3

Example: See Example "Activate basic PM" on page 657.

Manual operation: See "Modulation Frequency" on page 229

[:SOURce<hw>]:BB:GENeral:PM:PERiod <PhasePer>

Queries the period of the modulation signal.

Parameters:

<PhasePer> float

Range: 100E-9 to 100
Increment: 5E-9
*RST: 10E-6

Manual operation: See "Modulation Period" on page 230

[:SOURce<hw>]:BB:GENeral:PM:SHAPe <PmShape>

Queries the shape of the modulation signal.

Parameters:

<PmShape> SINE

*RST: SINE

Example: See

Manual operation: See "Modulation Shape" on page 230

[:SOURce<hw>]:BB:GENeral:PM[:STATe] <PhimModState>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:

<PhimModState> 0 | 1 | OFF | ON

*RST: 0

Manual operation: See "State" on page 229

PULM Commands

[:SOURce<hw>]:BB:GENeral:PULM:DELay <PulmDelay>

Sets the pulse delay in microseconds.

Parameters:

<PulmDelay> float

Range: 50E-9 to 100
Increment: 5E-9
*RST: 3E-6

Example: See Example "Activate PULM" on page 658.

Manual operation: See "Pulse Delay" on page 233

[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:DELay <PulmDblDel>

Sets the double pulse delay in microseconds.

Parameters:

<PulmDblDel> float

Range: 50E-9 to 100
Increment: 5E-9
*RST: 3E-6

Example: See Example "Activate PULM" on page 658.

Manual operation: See "Double Pulse Delay" on page 233

[:SOURce<hw>]:BB:GENeral:PULM:DOUBle:WIDTh <PulmDblWidth>

Defines the double pulse width in microseconds.

Parameters:

<PulmDblWidth> float

Range: 50E-9 to 100
Increment: 5E-9
*RST: 3E-6

Example: See Example "Activate PULM" on page 658.

Manual operation: See "Double Pulse Width" on page 233

[:SOURce<hw>]:BB:GENeral:PULM:MODE <PulmMode>

Sets the pulse mode.

You can set for single or double pulse signals.

Parameters:

<PulmMode> SINGle | DOUBle

*RST: SINGle

Example: See Example "Activate PULM" on page 658.

Manual operation: See "Pulse Mode" on page 232

[:SOURce<hw>]:BB:GENeral:PULM:PERiod <PulsModPer>

Defines the pulse period in microseconds.

Parameters:

<PulsModPer> float

Range: 100E-9 to 100
Increment: 5E-9
*RST: 10E-6

Example: See Example "Activate PULM" on page 658.

Manual operation: See "Pulse Period" on page 232

[:SOURce<hw>]:BB:GENeral:PULM:TRANsition:TYPE <PulmTransType>

Sets the transition type of the pulse modulation signal.

Parameters:

<PulmTransType> SMOothed | FAST

*RST: FAST

Example: See Example "Activate PULM" on page 658.

Manual operation: See "Transition Type" on page 233

[:SOURce<hw>]:BB:GENeral:PULM:VIDeo:POLarity <PulsVideoPol>

Sets the video polarity.

Parameters:

<PulsVideoPol> NORMal | INVerted

*RST: NORMal

Example: See Example "Activate PULM" on page 658.

Manual operation: See "Video Polarity" on page 233

[:SOURce<hw>]:BB:GENeral:PULM:WIDTh <PulmWidth>

Sets the pulse width in microseconds.

Parameters:

<PulmWidth> float

Range: 50E-9 to 100
Increment: 5E-9
*RST: 2E-6

Example: See Example "Activate PULM" on page 658.

Manual operation: See "Pulse Width" on page 233

[:SOURce<hw>]:BB:GENeral:PULM[:STATe] <PulmState>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

Parameters:

<PulmState> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Activate PULM" on page 658.

Manual operation: See "State" on page 232

13.15.3.5 SOURce:AWGN Subsystem

The `SOURce:AWGN` subsystem contains the commands for setting the noise generator.

Required options

See Chapter 6.1.1, "Required Options", on page 268.

Programming Examples

Example: Generating a pure noise signal

The following example generates a pure noise signal with 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?
```

Example: Generating a CW interferer signal

The following example generates a CW interferer signal with 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: Generating 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", i.e. "Occupied Bandwidth = 1.080 MHz"
  – "RF Frequency = 1.950 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 bandwidht
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
```

General Commands

[:SOURce<hw>]:AWGN:STATe <State>

Activates or deactivates the AWGN generator.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Generating a pure noise signal" on page 665.

Manual operation: See "State" on page 273

[: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 "Generating an additive noise signal" on page 666

Manual operation: See "Mode" on page 274

[:SOURce<hw>]:AWGN:BWIDth <BWidth>

Sets the system bandwidth.

Parameters:

<BWidth> float

Range: 1000 to 80E6
Increment: 100
*RST: 3.84E6

Example: See Example "Generating an additive noise signal" on page 666.

Manual operation: See "System Bandwidth" on page 274

[:SOURce<hw>]:AWGN:BWIDth:COUPling[:STATe] <AwgnBwCoupState>

Activates bandwidth coupling.If activated, the digital broadcast baseband signal bandwidth couples to the AWGN system bandwidth.

Parameters:

<AwgnBwCoupState> 0 | 1 | OFF | ON

*RST: 0

Example:

```
:SOURce1:AWGN:BWIDth?
// Response in Hz: 3840000
// Activate a digital broadcast standard, e.g.
DVB-T.
:SOURce1:BB:DVBT:STATe 1
:SOURce1:AWGN:BWIDth:COUPling:STATe 1
:SOURce1:AWGN:BWIDth?
// Response in Hz: 76071143
```

Manual operation: See "Bandwidth Coupling" on page 274

[: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 269.

Parameters:

<Ratio> float

Range: 1 to Max
Increment: 0.1
*RST: 1

Example: see Example "Generating an additive noise signal" on page 666.

Manual operation: See "Minimum Noise/System Bandwidth Ratio" on page 274

[: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 "Generating an additive noise signal" on page 666.

Usage: Query only

Manual operation: See "Noise Bandwidth" on page 280

[:SOURce<hw>]:AWGN:DISP:MODE <Mode>

Sets the output the AWGN settings are related to.

Parameters:

<Mode> RF | BB

*RST: RF

Example: See Example "Generating an additive noise signal" on page 666.

Manual operation: See "Display Mode" on page 276

[:SOURce<hw>]:AWGN:POWer:MODE <Mode>

Selects the mode for setting the noise level.

Parameters:

<Mode> CN | SN | EN

*RST: SN

Example: see Example "Generating an additive noise signal" on page 666

Manual operation: See "Set Noise Power Via" on page 276

[: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 "Generating an additive noise signal" on page 666

Manual operation: See "Reference Mode" on page 276

[: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 the installed options
Increment: 0.001
*RST: 100000

Example: see Example "Generating an additive noise signal" on page 666

Manual operation: See "Bit Rate" on page 276

[:SOURce<hw>]:AWGN:CNRatio <CnRatio>

Sets the carrier/interferer ratio.

Parameters:

<CnRatio> float

Range: -50 to 45
Increment: 0.01
*RST: 0

Example: See Example "Generating an additive noise signal" on page 666

Manual operation: See "Carrier/Noise Ratio, Signal/Noise Ratio" on page 277

[:SOURce<hw>]:AWGN:ENRatio <EnRatio>

Sets the ratio of bit energy to noise power density.

Parameters:

<EnRatio> float

Range: -50 to depends on the installed options
Increment: 0.01
*RST: 15.84
Default unit: dB

Example: See Example "Generating an additive noise signal" on page 666

Manual operation: See "E_b/N_0" on page 277

[:SOURce<hw>]:AWGN:POWer:CARRier <Carrier>

Sets the carrier power.

Parameters:

<Carrier> float

Increment: 0.01
*RST: 0

Example: see Example "Generating an additive noise signal" on page 666

Manual operation: See "Carrier Power, Signal Power" on page 277

[: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 "Generating an additive noise signal" on page 666

Manual operation: See "Noise Power (System Bandwidth), Interferer Power" on page 278

[: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 "Generating an additive noise signal" on page 666

Usage: Query only

Manual operation: See "Noise Power (Total Bandwidth)" on page 279

[: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 "Generating an additive noise signal" on page 666

Usage: Query only

Manual operation: See "Carrier + Noise Power, Signal + Noise Power (System Bandwidth), Carrier + Interferer Power, Signal + Interferer Power " on page 279

[: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 "Generating an additive noise signal" on page 666

Usage: Query only

Manual operation: See "Carrier + Noise PEP, Signal + Noise PEP (Total Bandwidth), Carrier + Interferer PEP, Signal + Interferer PEP" on page 279

[: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 "Generating a CW interferer signal" on page 665

Manual operation: See "Target CW Frequency Offset" on page 275

[: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 "Generating a CW interferer signal" on page 665

Usage: Query only

Manual operation: See "Resulting CW Frequency Offset" on page 280

13.15.3.6 SOURce:BB:IMPairment Subsystem

This subsystem contains the commands for digital I/Q impairments.

Required options

See Chapter 6.2.1, "Required Options", on page 282.

[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude] <IqRatio>

Parameters:

<IqRatio> float

Range: -1 to 1
Increment: 1E-4
*RST: 0

Manual operation: See "Gain Imbalance" on page 285

[:SOURce<hw>]:BB:IMPairment:LEAKage:I <I>
[:SOURce<hw>]:BB:IMPairment: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:LEAKage:I 0.04`
`SOURce:BB:IMPairment:LEAKage:Q 4 PCT`
Sets the leakage for the I component and Q component to 4 percent.

Manual operation: See "I/Q Offset" on page 285

[:SOURce<hw>]:BB:IMPairment: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.

Parameters:
<Angle> float

Range: -10 to 10
Increment: 0.01
*RST: 0
Default unit: DEG

Example:
`SOURce:BB:IMPairment:QUADrature:ANGLe -5`
Sets the quadrature offset to -5 degrees.

Manual operation: See "Quadrature Offset" on page 285

[:SOURce<hw>]:BB:IMPairment:STATe <State>

Activates the impairment or correction values `LEAKage`, `QUADrature` and `IQRatio`.

Parameters:
<State> 0 | 1 | OFF | ON

*RST: 0

Example:
`SOURce1:BB:IMPairment:STATe ON`
Activates digital impairment.

Manual operation: See "State" on page 285

[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE <Mode>

Sets the optimization mode.

Parameters:
<Mode> FAST | | QHTable

FAST
Optimization by compensation for I/Q skew.

QHTable
Improved optimization by maintained speed.

*RST: FAST

Example: `SOURce1:IQ:SOURce? BASeband`
`SOURce1:BB:IMPairment:OPTimization:MODE FAST`

Manual operation: See "Optimization Mode" on page 288

13.15.3.7 SOURce:BB:GRAPhics Subsystem

This subsystem contains the commands used to setup the graphical display.

Required options

See Chapter 9.1.1, "Required Options", on page 368.

[:SOURce<hw>]:BB:GRAPhics:MODE <Mode>

Selects the graphics mode of the graphical signal display.

Parameters:

<Mode> IQ | VECTor | CCDF | PSPectrum | CONStellation | EYEI | EYEQ
*RST: IQ

Example: `BB:GRAP:MODE VECT`
Selects the vector diagram graphics mode.

Manual operation: See "Mode" on page 376

[: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 377

[: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 378

[:SOURce]:BB:GRAPhics:CLOSe

Closes all graphical signal displays.

Usage: Event

Manual operation: See "Remove" on page 378

[: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 378

[: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 Chapter 9.1.2.2, "Signal Acquisition Points", on page 373.

Parameters:

<Source> STRA | BBA | RFA | BBIA | IQO1 | DO1

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

DO1
Digital I/Q output signals; outputs of the "IQ Stream Mapper"

*RST: STRA

Options: DO1 requieres R&S SMCVB-K19

Manual operation: See "Source" on page 376

[: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 377

[:SOURce]:BB:GRAPhics:FFTFscale <State>

Defines the normalization of the power values in the power spectrum diagram.

Parameters:

<State> 0 | 1 | OFF | ON

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 377

[: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 377

13.15.3.8 SOURce:BB:PROGress Subsystem General Commands

In the R&S SMCV100B, 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 file process

The following is an example on how to use these commands to retrieve information about how many percent of the initiated process are completed.

[: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, like for example the calculation of a signal in accordance to a digital standard, or the calculation of a multi-carrier 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 file process" on page 678

Usage: Query only

13.15.4 SOURce:CORRection Subsystem

The `SOURce:CORRection` subsystem contains the commands for defining correction values for external test assemblies.

You can acquire the correction values any time, regardless of the modulation settings of the generator. The correction is performed by adding 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.

Correction values can be stored in files with the predefined file extension `*.uco`.

Refer to Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 for general information on file handling in the default and in a specific directory.

Programming example

The examples in this section assume that:

- The files are stored in the default directory.
- `*RST` does not affect data lists.

Example: Create a table with user-defined correction values for the RF level

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 new one
// ******************************************************************
*RST; *CLS
SOURce1:CORRection:CSET:CATalog?
// Response: shows the name of available user correction files (if applicable)
// Select a file
SOURce1:CORRection:CSET:SELect "/var/user/ucor1"
// Create a new file (if not existing)
SOURce1:CORRection:CSET:SELect "/var/user/ucor2"

// Enter the frequency/level value pairs in the table;
// existing data is overwritten
// Query the number of frequency/power entries in the selected list
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: Fill user correction data with 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: User correction data exchange

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
```


13.15.4.1 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 "Create a table with user-defined correction values for the RF level" on page 679 .

Manual operation: See "Edit List Mode Data" on page 336

[: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 "Create a table with user-defined correction values for the RF level" on page 679 .

Manual operation: See "Edit List Mode Data" on page 336

[: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 "Create a table with user-defined correction values for the RF level" on page 679 .

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 "Fill user correction data with sensor" on page 680.

Usage: Event

Manual operation: See " Fill User Correction Data with Sensor" on page 351

[: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 "Create a table with user-defined correction values for the RF level" on page 679 .

Manual operation: See "UCOR Data" on page 346

[: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 "Create a table with user-defined correction values for the RF level" on page 679 .

Usage: Query only

Manual operation: See "User Correction" on page 346

[:SOURce<hw>]:CORRection:ZERoing:STATe <State>

Activates the zeroing procedure before filling the user correction data acquired by a sensor.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 1

Example: See Example "Fill user correction data with sensor" on page 680.

Manual operation: See " Fill User Correction Data with Sensor" on page 351

[: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 "Fill user correction data with sensor" on page 680.

Usage: Event

[:SOURce<hw>]:CORRection[:STATe] <State>

Activates user correction with the currently selected table.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Create a table with user-defined correction values for the RF level" on page 679 .

Manual operation: See "State" on page 346

[: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 "Create a table with user-defined correction values for the RF level" on page 679 .

Usage: Query only

Manual operation: See "UCOR Data" on page 346

[: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 "Create a table with user-defined correction values for the RF level" on page 679 .

Usage: Setting only

Manual operation: See "UCOR Data" on page 346

13.15.4.2 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 "Create a table with user-defined correction values for the RF level" on page 679 .

Usage: Query only

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 334

[: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 "User correction data exchange" on page 680 .

Manual operation: See "ASCII File Settings" on page 334

[: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 "User correction data exchange" on page 680 .

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 334

[: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 "User correction data exchange" on page 680 .

Manual operation: See "ASCII File Settings" on page 334

[: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 "User correction data exchange" on page 680 .

Manual operation: See "ASCII File Settings" on page 334

[: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 "User correction data exchange" on page 680 .

Usage: Event

Manual operation: See "Import / Export" on page 335

[: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 "User correction data exchange" on page 680 .

Manual operation: See " Mode " on page 334

[: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 "User correction data exchange" on page 680 .

Manual operation: See "Select Source/Select ASCII Destination" on page 334

13.15.5 SOURce:FREQuency Subsystem

The `SOURce:FREQuency` subsystem contains the commands used to define the frequency settings for the RF sources and sweeps.

Example: Frequency configuration

```
SOURce1:FREQuency:MODE CW
SOURce1:FREQuency:CW 6000000000
SOURce1:FREQuency:OFFSet 2000000000
SOURce1:FREQuency:MULTiplier 1.5
SOURce1:FREQuency:CW?
// 11000000000

// SOURce1:FREQuency:STEP:MODE USER
// SOURce1:FREQuency:STEP:INCRement 1000000
// SOURce1:FREQuency:CW UP

SOURce1:PHASe 2
SOURce1:PHASe:REFerence
```

[: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 691 and `[:SOURce<hw>]:FREQuency:STOP` on page 691,
`[:SOURce<hw>]:FREQuency:CENTer` on page 690,
`[:SOURce<hw>]:FREQuency:SPAN` on page 690,
`[:SOURce<hw>]:FREQuency:MANual` on page 689

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 Chapter 13.15.9, "SOURce:LIST Subsystem", on page 698.

*RST: CW

Example: See Example "Frequency configuration" on page 686

Example: See Example "Setup an RF frequency or power sweep" on page 725

Manual operation: See "State (RF frequency sweep)" on page 321

[: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.

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)
*RST: 100 MHz

Example: See Example "Frequency configuration" on page 686

Example: See Example "Setup an RF frequency or power sweep" on page 725

Options: RFmax depends on the installed options, for example 3 GHz with R&S SMCVB-B103

Manual operation: See "Frequency" on page 294

[: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 398

[: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 "Setup an RF frequency or power sweep" on page 725

Manual operation: See " Current Frequency" on page 322

[: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 "RF frequency and level display with a downstream instrument" on page 292.

Parameters:

<Multiplier> float

Range: -10000 to 10000
Increment: 0.001
*RST: 1

Example: See Example "Frequency configuration" on page 686

Manual operation: See "Multiplier" on page 295

[: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 "RF frequency and level display with a downstream instrument" on page 292.

Note: The offset also affects RF frequency sweep.

Parameters:

<Offset> float

Increment: 0.01
*RST: 0

Example: See Example "Frequency configuration" on page 686

Manual operation: See "Offset" on page 295

[:SOURce<hw>]:FREQuency:CENTer <Center>

Sets the center frequency of the sweep.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Parameters:

<Center> float

Range: 300 kHz to RFmax
Increment: 0.01 Hz
*RST: 300E6
Default unit: Hz

Example: See Example "Setup an RF frequency or power sweep" on page 725

Manual operation: See " Center Frequency " on page 326

[:SOURce<hw>]:FREQuency:SPAN <Span>

Sets the sapn of the frequency sweep range.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Parameters:

<Span> float

Full freqeuncy range

Increment: 0.01
*RST: 400E6

Example: See Example "Setup an RF frequency or power sweep" on page 725

Manual operation: See "Span" on page 326

[:SOURce<hw>]:FREQuency:STARt <Start>

Sets the start frequency for the RF sweep.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Parameters:

<Start> float

Range: 300kHz to RFmax
Increment: 0.01Hz
*RST: 100 MHz

Example: See Example "Setup an RF frequency or power sweep" on page 725

Manual operation: See " Start Frequency/Stop Frequency " on page 326

[:SOURce<hw>]:FREQuency:STOP <Stop>

Sets the stop frequency range for the RF sweep.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Parameters:

<Stop> float

Range: 300kHz to RFmax
Increment: 0.01Hz
*RST: 500 MHz
Default unit: Hz

Example: See Example "Setup an RF frequency or power sweep" on page 725

Manual operation: See " Start Frequency/Stop Frequency " on page 326

[: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:

```
// increasing the RF frequency with a step size of 50 KHz
SOURce1:FREQuency:STEP 50E3
SOURce1:FREQuency:STEP:MODE USER
SOURce1:FREQuency:CW UP
```

Manual operation: See "Variation Active" on page 295

[: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 "Frequency configuration" on page 686

Manual operation: See "Variation Step" on page 295

13.15.6 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]:INPut:TRIGger:SLOPe <Slope>

Sets the polarity of the active slope of an applied instrument trigger.

Parameters:

<Slope> NEGative | POSitive

*RST: POSitive

Example: `INP:TRIG:SLOP NEG`
Activates the falling slope of the external trigger signal at the trigger input.

Manual operation: See "Trigger Slope" on page 325

13.15.7 SOURce:IQ Subsystem

The `SOURce:IQ` subsystem contains the commands for configuring the I/Q modulation.

Required options

See Chapter 7.1, "Required Options", on page 286.

[:SOURce<hw>]:IQ:STATe <State>

Enables/disables the I/Q modulation.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `IQ:STAT ON`

Activates I/Q modulation.

Manual operation: See "State" on page 287

[:SOURce<hw>]:IQ:SWAP[:STATe] <State>

Swaps the I and Q channel.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `IQ:SWAP ON`

swaps the I and Q channel.

Manual operation: See "I/Q Swap" on page 287

13.15.8 SOURce:IQ:OUTPut Subsystem

The `SOURce:IQ:OUTPut` subsystem contains the commands for configuring the analog and digital I/Q output signals.

For information about the required options, see:

- "Required options" on page 261

13.15.8.1 SOURce:IQ:OUTPut:DIGital Commands

This section describes the commands of the output of a digital I/Q signal.

Required options

See "Required options" on page 261.

Example: Enabling and configuring the Dig. IQ HS x digital outputs

Option: R&S SMCVB-K19

```
SCONfiguration:OUTPut:MAPPing:DIGital:STReam1:STATe 1
SOURce1:IQ:OUTPut:DIGital:INTerface HSD
SOURce1:IQ:OUTPut:DIGital:STATe 1
SOURce1:IQ:OUTPut:DIGital:CHANnel0:NAME "CH0"
SOURce1:IQ:OUTPut:DIGital:CHANnel0:SRATe?
// 100000000
SOURce1:IQ:OUTPut:DIGital:CHANnel0:STATe 1
SOURce1:IQ:OUTPut:DIGital:BBMM1:SRATe:SUM?
SOURce1:IQ:OUTPut:DIGital:BBMM1:SRATe:MAX?
```

[:SOURce<hw>]:IQ:OUTPut:DIGital:STATe <State>

Activates the digital I/Q signal output.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example:

```
SOURce:IQ:OUTPut:DIGital:STATe ON
// activates the output connector
```

Manual operation: See "State" on page 263

[:SOURce<hw>]:IQ:OUTPut:DIGital:INTerface <BboutInterfMode>

Queries the connector at that the signal is output.

Parameters:

<BboutInterfMode> DIGital | HSDin | HSDin

HSDin

"Dig. IQ HS x"

*RST: DIN

[:SOURce<hw>]:IQ:OUTPut:DIGital:SRATe <SRate>

Sets/queries the sample rate of the digital I/Q output signal.

Parameters:
<SRate> float

Range: 400 to max*
Increment: 0.001
*RST: 1E8
*) max value depends on the interface as follows:
If "Interface = Dig. I/Q", max = 250E6 and depends on connected receiving device
If "Interface = HS Dig. I/Q", max = 600E6

Manual operation: See "Value" on page 263

[:SOURce<hw>]:IQ:OUTPut:DIGital:CDEVice?

Queries information on the connected device.

Return values:
<CDevice> string

Example: `SOURce:IQ:OUTPut:DIGital:CDEVice?`

Usage: Query only

Manual operation: See "Connected Device" on page 263

[:SOURce]:IQ:OUTPut:DIGital:POWer:VIA <Via>

Selects the respective level entry field for the I/Q output.

Parameters:
<Via> PEP | LEVel

*RST: PEP

Example: `SOURce:IQ:OUTPut:DIGital:POWer:VIA PEP`

Manual operation: See "Signal Output" on page 265

[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:PEP <Pep>

Enters the peak level of the output signal relative to full scale of 0.5 V (in terms of dB full scale).

Parameters:
<Pep> float

Range: -80 to 0
Increment: 0.01
*RST: 0

Example:
```
SOURce:IQ:OUTPut:DIGital:POWer:VIA PEP
SOURce:IQ:OUTPut:DIGital:POWer:PEP -10
```

Manual operation: See "Signal Output" on page 265

[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:LEVel <Level>

Enters the RMS level of the output signal.

Parameters:

<Level> float

Range: -80 to 0
Increment: 0.01
*RST: 0

Example:
```
SOURce:IQ:OUTPut:DIGital:POWer:LEVel -10
```

Manual operation: See "Signal Output" on page 265

[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP:MODE <Mode>

Defines the type of step size to vary the digital output power step-by-step.

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>]:IQ:OUTPut:DIGital:POWer:STEP[:INCRement].

*RST: DECimal

Example:
```
SOURce:IQ:OUTPut:DIGital:POWer:STEP:MODE USER
SOURce:IQ:OUTPut:DIGital:POWer:STEP 5 dB
// activates the step width for level variation in 5 dB steps
```

[:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP[:INCRement] <Increment>

Sets the step width. Use this value to vary the digital I/Q output level step-by-step.

Parameters:

<Increment> float

Range: 0 to 100
Increment: 0.01
*RST: 1

Example: See [:SOURce<hw>]:IQ:OUTPut:DIGital:POWer:STEP:MODE on page 696.

[:SOURce<hw>]:IQ:OUTPut:DIGital:PON <Pon>

Sets the power-on state of the selected digital I/Q output.

Parameters:

<Pon> OFF | UNCHanged

*RST: OFF

Example:

```
SOURce:IQ:OUTPut:DIGital:PON OFF
// deactivates the output connector
// when the instrument is switched on
```

Manual operation: See "Power-On State" on page 265

[:SOURce]:IQ:OUTPut:DIGital:GDELay:CSTate <CompState>

Enables/disables group delay compensation.

Parameters:

<CompState> 0 | 1 | OFF | ON

*RST: 0

Example:

```
SOURce:IQ:OUTPut:DIGital:GDELay:CSTate 1
```

[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:NAME <DigIqHsCHName>

Sets the channel name.

Parameters:

<DigIqHsCHName> string

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 693.

Options: R&S SMCVB-K19

Manual operation: See "Name" on page 264

[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:SRATe <DigIqHsSratChan>

Sets the sample rate per channel.

Parameters:

<DigIqHsSratChan> float

Range: 400 to 600E6

Increment: 0.001

*RST: 100E6

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 693.

Options: R&S SMCVB-K19

Manual operation: See "Sample Rate" on page 264

[:SOURce]:IQ:OUTPut:DIGital:CHANnel<st0>:STATe <DigIqHsOutChSta>

Activates the channel.

Parameters:
<DigIqHsOutChSta> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 693.

Options: R&S SMCVB-K19

Manual operation: See "Active" on page 264

[:SOURce]:IQ:OUTPut:DIGital:SRATe:COMMon:STATe <DigIqHsComState>

If enabled, the same sample rate value is applied to all channels.

Parameters:
<DigIqHsComState> 0 | 1 | OFF | ON

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 693.

Options: R&S SMCVB-K19

[:SOURce]:IQ:OUTPut:DIGital:SRATe:SUM?
[:SOURce]:IQ:OUTPut:DIGital:SRATe:MAX?

Queries the maximum supported sample rate.

Return values:
<DigIqhsInSRMax> integer

Range: 400 to 600E6
*RST: 600E6

Example: See Example "Enabling and configuring the Dig. IQ HS x digital outputs" on page 693.

Usage: Query only

Options: R&S SMCVB-K19

Manual operation: See "Aggregated Link Sample Rate" on page 264

13.15.9 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 Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521 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
SOUR1:LIST:CAT?
// Response:- shows the name of available list files (if applicable)
SOUR1: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
SOUR1:LIST:FREQ 58 MHz, 61 MHz, 73 MHz, 86 MHz, 91 MHz, 92 MHz, 98 MHz
SOUR1:LIST:POW 13 dBm, 12 dBm, 5 dBm, 3 dBm, 0 dBm, 4 dBm, 6 dBm
SOUR1:LIST:DWEL:LIST 10000, 100000, 200000, 19000, 10000, 150000, 220000
SOUR1:LIST:FREQ:POIN?
// 7
SOUR1:LIST:POW:POINT?
// 7
SOUR1:LIST:DWEL:LIST:POIN?
// 7
SOUR1:LIST:FREE?
// 2147483647 (bytes of free memory)

// Use dwell times from list
// Configure the list mode parameters
// Enable RF output
SOUR1:LIST:MODE AUTO
SOUR1:LIST:TRIG:SOUR AUTO
SOUR1:LIST:DWEL:MODE "LIST"

OUTP1: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
```

```
SOUR1:LIST:IND:START 2
SOUR1:LIST:IND:STOP 4
SOUR1:LIST:MODE AUTO
SOUR1:LIST:TRIG:SOUR AUTO
SOUR1:LIST:DWEL:LIST 500 ms
OUTP1: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
SOUR1:FREQ:MODE LIST
SOUR1:LIST:TRIG:EXEC
SOUR1:LIST:RUNN?
SOUR1:LIST:IND?
// 3
// value changes when the value is queried again
SOUR1:LIST:RES

// For list mode STEP use the following commands
*RST; *CLS
// Change list mode to STEP
SOUR1:LIST:MODE STEP
// Activate RF Output1
OUTP1:STAT 1
// Activate the list mode
SOUR1:FREQ:MODE LIST
// For each step: select frequency/powerlevel pair as index from the list
SOUR1:LIST:IND 2
SOUR1:LIST:IND 3
SOUR1:LIST:IND 4

// Use the selected list for path B (with List Mode B default settings)
SOUR2:LIST:SEL "/var/user/list1.lsw"
OUTP2:STAT ON
SOUR2:FREQ:MODE LIST
SOUR2:LIST:IND?
// 2
// value canges when the value is queried again

// Deactivate the list mode
SOUR1: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
SOUR1:LIST:DEXC:AFIL:EXT CSV
SOUR1:LIST:DEXC:AFIL:SEP:DEC DOT
SOUR1:LIST:DEXC:AFIL:SEP:COL COMM

// Select source and destination path/directory
// Query available listfiles in default directory "/var/user"
SOUR1:LIST:CAT?
// list1
SOUR1:LIST:DEXC:AFIL:SEL "/var/user/list1ASCII"
SOUR1:LIST:DEXC:SEL "/var/user/list1"

// Export the list file data into the ASCII file
SOUR1:LIST:DEXC:EXEC

// Query the available ASCII files with extension .csv
SOUR1:LIST:DEXC:AFIL:CAT?
// Response: "list1ASCII"

// Deactivate the list mode
SOUR1:FREQ:MODE CW
```


13.15.9.1 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 <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 699.

Manual operation: See "Global Dwell Time" on page 331

[: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 699.

Manual operation: See "Dwell Time Mode" on page 330

[: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 540 for more details.

Example: See Example "Create an RF list and activate the list mode" on page 699.

Manual operation: See "Edit List Mode Data" on page 336

[:SOURce<hw>]:LIST:DWELl: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 699.

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 the installed options)

Example: See Example "Create an RF list and activate the list mode" on page 699.

Manual operation: See "Edit List Mode Data" on page 336

[: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 699.

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 699.

Manual operation: See " Current Index " on page 330

[: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 699.

Manual operation: See " List Range from/to " on page 333

[: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 699.

Manual operation: See "Run Mode" on page 331

[: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 319.

Example: See Example "Create an RF list and activate the list mode" on page 699.

Usage: Event

Manual operation: See " Learn List Mode Data " on page 331

[: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 699.

Manual operation: See "Mode" on page 330

[: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 the installed options
Default unit: dBm

Example: See Example "Create an RF list and activate the list mode" on page 699.

Manual operation: See "Edit List Mode Data" on page 336

[: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 699.

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 699.

Usage: Event

Manual operation: See " Execute Single" on page 332

[: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 699.

Manual operation: See "Mode" on page 330

[:SOURce<hw>]:LIST:RUNNing?

Queries the current state of the list mode.

Return values:

<State> 0 | 1 | OFF | ON

1
Signal generation based on the list mode is active.

Example: See Example "Create an RF list and activate the list mode" on page 699.

Usage: Query only

13.15.9.2 List Mode File Operation

The following section covers basic commands to file handling in list mode.

[: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 699.

Usage: Query only

Manual operation: See " List Mode Data " on page 332

[: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 708.

Usage: Setting only

Manual operation: See " List Mode Data " on page 332

[: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 332

[: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 699.

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 699.

Usage: Event

Manual operation: See " Reset " on page 332

[: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 699.

Manual operation: See " List Mode Data " on page 332

13.15.9.3 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?

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 700.

Usage: Query only

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 334

[: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 700.

Usage: Event

Manual operation: See "Import / Export" on page 335

[: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 700.

Manual operation: See "ASCII File Settings" on page 334

[: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 700.

Manual operation: See "Select (ASCII) Source/Select (ASCII) Destination" on page 334

[: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 700.

Manual operation: See "ASCII File Settings" on page 334

[: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 700.

Manual operation: See "ASCII File Settings" on page 334

[: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 700.

Manual operation: See " Mode " on page 334

[: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 700.

Manual operation: See "Select Source/Select ASCII Destination" on page 334

13.15.10 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 <Phase>

Sets the phase variation relative to the current phase.

Parameters:

<Phase> float

Range: -36000 to 36000
Increment: 0.001
*RST: 0
Default unit: DEG

Example: See Example "Programming Example" on page 712.

Manual operation: See "Delta Phase" on page 299

[:SOURce<hw>]:PHASe:REFerence

Example: See Example "Programming Example" on page 712.

Usage: Event

Manual operation: See "Reset Delta Phase Display" on page 299

13.15.11 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 on of the following:

- Enter the unit after the numerical value
  Example: `:POW 0.5V`
- Set the unit with the command `:UNIT:POWer`.

[:SOURce<hw>]:POWer:ALC:MODE?

Queries the currently set ALC mode.

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

[: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 298

[: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

UNCHanged
Retains the current setting and keeps the output impedance constant during RF off.

*RST: n.a. (factory preset: FATTenuation)

Example: `SOURce1:POWer:ATTenuation:RFOFf:MODE FATTenuation`
uses maximum attenuation when the RF output is turned off.

Manual operation: See " RF OFF Mode " on page 342

[: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> 0 | 1 | OFF | ON
*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 419

[:SOURce<hw>]:POWer:LBEHaviour <Behaviour>

Set the RF level behaviour.

Parameters:
<Behaviour> AUTO | UNINterrupted

UNINterrupted
Do not use the uninterrupted level settings in combination with the high-quality optimization mode (see `[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE` on page 674)
*RST: AUTO

Example: `SOURce1:POWer:LBEHaviour AUTO`

Manual operation: See " Setting Characteristics " on page 298

[: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 the installed options
Increment: 0.01
*RST: n.a. (factory preset: 30)

Example: `SOURce1:POWer:LIMit:AMPLitude 10`

Manual operation: See " Limit " on page 297

[: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.

[: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 "Setup an RF frequency or power sweep" on page 725

Manual operation: See " Current Level" on page 322

[: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 "Setup an RF frequency or power sweep" on page 725

Manual operation: See "State (RF level sweep)" on page 322

[: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 "RF frequency and level display with a downstream instrument" on page 292.

Parameters:

<Power> float

Level at the RF output, without level offset

Range: See data sheet
Increment: 0.01
Default unit: dBm

Example: `SOURce1:POWer:POWer 15`
Sets the level at RF output

Manual operation: See "Amplitude" on page 297

[: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 "Setup an RF frequency or power sweep" on page 725

Manual operation: See " Start Level / Stop Level " on page 328

[: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:

```
SOURce1:POWer:STEP:INCRement 2
SOURce1:POWer:STEP:MODE USER
SOURce1:POWer:LEVel:IMMediate:AMPLitude UP
```

Increasing the RF level with a step size of 2 dB

Manual operation: See "Variation Active" on page 295

[: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`.

Parameters:

<Increment> float

Range: 0 to 200
Increment: 0.01
*RST: 1
Default unit: dB

Example: See `[:SOURce<hw>]:POWer:STEP:MODE` on page 718.

Manual operation: See "Variation Step" on page 295

[: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 "RF frequency and level display with a downstream instrument" on page 292.

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 297

[: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 398

[: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`
- `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 718.

Manual operation: See "Amplitude" on page 297

[: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 298

13.15.12 SOURce:ROSCillator Subsystem

The `SOURce:ROSCillator` subsystem contains the commands for setting the external and internal reference frequency.

The commands of this subsystem are not affected by an instrument reset (`*RST` on page 516).

Example: Configuring the reference oscillator

```
// 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

// to resume calibrated state
SOURce:ROSCillator:INTernal:ADJust:VALue 0
SOURce:ROSCillator:INTernal:ADJust:STATe 0
// or
// SYSTem:FPRest
```

[:SOURce]:ROSCillator:PRESet

Resets the reference oscillator settings.

Example: See Example "Configuring the reference oscillator" on page 721.

Usage: Event

Manual operation: See "Set to Default" on page 301

[: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 721.

Manual operation: See "Source" on page 301

[: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> 0 | 1 | OFF | ON

*RST: n.a. (factory preset: 0)

Example: See Example "Configuring the reference oscillator" on page 721.

Manual operation: See "Deactivate RF Output (if external reference is missing)" on page 301

[:SOURce]:ROSCillator:EXTernal:FREQuency <Frequency>

Queries the frequency of the external reference.

Parameters:

<Frequency> 10MHZ

*RST: n.a. (factory preset: 10MHZ)

Example: See Example "Configuring the reference oscillator" on page 721.

Manual operation: See "External Reference Frequency" on page 302

[: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 synchronizsation bandwidth varies.

For more information, see data sheet.

Parameters:

<SBandwidth> WIDE | NARRow

NARRow
The synchronization bandwidth is a few Hz.

WIDE
Uses the widest possible synchronization bandwidth.

*RST: n.a. (factory preset)

Example: See Example "Configuring the reference oscillator" on page 721.

Manual operation: See "Synchronization Bandwidth" on page 302

[: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, see data sheet.

Return values:
<MinLockRange> string

Example: `SOUR:ROSC:EXT:MLR?`

Usage: Query only

Manual operation: See "Minimum Locking Range" on page 302

[: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 302

[: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 option 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 721.

Manual operation: See "Reference Output" on page 303

[: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 724

Manual operation: See "Adjustment Value" on page 304

[: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> 0 | 1 | OFF | ON

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)

Example: See Example "Configuring the reference oscillator" on page 721.

Manual operation: See "Adjustment Active" on page 304

13.15.13 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))
  - RF combined sweep: `SOURce:FREQuency:MODE SWEep` (`SOURce:FREQuency:MODE CW` (off)
- All sweeps can be set independently of each other.

See Chapter 8.9.1, "Signal Generation and Triggering in the Sweep and List Modes", on page 306.

Example: Setup 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
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

// 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
// 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
// Input 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
```

[:SOURce<hw>]:SWEep:POWer:DWELl <Dwell>

Sets the dwell time for a level sweep step.

Parameters:

<Dwell> float

Range: 10E-3 to 100
Increment: 100E-6
*RST: 10E-3
Default unit: s

Example: See Example "Setup an RF frequency or power sweep" on page 725.

Manual operation: See " Dwell Time " on page 324

[: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 "Setup an RF frequency or power sweep" on page 725.

Manual operation: See "Mode" on page 322

[:SOURce<hw>]:SWEep:POWer:POINts <Points>

Sets the number of steps within the RF level sweep range.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Parameters:

<Points>	integer	
	Range:	2 to Max

Example: See Example "Setup an RF frequency or power sweep" on page 725.

[: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.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Parameters:

<Logarithmic> float

The unit `dB` is mandatory.

Range:	0.01 to 139 dB
Increment:	0.01
*RST:	1
Default unit:	dB

Example: See Example "Setup an RF frequency or power sweep" on page 725.

Manual operation: See " Step " on page 328

[:SOURce<hw>]:SWEep[:FREQuency]:DWELl <Dwell>

Sets the dwell time for a frequency sweep step.

Parameters:

<Dwell> float

Range:	1E-3 to 100
Increment:	100E-6
*RST:	10E-3
Default unit:	s

Example: See Example "Setup an RF frequency or power sweep" on page 725.

Manual operation: See " Dwell Time " on page 324

[: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 "Setup an RF frequency or power sweep" on page 725.

Manual operation: See "Mode" on page 322

[:SOURce<hw>]:SWEep[:FREQuency]:POINts <Points>

Sets the number of steps within the RF frequency sweep range.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Two separate `POINts` values are used for linear or logarithmic sweep spacing (`[:SOURce<hw>]:SWEep[:FREQuency]:SPACing LIN | LOG`). The command always affects the currently set sweep spacing.

Parameters:

<Points> integer

Range: 2 to Max

Example: See Example "Setup an RF frequency or power sweep" on page 725.

[: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 "Setup an RF frequency or power sweep" on page 725.

Manual operation: See " Spacing" on page 324

[: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 "Setup an RF frequency or power sweep" on page 725.

Manual operation: See " Shape" on page 323

[: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 "Setup an RF frequency or power sweep" on page 725.

Usage: Event

Manual operation: See " Execute Single Sweep " on page 325

[: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> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Setup an RF frequency or power sweep" on page 725.

Manual operation: See "Retrace" on page 323

[:SOURce<hw>]:SWEep:POWer:RUNNing?
[:SOURce<hw>]:SWEep[:FREQuency]:RUNNing?

Queries the current sweep state.

Return values:

<State> 0 | 1 | OFF | ON

Example: See Example "Setup an RF frequency or power sweep" on page 725.

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.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Parameters:

<Logarithmic> float

The unit is mandatory.

Range: 0.01 to 100
Increment: 1E-3
*RST: 1
Default unit: PCT

Example: See Example "Setup an RF frequency or power sweep" on page 725.

Manual operation: See " Step Linear/Step Logarithmic " on page 327

[:SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear] <Linear>

Sets the step width for linear sweeps.

See Chapter 8.9.2.1, "Correlating Parameters in Sweep Mode", on page 314.

Omit the optional keywords so that the command is SCPI-compliant.

Parameters:

<Linear> float

Range: 0.001 Hz to (STOP - STARt)
Increment: 0.01

Example: See Example "Setup an RF frequency or power sweep" on page 725.

Manual operation: See " Step Linear/Step Logarithmic " on page 327

[:SOURce<hw>]:SWEep:RESet[:ALL]

Resets all active sweeps to the starting point.

Usage: Event

Manual operation: See " Reset Sweep " on page 325

13.16 SYSTem Subsystem

The `SYSTem` subsystem contains a series of commands for general functions which do not directly affect signal generation.

Example: Retrieving information on network-related settings

```
SYSTem:COMMunicate:NETWork:STATus?
// 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?
// "SMCV100B-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: Finding out the used VISA ressource strings

```
SYSTem:COMMunicate:NETWork:RESource?
// "TCPIP::10.113.0.104::inst0::INSTR"


SYSTem:COMMunicate:HISLip:RESource?
```

```
// "TCPIP::10.113.0.104::hislip0::INSTR"

SYSTem:COMMunicate:SOCKet:RESource?
// "TCPIP::10.113.0.104::5025::SOCKET"
SYSTem:COMMunicate:USB:RESource?
// "USB::0x0AAD::0x01df::100001::INSTR"
```

Example: Querying the error queue

```
SYSTem:ERRor:STATic?
// -221,"Settings conflict", 153,"Input voltage out of range", ...
// returns all static errors that are collected in the error queue

SYSTem:ERRor:HISTory:ClEar
// deletes the history entries
```

: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: `SYST:ERR: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 766

: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: `SYST:ERR: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: `SYST:ERR:CODE`
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: `SYST:ERR:COUN`
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: `SYST:ERR?`
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 Errors/Error History" on page 765

:SYSTem:ERRor:GNEXt?

Similar to `:SYSTem:ERRor[:NEXT]?`, but queries the next entry from the global persistent 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: `SYST:ERR:GNEX?`
Returns the next error message from the global error queue.

Usage: Query only

:SYSTem:ERRor:HISTory:CLEar

Clears the error history.

Example: See Example "Querying the error queue" on page 733

Usage: Event

Manual operation: See "Clear History" on page 766

: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 "Querying the error queue" on page 733

Usage: Query only

Manual operation: See "Static Errors/Error History" on page 765

:SYSTem:DLOCk <DispLockStat>

Disables the manual operation via the display, including the front panel keyboard of the instrument and the Local key.

Parameters:

<DispLockStat> 0 | 1 | OFF | ON

*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 445

:SYSTem:KLOCk <State>

Disables the front panel keyboard of the instrument including the Local key.

Parameters:

<State> 0 | 1 | OFF | ON

*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 445

: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 <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)

Example: `:SYST:ULOC DIS`
Activates the user interface lock, including display and controls.

Manual operation: See "User Interface" on page 445

: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 instrument settings to a file with defined filename.

Setting parameters:

<Pathname> string

Example: `SYSTem:SAV "/var/user/Instrument_settings.savrcltxt"`

Usage: Setting only

:SYSTem:RCL <Pathname>

Loads a file with previously saved instrument settings.

Setting parameters:

<Pathname> string

Example: `SYSTem:RCL "/var/user/Instrument_settings.savrcltxt"`

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 440

Parameters:

<State> 0 | 1 | OFF | ON

*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 441

: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 444

: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 "Finding out the used VISA ressource strings" on page 732.

Usage: Query only

: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 "Retrieving information on network-related settings" on page 732.

Manual operation: See "IP Address" on page 469

: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 "Retrieving information on network-related settings" on page 732.

Example:
```
SYSTem:COMMunicate:NETWork:IPADdress:MODE
STATic
SYSTem:COMMunicate:NETWork:IPADdress
"10.113.0.105"
```

Manual operation: See "Address Mode" on page 468

: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 "Retrieving information on network-related settings" on page 732.

Manual operation: See "MAC Address" on page 470

:SYSTem:COMMunicate:NETWork:RESource?

Queries the visa resource string for Ethernet instruments.

Return values:
<Resource> string

Example: See Example "Finding out the used VISA ressource strings" on page 732.

Usage: Query only

:SYSTem:COMMunicate:NETWork:RESTart

Restarts the network.

Example:
```
SYSTem:COMMunicate:NETWork:RESTart
// Terminates the network connection and sets it up again
```

Usage: Event

Manual operation: See "Restart Network" on page 468

:SYSTem:COMMunicate:NETWork:STATus?

Queries the network configuration state.

Return values:
<State> 0 | 1 | OFF | ON

Example: See Example "Retrieving information on network-related settings" on page 732.

Usage: Query only

Manual operation: See "Network Status" on page 468

:SYSTem:COMMunicate:NETWork[:COMMon]:DOMain <Domain>

Determines the primary suffix of the network domain.

Parameters:
<Domain> string

Example: See Example "Retrieving information on network-related settings" on page 732.

Manual operation: See "DNS Suffix" on page 469

:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname <Hostname>

Sets an individual hostname for the vector signal generator.

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 "Retrieving information on network-related settings" on page 732.

Manual operation: See "Hostname" on page 468

:SYSTem:COMMunicate:NETWork[:COMMon]:WORKgroup <Workgroup>

Sets an individual workgroup name for the instrument.

Parameters:
<Workgroup> string

Example: See Example "Retrieving information on network-related settings" on page 732.

Manual operation: See "Workgroup" on page 468

:SYSTem:COMMunicate:NETWork[:IPADdress]:DNS <DNS>

Determines or queries the network DNS server to resolve the name.

Parameters:
<DNS> string

Example:	See Example "Retrieving information on network-related settings" on page 732.
Manual operation:	See "DNS Server" on page 469

: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 "Retrieving information on network-related settings" on page 732.
Manual operation:	See "Default Gateway" on page 469

:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK <Mask>

Sets the subnet mask.

Parameters:

<Mask>	string
Example:	See Example "Retrieving information on network-related settings" on page 732.
Manual operation:	See "Subnet Mask" on page 469

: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 "Finding out the used VISA ressource strings" on page 732.
Usage:	Query only

:SYSTem:COMMunicate:USB:RESource?

Queries the visa resource string for remote control via the USB interface.

Return values:

<Resource>	string
Example:	See Example "Finding out the used VISA ressource strings" on page 732.
Usage:	Query only

: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 SMCV100B 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 471

: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 471

: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 471

: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 472

: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 471

: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: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 444

:SYSTem:SECurity:SUPolicy <SecPassWord>, <UpdatePolicy>

Configures the automatic signature verification for firmware installation.

Parameters:

<UpdatePolicy> STRict | CONFirm | IGNore
*RST: n.a. (factory preset: CONFirm)

Setting parameters:

<SecPassWord> string

Manual operation: See "Secure Update Policy" on page 443

: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 quieried with the command `:SYSTem:SPECification:IDENtification:CATalog?` on page 748

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: Retrieving instruments specification
Note: The following values are merely an example.
Query the data sheet versions stored in 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 data sheet version with that the instrument was delivered:
`:SYSTem:SPECification:VERSion:FACTory?`
`"04.00"`
Select a data sheet version:
`:SYSTem:SPECification:VERSion?`
`"04.00"`
`:SYSTem:SPECification:VERSion "04.01"`
Selects one particular data sheet version.
Queries regarding data sheet parameters (IDs) and their values
Rrefer to this particular data sheet
Query the IDs of all parameters listed in the **selected** data sheet version:
`:SYSTem:SPECification:IDENtification:CATalog?`
`"ID_RF_FREQ_SETTING_TIME_ALC_ON_MS,`
`ID_RF_FREQ_SETTING_TIME_MS,..."`
Query the data sheet information on a specific parameter, defined by its ID
`:SYSTem:SPECification?`
`"ID_RF_FREQ_SETTING_TIME_ALC_ON_MS"`
Rreturned is the specified and, if available, the typical value of the parameter

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 749.

Parameters:
<Version> string

Example: See `:SYSTem:SPECification?` on page 747.

: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 `:SYSTem:SPECification?` on page 747.

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: **Note:** The following values are merely an example. Your instrument may not support the same parameters.

```
SYST:SPEC:PAR? "ID_RF_FREQ_SETTING_TIME_MS",0.1
SYST:SPEC:PAR? "ID_RF_LEVEL_MAX_GENERAL_DBM",
0.1
```

Usage: Query only

:SYSTem:SPECification:VERSion:CATalog?

Queries all data sheet versions stored in the instrument.

Return values:

<VersCatalog> string

Example: See `:SYSTem:SPECification?` on page 747.

Usage: Query only

:SYSTem:SPECification:VERSion:FACTory?

Queries the data sheet version of the factory setting.

Return values:

<Version> string

Example: See `:SYSTem:SPECification?` on page 747.

Usage: Query only

Manual operation: See "Versions" on page 770

: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> 0 | 1 | OFF | ON
*RST: 0

Example: `SYST:STAR:COMP?`
Response: `1`
the startup of the instrument is completed.

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:

```
:SYSTem:DATE?
// 2016,05,01
```

Manual operation: See "Date" on page 776

: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 777

:SYSTem:NTP:STATe <UseNtpState>

Activates clock synchronization via NTP.

Parameters:

<UseNtpState> 0 | 1 | OFF | ON

*RST: n.a. (factory preset: 0)

Example: `SYSTem:NTP:STATe 1`

Manual operation: See "Use Time from NTP Server" on page 777

: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:

```
SYSTem:TIME?
// 10,27,14
```

Manual operation: See "Time" on page 776

:SYSTem:TIME:ZONE <TimeZone>

Sets the timezone. You can query the list of the available timezones with `:SYSTem:TIME:ZONE:CATalog?`.

Parameters:

<TimeZone> string

Manual operation: See "Timezone" on page 776

:SYSTem:TIME:ZONE:CATalog?

Querys the list of available timezones.

Return values:
<Catalog>

Usage: Query only

Manual operation: See "Timezone" on page 776

: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: `SYST:VERS`
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 SMCV100B stores user files on.

Return values:
<PathUser> string

Example: `SYSTem:MMEMory:PATH:USER?`
Response: "'/var/user/"

Usage: Query only

:SYSTem:DFPR?

Queries the device footprint of the instrument. The retrieved information is in machine-readable form suitable for automatic further processing.

Return values:
<DeviceFootprint> string
Information on the instrument type, device identification and details on the installed FW version, hardware and software options.

Example: `:SYSTem:DFPR?`

Usage: Query only

: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 Chapter 11.3.4, "How to Assign Actions to the [★ (User)] Key", on page 435.

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

13.17 STATus Subsystem

This system contains the commands for the status reporting system. See also Chapter A.1.5, "Status Reporting System", on page 799 for detailed information.

`*RST` on page 516 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 SMCV100B cause the status registers to be changed.
  Setting values: A decimal value in the range 0 to 32767 (=2^{15}-1)

: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] <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:

<Event> 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] <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:

<Event> 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[:NEXT]?` on page 736.

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

13.18 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.

:TEST<hw>:ALL:STARt

Usage: Event

Manual operation: See "Run Module Test" on page 780

Starts the selftest. Use the command `:TEST<hw>:ALL:RESult?` to query the result.

:TEST<hw>:ALL:RESult?

Queries the result of the performed selftest. Start the selftest with `:TEST<hw>:ALL:STARt`.

Return values:

<Result> 0 | 1 | RUNning | STOPped

*RST: STOPped

Usage: Query only

Manual operation: See "Result" on page 780

13.19 TRIGger Subsystem

The `TRIGger` system contains the commands for selecting the trigger source for the RF 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 SMCV100B 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 13-2: 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.
EAUTo	-	"Ext Start/Stop" mode.

:TRIGger<hw>:FSWeep:SOURce <Source>
:TRIGger<hw>:PSWeep:SOURce <Source>
:TRIGger<hw>[:SWEep]:SOURce <Source>

Selects the trigger source for the corresponding sweeps:

- `FSWeep` - RF 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 517
`[: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`
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 Chapter 13.15.13, "SOURce:SWEep Subsystem", on page 724.

Usage: Setting only

:TRIGger<hw>:FSWeep[: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
- `SWEep` - all sweeps

Effective in the following configuration:

- `TRIG:FSW|PSW|[:SWE]:SOUR` **SING**
- `SOUR:SWE:FREQ|POW: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 325

13.20 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 <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 Error Messages

The R&S SMCV100B distinguishes between various messages such as status messages, error messages, warnings, or information that are displayed in the "Info" line on the screen, and also entered in the error/event queue of the status reporting system.

This section describes the types of error messages and warnings. The status reporting system is described in detail in Chapter A.1.5, "Status Reporting System", on page 799.

You can also access an Info window with detailed information about all messages in a history list. For details, see Chapter 14.4, "Querying Error Messages", on page 764

14.1 Error Messages

Error messages indicate errors in the instrument. They are displayed in different colors depending on their importance and display duration. Errors (e.g. no calibration data) are displayed in red, information (e.g. file not found) and warnings in black. Warnings indicate less significant errors (e.g. the instrument operates outside specified data).

Some error messages require that the error must be eliminated before correct instrument operation can be ensured. To access the "Info" dialog with a list of current messages and a detailed description of each message, select "Info".

In the remote control mode, error messages are entered in the error/event queue of the status reporting system and can be queried with the command `SYSTem:ERRor?`. If the error queue is empty, 0 ("No error") is returned.

14.1.1 Volatile Messages

Volatile messages report automatic settings in the instrument (e.g. switching off incompatible types of modulation) or on illegal entries that are not accepted by the instrument (e.g. range violations). They are displayed in the info line on a yellow background. They are displayed on top of status information or permanent messages.

Volatile messages do not normally demand user actions and disappear automatically after a brief period of time. They are stored in the history, however.

Remote command:

`:SYSTem:ERRor:ALL?` or

`:SYSTem:ERRor:CODE[:NEXT]?`

14.1.2 Permanent Messages

Permanent messages are displayed if an error occurs that impairs further instrument operation, e.g. a hardware fault. The error signaled by a permanent message 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-Error Messages

The SCPI error messages are the same in all SCPI instruments. Detailed information and an overview of all error messages as defined in SCPI standard can be found in the corresponding documentation.

SCPI errors 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 as to the respective error.

14.3 Device-Specific Error Messages

The following table contains all error messages specific for the instrument in alphabetical order, as well as an explanation of the error situation. The positive error codes mark the errors specific to the instrument.

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	Extern reference out of range or disconnected	External reference is selected but no external signal is applied or the signal is out of range.	• Check the selected reference signal source (internal or external) in the "Setup > Reference Oscillator" dialog. • Change setting to 'internal' if no appropriate external source is available.
140	This modulation forces other modulations off	A modulation has been switched on which cannot be used at the same time as an already active modulation. The previous modulation has been switched off.	
180	Adjustment failed	Adjustment could not be executed	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

Error Code	Error	Description	Remedy
183	Adjustment data invalid	Adjustment data is invalid and must be restored.	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	A later version of certain parts of the instrument is necessary to execute the function selected.	The driver does not support the installed version of a module.
202	Cannot access the EEPROM	An error occurs when writing or reading a EEPROM.	The EEPROM is possibly defect. 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 selected. To execute the required operation, a list has to be selected in the related dialog. If no list is available, a new list must be created.	
242	Unknown list type specified	The list type selected is not valid for the required operation.	Check the selected list type.
460	Cannot open the file	The selected file cannot be opened.	Check the path and file name.
461	Cannot write file	The file cannot be written.	Check if the file is read-only.
462	Cannot read file	The file cannot be read.	Check if the file contents are compatible with the file type.
463	Filename missing	The required operation cannot be executed because the file name is not specified.	Enter file name when creating list.
464	Invalid filename extension	The file extension is not valid for the required operation.	Check the file extension.
465	File contains invalid data	The selected file contains data that is not valid for the file type. The file extension determines the data that is valid for this file type. If the file extension is changed, the lists are no longer recognized and the data is therefore invalid.	Check the file extension.

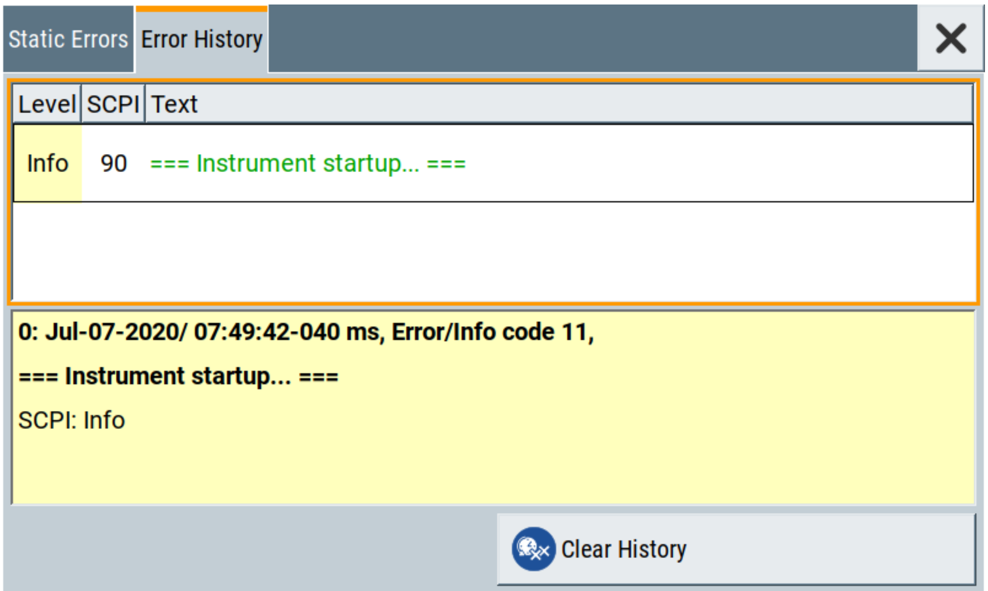
14.4 Querying Error Messages

The R&S SMCV100B monitors the functions performed and automatically detects errors and irregularities. The instrument displays the messages in the "Info" line and records them in the background with a detailed description.

Find details to the system messages in Chapter 14, "Troubleshooting and Error Messages", on page 762.

To display information on static errors and error history

1. In the taskbar, select the "Info" icon.
2. For some messages, the information line appears briefly on the block diagram.
   To open the dialog, in the "Info" line select the "Info" button.



- The "Static Errors" dialog lists the last monitored messages chronologically and displays additional information on the highlighted message.
- The "Error History" dialog lists the accumulated messages with a short description.
  Volatile errors are reported once, at the time they appear. If identical errors occur subsequently, they are not reported repeatedly.
  In the "Info" line, identical errors are displayed repeatedly only if the original error has already disappeared from the display. If queried by SCPI command, identical errors are only reported if the original error has already been retrieved from (and hence not any more present in) the error queue.

Indication and handling of permanent messages

If any critical error occurs, the R&S SMCV100B automatically shows the icon in the taskbar. Select the icon to obtain information on the error and the number of occurrences.

The icon is assigned to permanent messages. The message and icon are displayed until the error is eliminated.

Static Errors/Error History

Toggles between "Static" and "History" view of the info dialog.

Remote command:
`:SYSTem:ERRor[:NEXT]?` on page 736
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 737
Queries the list of all errors.

Clear History
Clears all messages in the "History" view.

Remote command:
:SYSTem:ERRor:ALL? on page 734
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 737
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 SMCV100B 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!** 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:
   - Check the network infrastructure. Exchange connecting cables, if obvious damage is visible.
     See also "Cable selection and electromagnetic interference (EMI)" on page 24.
   - 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.
   - If the IP address is set manually (no DHCP) or obtained via the Zeroconf (APIPA) protocol:
     – Check whether the IP address of the instrument is within the network's address range.
     – Check whether the IP address is valid.

14.6 Measuring USB cable quality

To check the quality of the USB cable, see the service manual of the R&S SMCV100B.

14.7 Requesting Instrument Configuration and Specifications

The R&S SMCV100B is equipped with various hardware and software components. To get an overview of what your instrument is equipped with, you can request the assemblies, hardware and software options, and the firmware version. The components are structured according to the hardware configuration, software options, including the license management, and externally used Rohde & Schwarz equipment, like R&S NRP power sensors.

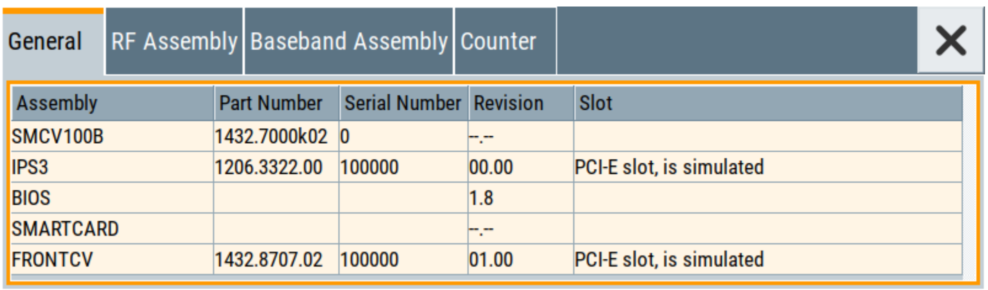
Software options purchased at a later stage can be activated with a keycode. The activation code is supplied with the software option. How to install options is described in chapter 4 of the R&S SMCV100B service manual.

The installation of hardware options purchased at a later stage is also described in chapter 4 of the service manual. Most of the hardware options have to be installed at an authorized Rohde & Schwarz service center.

14.7.1 Hardware Configuration Settings

Access:

► Select "System Config > Setup > Instrument Assembly > Hardware Config".



Assembly	Part Number	Serial Number	Revision	Slot
SMCV100B	1432.7000k02	0	--.--	
IPS3	1206.3322.00	100000	00.00	PCI-E slot, is simulated
BIOS			1.8	
SMARTCARD			--.--	
FRONTCV	1432.8707.02	100000	01.00	PCI-E slot, is simulated

The "Hardware Config" dialog lists all installed assemblies and externally connected instruments with information on their part and serial numbers, and revision states. The BIOS version is also listed; firmware updates do not update the BIOS version.
The dialog is divided in tabs, according to the hardware components of the signal domains. The "Counter" tab provides information on the operation time and number of times the instrument was powered on.

The remote commands required to query the hardware configuration are described in Chapter 13.7, "DIAGnostic Subsystem", on page 532.

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 533

Counter
Displays information on the operation times of the R&S SMCV100B.

Operation Time / h ← Counter
Displays the operation time in hours so far.

Remote command:
`:DIAGnostic:INFO:OTIMe?` on page 534

Power On Count ← Counter
Displays the number the instrument has been turned on.

Remote command:
`:DIAGnostic:INFO:POCount?` on page 534

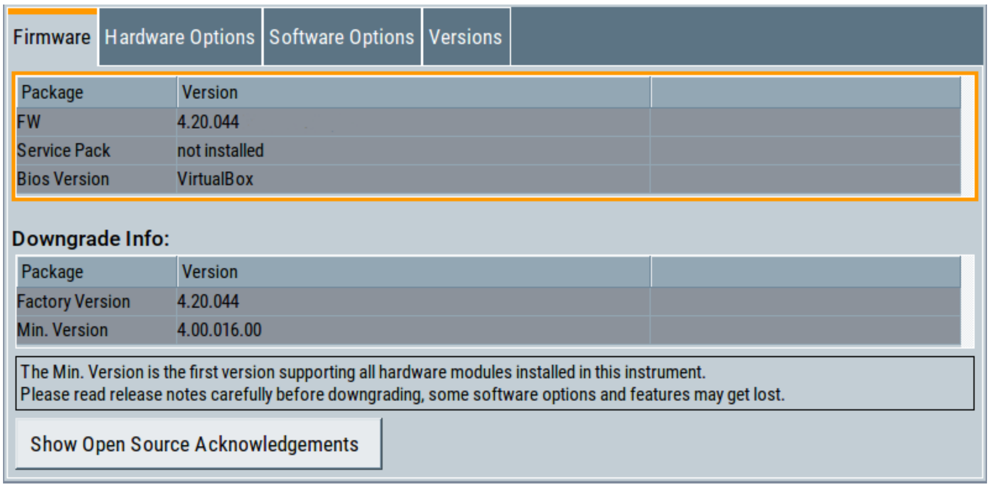
Last Factory Calibration ← Counter
Displays the date of the last factory calibration.

Remote command:
`:CALibration:DATA:FACTory:DATE?` on page 531

14.7.2 Versions/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 Chapter 13.7, "DIAGnostic Subsystem", on page 532.

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.

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.

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

"Expiration Date"
For regular options, "Permanent" is indicated in this column. Some options are available as trial versions. This column shows their expiration date. After this date, the option is no longer available on the instrument.

Remote command:
`*OPT?` on page 515
`*IDN?` on page 514

Versions
The "Versions" tab shows the versions of the technical specification of the R&S SMCV100B and of the software components that comprise the firmware.

"Package" Name of the component.

"Version" Current issue of the component.

Remote command:
`:SYSTem:SPECification:VERSion:FACTory?` on page 749

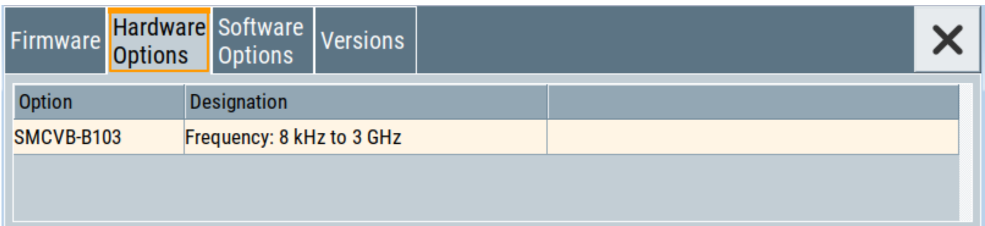
14.7.3 How to Query Instrument Configuration

To get information on the components and installed options of the R&S SMCV100B, proceed as described in the following examples.

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 all hardware options that are installed on the R&S SMCV100B.

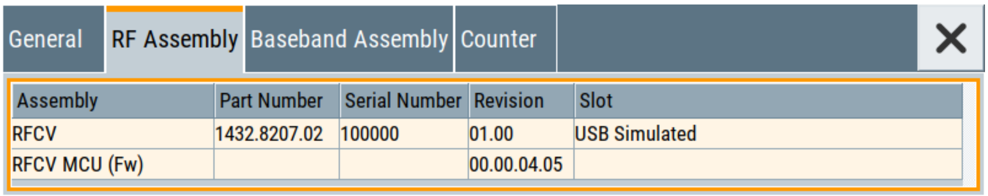
Proceed the same way to get information for instance on the firmware, or the installed software options in the corresponding tab.

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".



Assembly	Part Number	Serial Number	Revision	Slot
RFCV	1432.8207.02	100000	01.00	USB Simulated
RFCV MCU (Fw)			00.00.04.05	

The dialog lists the RF hardware components that are installed on the R&S SMCV100B.

Proceed the same way to get information for instance on general or baseband hardware modules, or on the operating times of the R&S SMCV100B in the corresponding tab.

14.8 Collecting Information for Technical Support

If you encounter problems that you cannot solve yourself, contact your Rohde & Schwarz support center as listed at http://www.customersupport.rohde-schwarz.com. Our support center staff is optimally trained to assist you in solving problems.

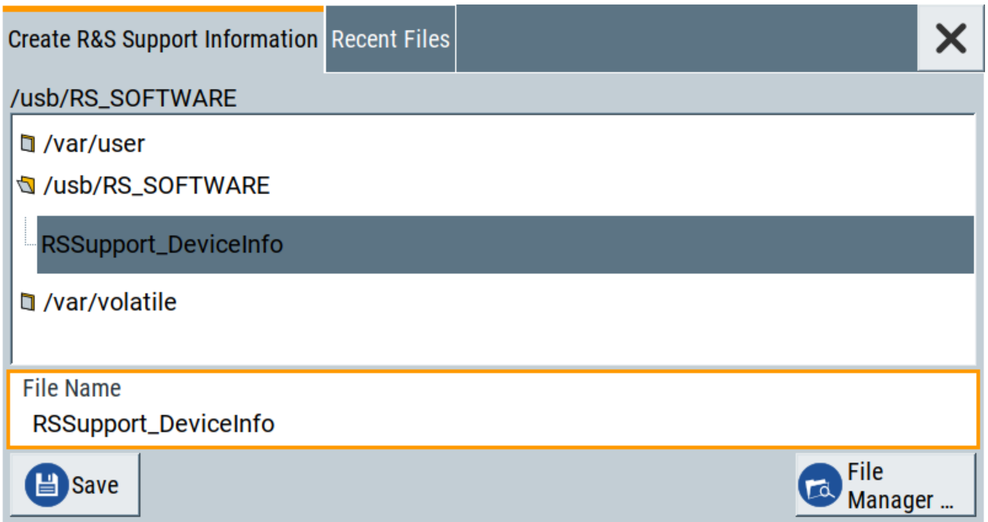
The support center finds solutions more quickly and efficiently if you provide them with information on the instrument and an error description.

- 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
  - SystemRestaurationSMCV100B.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 Chapter 14.1, "Error Messages", on page 762.

To collect error information in a support file

1. Connect a USB device to the R&S SMCV100B.
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 is 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 for your region as listed on the Internet (http://www.customersupport.rohde-schwarz.com).

To remove sensitive data

► For information on how to handle or remove the sensitive data from your instrument, refer to the description "Resolving Security Issues when working with R&S SMCV100B".

Packing and transporting the instrument

► If the instrument has to be transported or shipped, see Chapter 15, "Transporting", on page 774.

14.9 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

See:

- "Lifting and carrying the product" on page 15
- Chapter 3.1.1, "Lifting and Carrying", on page 22.

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.

Securing

When moving the R&S SMCV100B in a vehicle or using transporting equipment, make sure that the R&S SMCV100B is properly secured. Only use items intended for securing objects.

Transport altitude

Unless otherwise specified in the data sheet, the maximum transport altitude without pressure compensation is 4500 m above sea level.

16 Maintenance, Storage and Disposal

The product does not require regular maintenance. It only requires occasional cleaning. It is however advisable 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 17.

Do not use any liquids for cleaning. Cleaning agents, solvents (thinners, acetone), 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 data sheet.

16.3 Performing Maintenance Tasks

The vector signal generator is accurate due to integrated adjustment procedures and the following additional capabilities that assure correct functioning:

- Self-test
  A self-test is provided for service purposes.
- Test points
  If necessary for service purposes, internal test points can be queried. For description, see the R&S SMCV100B service manual.

When to run selftest?

We recommend that you perform a selftest, if the instrument does not respond as expected.

How to: Chapter 16.3.3.2, "How to run Hardware Module Selftests on the R&S SMCV100B", on page 782

16.3.1 Date and Time

The R&S SMCV100B 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 Data 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.

The required remote commands are described in Chapter 13.16, "SYSTem Subsystem", on page 732.

Settings:

Date
Displays the date set in the operating system in the format [dd.mm.yyyy].

Remote command:
`:SYSTem:DATE` on page 750

Time
Displays the time set in the operating system in the format [hh.mm.ss].

The time setting corresponds to the selected Use Time from NTP Server.

Remote command:
`:SYSTem:TIME` on page 751

Timezone
Selects the timezone.

You can select the timezone according to the major cities on the respective continents.

Note: By typing the first letter, you can quickly navigate through the lists to find the desired destination.

Remote command:
`:SYSTem:TIME:ZONE` on page 751
`:SYSTem:TIME:ZONE:CATalog?` on page 752

NTP Address
Sets the IP address or host name of the NTP server.

NTP is a network time protocol used for synchronizing all participating devices in a data network.

You can select a high-precision time server to reduce the impact of varying network delays.

Remote command:
`:SYSTem:NTP:HOSTname` on page 751

Use Time from NTP Server
Activates clock synchronization of the network via the NTP protocol.

Remote command:
`:SYSTem:NTP:STATe` on page 751

16.3.1.2 How To Set Data 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. 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 adopts 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 Chapter 16.3.2.2, "How to Test the Front Panel", on page 778

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.

16.3.2.2 How to Test the Front Panel

See:

- "Testing the key panel" on page 778
- "Testing the touchscreen" on page 779
- "Terminating the test" on page 779
- "Debuging" on page 779

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.

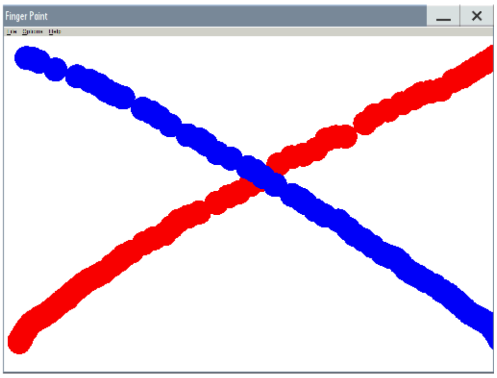
5. Continue with the next key on the front panel and repeat step 3 to step 5 until all keys are tested.

   The test is completed, when each key is verified successfully, confirmed by a "Test passed" message.

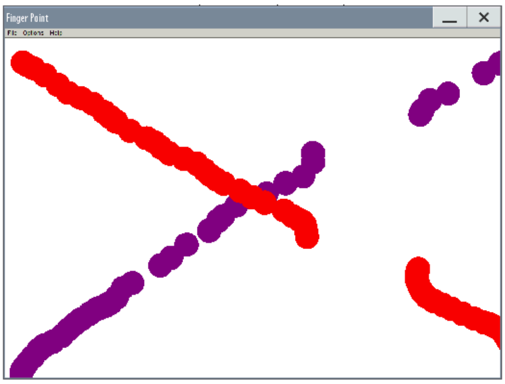
Testing the touchscreen

1. Press the [Setup] key.
2. 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.

Debuging

1. If you detect a malfunction, for example, you press the front panel key the first time, and the color of the button in the dialog turns red (instead of green), the front panel key may be stuck.

2. Contact the Rohde & Schwarz customer support, see Chapter 14.8, "Collecting Information for Technical Support", on page 771.

16.3.3 Selftest

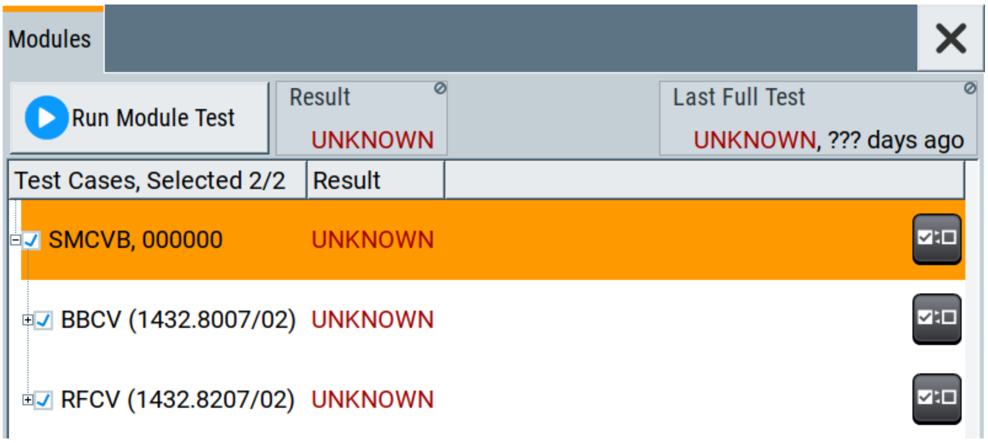
Self-test is provided for service purposes.

16.3.3.1 Selftest Modules Settings

Access:

► Select "System Config > Setup > Maintenance > Selftest".

The "Modules" dialog opens.



The dialog contains parameters for testing the baseband and RF hardware modules of the R&S SMCV100B.

The remote commands required to define these settings are described in Chapter 13.18, "TEST Subsystem", on page 758.

Run Module Test

Runs selftests of the hardware modules selected in the test table.

You can run seftests for the "BBCV" baseband module and the "RFCV" RF module. Also you can execute the tests separately.

Remote command:

`:TEST<hw>:ALL:STARt` on page 758

Result

Displays the result of the hardware module selftests.

Remote command:
`:TEST<hw>:ALL:RESult?` on page 758

Last Full Test

Displays the result and date of the last hardware module test run including the elapsed time since the last test run.

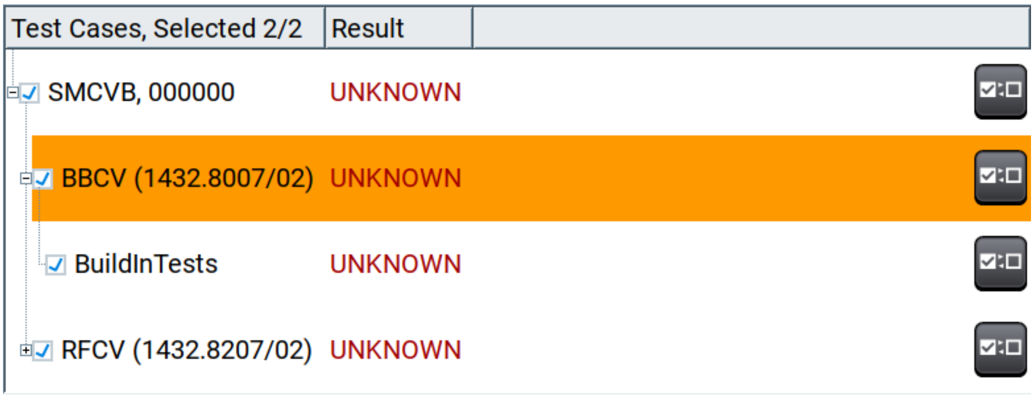
For example, "PASS, 4 Jul 20, 10 days ago" implies a successful test on July 04, 2020.

Remote command:
`:TEST<hw>:ALL:RESult?` on page 758

Test table

Displays hardware module selftests available on the R&S SMCV100B.

The table displays the R&S SMCV100B, its serial number, available test cases, test types and test case results.



"Instrument, Serial number"
Displays the instrument and its serial number, e.g., "SMCVB, 123456".
Click ⊞ to monitor installed test cases and test types.

"Test cases, Test types"
Displays the test case name and material number installed on the R&S SMCV100B including the test type. The following test cases are available:

Test case	Material number	Test types
"BBCV"	1432.8007/02	"BuildInTests"
"RFCV"	1432.8207/02	"BuildInTests"

"Result"
The column displays the selftest results for the instrument, the test cases and the test types.

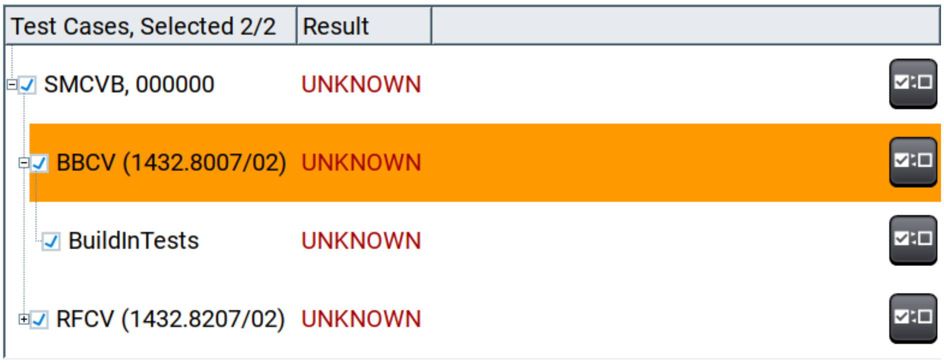
- "UNKNOWN": No test result available. Select the test and click "Run Module Test" to get test results.
- "PASS": The test is successful.
- "ERROR/FAIL": The test is erroneous.
  If you receive an error result, contact the R&S Support, see Chapter 14.9, "Contacting Customer Support", on page 773.

Remote command:
:TEST<hw>:ALL:RESult? on page 758

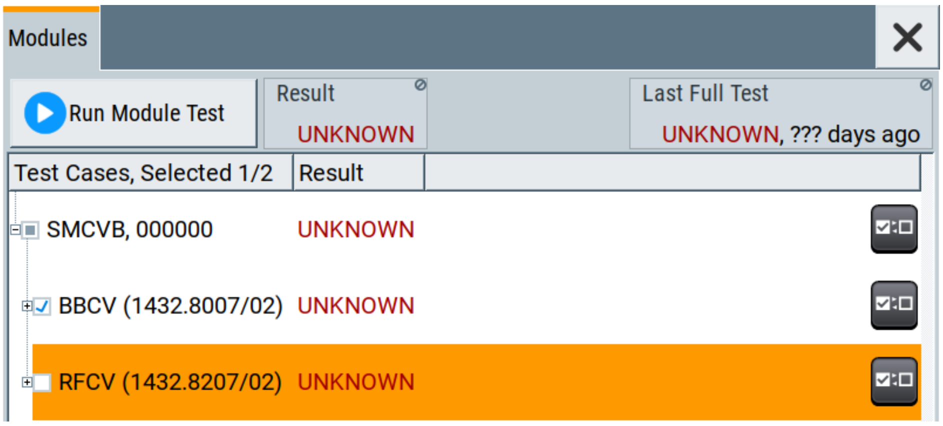
16.3.3.2 How to run Hardware Module Selftests on the R&S SMCV100B

For related settings, see Chapter 16.3.3.1, "Selftest Modules Settings", on page 780.

1. Select "System Config > Setup > Maintenance > Selftest > Modules".
2. In the test table, select test cases that you want to execute. By default, the "BBCV" and "RFCV" test cases are selected.
   a) To view test types included in the test case, click ⊞ on the left of the test case. The "BBCV" and "RFCV" offer build-in tests.

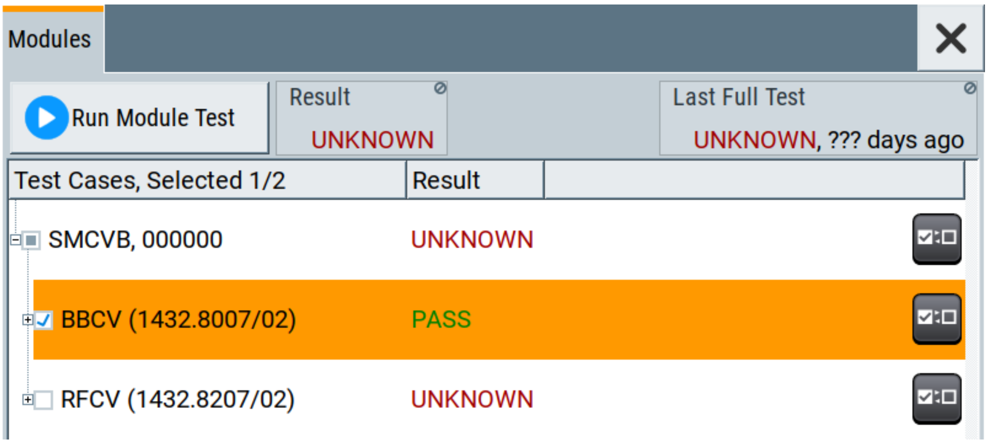
   

   b) To deselect a test case, click on the right of the test case. For example, deselect "RFCV".

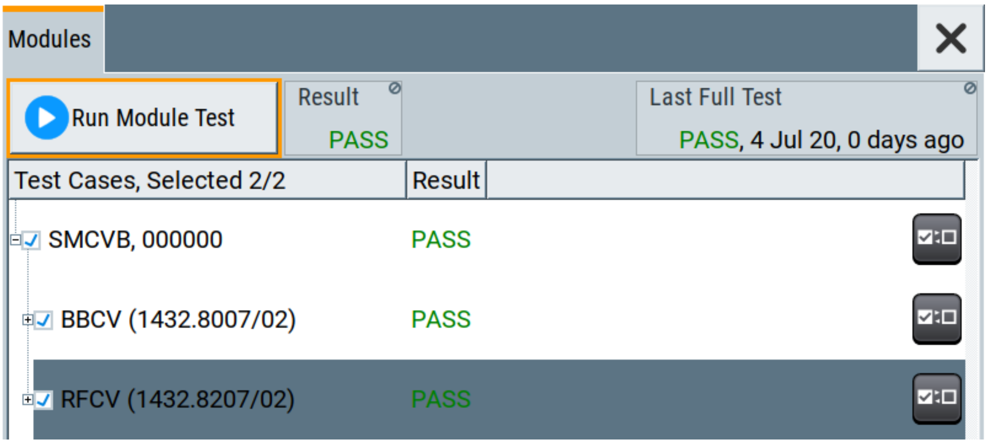
   

3. Click "Run Module Test".

   The selected test case tests are executed. After the test run, results with "PASS" or "FAIL" information are available. "UNKNOWN" indicates, that no results are available.



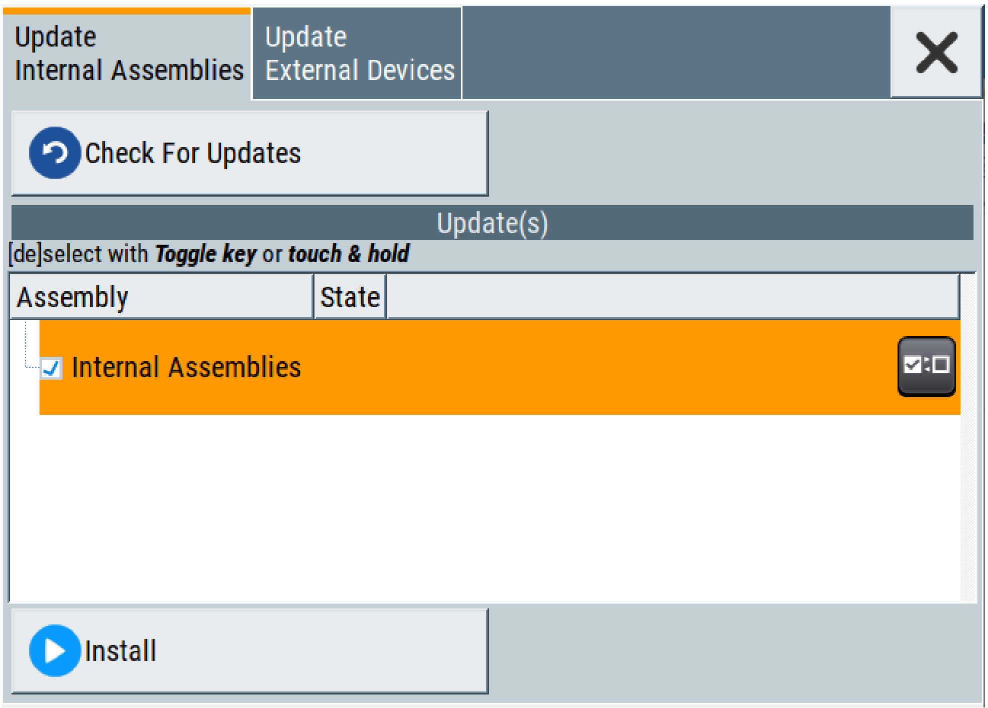
4. To retrieve composite result information, select all test cases and click "Run Module Test".
   To the right of the "Run Module Test" button, the full selftest "Result" and "Last Full Test" including the test result and the date of the last full test and the elapsed time since the last test run.



16.3.4 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:

Check For Updates

Check for updates of the FPGA/µC.

Remote command:
n.a.

Assembly

The table shows the installed assemblies and their states.

"Assembly"	Assembly designation.
"State"	Indicates the current state of installed assemblies.

Install

Install all available updates for the FPGA/µC.

Remote command:
n.a.

Update External Devices

This dialog shows the update options of external devices connected to the instrument.

Check For Updates ← Update External Devices
Check for updates of external devices.

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.

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 service life. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.

Figure 16-1: Labeling in line with EN 50419

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 Reference

The chapter provides reference information on GUI and remote control opertation of the R&S SMCV100B.

A.1 Additional Basics on Remote Control

This section provides basic information using the remote control.

A.1.1 Messages

The messages transferred on the data lines are divided into the following categories:

- Interface messages
  Interface messages are transmitted to the instrument on the data lines, with the attention line being active (LOW). They are used to communicate between the controller and the instrument. Interface messages can only be sent by instruments that have GPIB bus functionality. For details see the sections for the required interface.
- Instrument messages
  Instrument messages are employed in the same way for all interfaces, if not indicated otherwise in the description. Structure and syntax of the instrument messages are described in Chapter A.1.3, "SCPI Command Structure", on page 788. A detailed description of all messages available for the instrument is provided in the chapter "Remote Control Commands".
  There are different types of instrument messages, depending on the direction they are sent:
  – Commands
  – Instrument responses

Commands

Commands (program messages) are messages the controller sends to the instrument. They operate the instrument functions and request information. The commands are subdivided according to two criteria:

- According to the effect they have on the instrument:
  - **Setting commands** cause instrument settings such as a reset of the instrument or setting the frequency.
  - **Queries** cause data to be provided for remote control, e.g. for identification of the instrument or polling a parameter value. Queries are formed by directly appending a question mark to the command header.
- According to their definition in standards:
  - **Common commands**: their function and syntax are precisely defined in standard IEEE 488.2. They are employed identically on all instruments (if implemented). They refer to functions such as management of the standardized status registers, reset and self-test.
  - **Instrument control commands** refer to functions depending on the features of the instrument such as frequency settings. Many of these commands have also been standardized by the SCPI committee. These commands are marked as "SCPI confirmed" in the command reference chapters. Commands without this SCPI label are device-specific; however, their syntax follows SCPI rules as permitted by the standard.

Instrument responses

Instrument responses (response messages and service requests) are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status.

A.1.2 LAN Interface Messages

In the LAN connection, the interface messages are called low–level control messages. These messages can be used to emulate interface messages of the GPIB bus.

Command	Long term	Effect on the instrument
&ABO	Abort	Aborts processing of the commands just received.
&DCL	Device Clear	Aborts processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
&GTL	Go to Local	Transition to the "local" state (manual control). (The instrument automatically returns to remote state when a remote command is sent UNLESS `&NREN` was sent before.)
&GTR	Go to Remote	Enables automatic transition from local state to remote state by a subsequent remote command (after `&NREN` was sent).

Command	Long term	Effect on the instrument
&GET	Group Execute Trigger	Triggers a previously active instrument function (e.g. a sweep). The effect of the command is the same as with that of a pulse at the external trigger signal input.
&LLO	Local Lockout	Disables transition from remote control to manual control by means of the front panel keys.
&NREN	Not Remote Enable	Disables automatic transition from local state to remote state by a subsequent remote command. (To re-activate automatic transition use `&GTR`.)
&POL	Serial Poll	Starts a serial poll.

A.1.3 SCPI Command Structure

SCPI commands consist of a header and, in most cases, one or more parameters. The header and the parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several mnemonics (keywords). Queries are formed by appending a question mark directly to the header.

The commands can be either device-specific or device-independent (common commands). Common and device-specific commands differ in their syntax.

A.1.3.1 Syntax for Common Commands

Common (= device-independent) commands consist of a header preceded by an asterisk (*), and possibly one or more parameters.

Table A-1: Examples of common commands

*RST	RESET	Resets the instrument.
*ESE	EVENT STATUS ENABLE	Sets the bits of the event status enable registers.
*ESR?	EVENT STATUS QUERY	Queries the contents of the event status register.
*IDN?	IDENTIFICATION QUERY	Queries the instrument identification string.

A.1.3.2 Syntax for Device-Specific Commands

Not all commands used in the following examples are necessarily implemented in the instrument. For demonstration purposes only, assume the existence of the following commands for this section:

- `DISPlay[:WINDow<1...4>]:MAXimize <Boolean>`
- `FORMat:READings:DATA <type>[,<length>]`
- `HCOPy:DEVice:COLor <Boolean>`
- `HCOPy:DEVice:CMAP:COLor:RGB <red>,<green>,<blue>`
- `HCOPy[:IMMediate]`
- `HCOPy:ITEM:ALL`
- `HCOPy:ITEM:LABel <string>`
- `HCOPy:PAGE:DIMensions:QUADrant[<N>]`
- `HCOPy:PAGE:ORIentation LANDscape | PORTrait`
- `HCOPy:PAGE:SCALe <numeric value>`
- `MMEMory:COPY <file_source>,<file_destination>`
- `SENSE:BANDwidth|BWIDth[:RESolution] <numeric_value>`
- `SENSe:FREQuency:STOP <numeric value>`
- `SENSe:LIST:FREQuency <numeric_value>{,<numeric_value>}`

Long and short form

The mnemonics feature a long form and a short form. The short form is marked by upper case letters, the long form corresponds to the complete word. Either the short form or the long form can be entered; other abbreviations are not permitted.

Example:

`HCOPy:DEVice:COLor ON` is equivalent to `HCOP:DEV:COL ON`.

Case-insensitivity

Upper case and lower case notation only serves to distinguish the two forms in the manual, the instrument itself is case-insensitive.

Numeric Suffixes

If a command can be applied to multiple instances of an object, e.g. specific channels or sources, the required instances can be specified by a suffix added to the command. Numeric suffixes are indicated by angular brackets (<1...4>, <n>, <i>) and are replaced by a single value in the command. Entries without a suffix are interpreted as having the suffix 1.

Example:

Definition: `HCOPy:PAGE:DIMensions:QUADrant[<N>]`

Command: `HCOP:PAGE:DIM:QUAD2`

This command refers to the quadrant 2.

Different numbering in remote control

For remote control, the suffix may differ from the number of the corresponding selection used in manual operation. SCPI prescribes that suffix counting starts with 1. Suffix 1 is the default state and used when no specific suffix is specified.

Some standards define a fixed numbering, starting with 0. If the numbering differs in manual operation and remote control, it is indicated for the corresponding command.

Optional Mnemonics

Some command systems permit certain mnemonics to be inserted into the header or omitted. These mnemonics are marked by square brackets in the description. The instrument must recognize the long command to comply with the SCPI standard. Some commands are considerably shortened by these optional mnemonics.

Example:

Definition: `HCOPy[:IMMediate]`

Command: `HCOP:IMM` is equivalent to `HCOP`

Optional mnemonics with numeric suffixes

Do not omit an optional mnemonic if it includes a numeric suffix that is relevant for the effect of the command.

Example:

Definition:`DISPlay[:WINDow<1...4>]:MAXimize <Boolean>`

Command: `DISP:MAX ON` refers to window 1.

In order to refer to a window other than 1, you must include the optional `WINDow` parameter with the suffix for the required window.

`DISP:WIND2:MAX ON` refers to window 2.

A.1.3.3 SCPI Parameters

Many commands are supplemented by a parameter or a list of parameters. The parameters must be separated from the header by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank).

The parameters required for each command and the allowed range of values are specified in the command description.

Allowed parameters are:

Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not allowed.

Example:

`SENS:FREQ:STOP 1500000` = `SENS:FREQ:STOP 1.5E6`

Units

For physical quantities, the unit can be entered. If the unit is missing, the basic unit is used. Allowed unit prefixes are:

- G (giga)
- MA (mega), MOHM, MHZ
- K (kilo)
- M (milli)
- U (micro)
- N (nano)

Example:

`SENSe:FREQ:STOP 1.5GHz` = `SENSe:FREQ:STOP 1.5E9`

Some settings allow relative values to be stated in percent. According to SCPI, this unit is represented by the `PCT` string.

Example:

`HCOP:PAGE:SCAL 90PCT`

Special Numeric Values

The following mnemonics are special numeric values. In the response to a query, the numeric value is provided.

- **MIN and MAX**: denote the minimum and maximum value.
- **DEF**: denotes a preset value which has been stored in the EPROM. This value conforms to the default setting, as it is called by the *RST command.
- **UP and DOWN**: increases or reduces the numeric value by one step. The step width can be specified via an allocated step command for each parameter which can be set via UP and DOWN.

- **INF and NINF**: INFinity and negative INFinity (NINF) represent the numeric values 9.9E37 or -9.9E37, respectively. INF and NINF are only sent as instrument responses.
- **NAN**: Not A Number (NAN) represents the value 9.91E37. NAN is only sent as a instrument response. This value is not defined. Possible causes are the division of zero by zero, the subtraction of infinite from infinite and the representation of missing values.

Example:

Setting command: `SENSe:LIST:FREQ MAXimum`

Query: `SENS:LIST:FREQ?`

Response: `3.5E9`

Queries for special numeric values

The numeric values associated to `MAXimum/MINimum/DEFault` can be queried by adding the corresponding mnemonic after the quotation mark.

Example: `SENSe:LIST:FREQ? MAXimum`

Returns the maximum numeric value as a result.

Boolean Parameters

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0. The numeric values are provided as the response for a query.

Example:

Setting command: `HCOPy:DEV:COL ON`

Query: `HCOPy:DEV:COL?`

Response: `1`

Text Parameters

Text parameters observe the syntactic rules for mnemonics, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the response to a query, the short form of the text is provided.

Example:

Setting command: `HCOPy:PAGE:ORIentation LANDscape`

Query: `HCOP:PAGE:ORI?`

Response: `LAND`

Character Strings

Strings must always be entered in quotation marks (' or ").

Example:

```
HCOP:ITEM:LABel "Test1"
HCOP:ITEM:LABel 'Test1'
```

Block Data

Block data is a format which is suitable for the transmission of large amounts of data. For example, a command using a block data parameter has the following structure:

```
FORMat:READings:DATA #45168xxxxxxxx
```

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted.

#0 specifies a data block of indefinite length. The use of the indefinite format requires a `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

A.1.3.4 Overview of Syntax Elements

The following tables provide an overview of the syntax elements and special characters.

Table A-2: Syntax elements

:	The colon separates the mnemonics of a command.
;	The semicolon separates two commands of a command line. It does not alter the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*	The asterisk marks a common command.
' ' "	Quotation marks introduce a string and terminate it (both single and double quotation marks are possible).
#	The hash symbol introduces binary, octal, hexadecimal and block data. ● Binary: #B10110 ● Octal: #O7612 ● Hexa: #HF3A7 ● Block: #21312
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates the header from the parameters.

Table A-3: Special characters

<table>
<tr><td>|</td><td>Parameters
A vertical stroke in parameter definitions indicates alternative possibilities in the sense of "or". The effect of the command differs, depending on which parameter is used.
Example:
Definition:HCOPy:PAGE:ORIentation LANDscape | PORTrait
Command HCOP:PAGE:ORI LAND specifies landscape orientation
Command HCOP:PAGE:ORI PORT specifies portrait orientation
Mnemonics
A selection of mnemonics with an identical effect exists for several commands. These mnemonics are indicated in the same line; they are separated by a vertical stroke. Only one of these mnemonics needs to be included in the header of the command. The effect of the command is independent of which of the mnemonics is used.
Example:
DefinitionSENSE:BANDwidth|BWIDth[:RESolution] <numeric_value>
The two following commands with identical meaning can be created:
SENS:BAND:RES 1
SENS:BWID:RES 1</td></tr>
<tr><td>[ ]</td><td>Mnemonics in square brackets are optional and may be inserted into the header or omitted.
Example: HCOPy[:IMMediate]
HCOP:IMM is equivalent to HCOP</td></tr>
<tr><td>{ }</td><td>Parameters in curly brackets are optional and can be inserted once or several times, or omitted.
Example: SENSe:LIST:FREQuency <numeric_value>{,<numeric_value>}
The following are valid commands:
SENS:LIST:FREQ 10
SENS:LIST:FREQ 10,20
SENS:LIST:FREQ 10,20,30,40</td></tr>
</table>

A.1.3.5 Structure of a Command Line

A command line may consist of one or several commands. It is terminated by one of the following:

- <New Line>
- <New Line> with EOI
- EOI together with the last data byte

Several commands in a command line must be separated by a semicolon ";".

Example:

```
MMEM:COPY "Test1","MeasurementXY";:HCOP:ITEM ALL
```

This command line contains two commands. The first command belongs to the MMEM system, the second command belongs to the HCOP system. If the next command belongs to a different command system, the semicolon is followed by a colon.

Example:

`HCOP:ITEM ALL;:HCOP:IMM`

This command line contains two commands. Both commands are part of the `HCOP` command system, i.e. they have one level in common.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. When abbreviating the command line, the second command begins with the level below HCOP. The colon after the semicolon is omitted. The abbreviated form of the command line reads as follows:

`HCOP:ITEM ALL;IMM`

Example:

`HCOP:ITEM ALL`

`HCOP:IMM`

A new command line always begins with the complete path.

A.1.3.6 Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

- The requested parameter is transmitted without a header.
  Example: `HCOP:PAGE:ORI?`, Response: `LAND`
- Maximum values, minimum values and all other quantities that are requested via a special text parameter are returned as numeric values.
  Example: `SENSe:FREQuency:STOP? MAX`, Response: `3.5E9`
- Numeric values are output without a unit. Physical quantities are referred to the basic units or to the units set using the `Unit` command. The response `3.5E9` in the previous example stands for 3.5 GHz.
- Truth values (Boolean values) are returned as `0` (for OFF) and `1` (for ON).
  Example:
  Setting command: `HCOPy:DEV:COL ON`
  Query: `HCOPy:DEV:COL?`
  Response: `1`
- Text (character data) is returned in a short form.
  Example:
  Setting command: `HCOPy:PAGE:ORIentation LANDscape`
  Query: `HCOP:PAGE:ORI?`
  Response: `LAND`
- Invalid numerical results
  In some cases, particularly when a result consists of multiple numeric values, invalid values are returned as 9.91E37 (not a number).

A.1.4 Command Sequence and Synchronization

IEEE 488.2 defines a distinction between overlapped and sequential commands:

- A sequential command always completes executing before the next command starts. Commands that are processed quickly are defined as sequential commands. They are not implemented in the instrument. However, the execution time of most of the commands is so short that they act as sequential commands, if they are sent in separate command lines.
- An overlapping command is still running when the next command starts. Usually, an overlapping command takes a certain time to process its task, and thus allows the program to execute other tasks, while it is still running. If overlapping commands have to follow a specific order, for example to avoid incorrect measurement readings, they must be executed in sequence. This is called synchronization between the controller and the instrument.

Several setting commands within a command line are not necessarily processed in the order they are received. Even if they are implemented as sequential commands. To follow a particular sequence, send each command in a separate line.

As a rule, send commands and queries in different program messages.

A.1.4.1 Preventing Overlapping Execution

To prevent an overlapping execution of commands, one of the commands `*OPC`, `*OPC?` or `*WAI` can be used. All three commands cause a certain action only to be carried out after the hardware has been set. The controller can be forced to wait for the corresponding action to occur.

Table A-4: Synchronization using *OPC, *OPC? and *WAI

Command	Action	Programming the controller
*OPC	Sets the Operation Complete bit in the ESR after all previous commands have been executed.	• Setting bit 0 in the ESE • Setting bit 5 in the SRE • Waiting for service request (SRQ)
*OPC?	Stops command processing until 1 is returned. This occurs when all pending operations are completed.	Send *OPC? directly after the command whose processing must be terminated before other commands can be executed.
*WAI	Stops further command processing until all commands sent before *WAI have been executed.	Send *WAI directly after the command whose processing must be terminated before other commands are executed.

Command synchronization using `*WAI` or `*OPC?` is a good choice if the overlapped command takes only little time to process. The two synchronization commands simply block overlapped execution of the command. Append the synchronization command to the overlapping command, for example:

```
SINGle; *OPC?
```

For time consuming overlapped commands, you can allow the controller or the instrument to do other useful work while waiting for command execution. Use one of the following methods:

***OPC with a service request**

1. Set the OPC mask bit (bit no. 0) in the ESE: *ESE 1
2. Set bit no. 5 in the SRE: `*SRE 32` to enable ESB service request.
3. Send the overlapped command with `*OPC` .
4. Wait for a service request.

   The service request indicates that the overlapped command has finished.

***OPC? with a service request**

1. Set bit no. 4 in the SRE: `*SRE 16` to enable MAV service request.
2. Send the overlapped command with `*OPC?`.
3. Wait for a service request.

   The service request indicates that the overlapped command has finished.

Event status register (ESE)

1. Set the OPC mask bit (bit no. 0) in the ESE: `*ESE 1`
2. Send the overlapped command without `*OPC`, `*OPC?` or `*WAI`.
3. Poll the operation complete state periodically (with a timer) using the sequence: `*OPC; *ESR?`

   A return value (LSB) of 1 indicates that the overlapped command has finished.

A.1.4.2 Examples to Command Sequence and Synchronization

See the following examples to command sequences and synchronization. Some examples given illustrate possible constellations for overlapping tasks.

Example: Commands and queries in one message

The response to a query combined in a program message with commands that affect the queried value is not predictable.

The following commands always return the specified result:

`:FREQ:STAR 1GHZ;SPAN 100 :FREQ:STAR?`

Result:

`1000000000` (1 GHz)

Whereas the result for the following commands is not specified by SCPI:

`:FREQ:STAR 1GHz;STAR?;SPAN 1000000`

The result could be the value of `STARt` before the command was sent since the instrument might defer executing the individual commands until a program message terminator is received. The result could also be 1 GHz if the instrument executes commands as they are received.

Example: Overlapping command with *OPC

The instrument implements `*RST` as an overlapped command. Assuming that `*RST` takes longer to execute than `*OPC`, sending the following command sequence results in initiating a reset and, after some time, setting the `OPC` bit in the `ESR`:

`*RST; *OPC`

Sending the following commands still initiates a reset:

`*RST; *OPC; *CLS`

However, since the operation is still pending when the instrument executes `*CLS`, forcing it into the "Operation Complete Command Idle" State (OCIS), `*OPC` is effectively skipped. The `OPC` bit is not set until the instrument executes another `*OPC` command.

Example: Overlapped command followed by non-conflicting commands

Suppose that the instrument is switched on to provide a real time test signal that requires some calculation time. At the same time, some settings for the configuration of a different signal are made which do not interact with the generated signal (for example the signal may be used later on). The signal generation and the signal configuration are independent from each other, so there is no need to synchronize the following overlapped commands:

```
SOUR:BB:3GPP:STAT ON
SOUR:BB:GSM:FORM FSK2
```

Example: Overlapped command followed by conflicting commands

Suppose that the generator is switched on to provide a real time test signal that requires some calculation time. This signal is to be added to a waveform from the second baseband generator. In this case, the application program has to make sure that the real signal is available in the added signal before further action is started. This involves an appropriate synchronization technique for the first command (the following sequence assumes an appropriate routing):

`SOUR:BB:3GPP:STAT ON`

The instrument waits until command has finished.

`SOUR2:BB:GSM:STAT ON`

Depending on the selected synchronization techniques, non-conflicting commands can be executed while waiting until the synchronized overlapped command has finished.

Example: Polling the progress of the zeroing process

Suppose that you start the zeroing for a connected power sensor via the remote control command `SENS1:ZERO`. This process blocks the processing of further tasks during execution. The query for completeness is performed with the `*OPC?` command. It returns a `1` in the output buffer when the process is completed.

`SENS:ZERO;*OPC?`

Instead of waiting via `*OPC?`, you can perform alternative tasks while the zeroing is running, as for example updating the GUI or adjusting other instruments. Synchronize the commands by querying the progress of the zeroing process periodically via the event status register `*ESR?`:

`*SRE 32`

Sets the service request enable. The bit is set when an event in the event status register occurs.

`*ESE 1`

Configures the mask of the event status register to "Operation Complete".

`SENS:ZERO;*OPC`

Sets the evaluation via the status byte query. It uses `*OPC?` as the reference.

`*CLS`

Clears all status registers.

Even if the instrument is busy, you can perform this procedure, since the query is executed in a subchannel.

A.1.5 Status Reporting System

The status reporting system stores all information on the current operating state of the instrument, and on errors which have occurred. This information is stored in the status registers and in the error queue.

You can query both with the commands of the STATus Subsystem.

A.1.5.1 Hierarchy of the Status Registers

The Figure A-1 shows the hierarchical structure of information in the status registers (ascending from left to right).

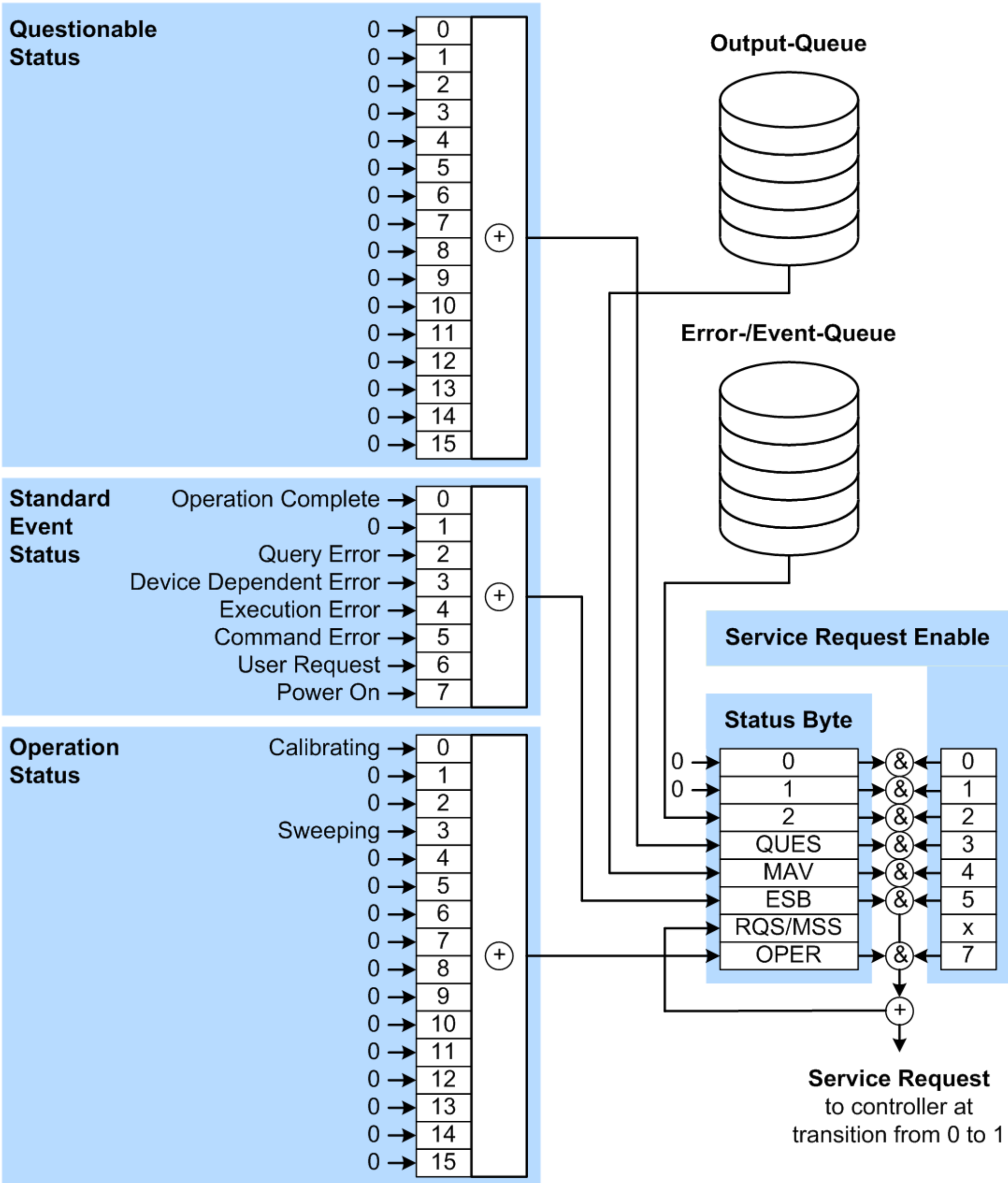


Figure A-1: Graphical overview of the status registers hierarchy

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

Note: This legend explains the abbreviations to the Status Byte Register.

The R&S SMCV100B uses the following status registers:

- **Status Byte** (STB) and **Service Request Enable** (SRE), see Chapter A.1.5.3, "Status Byte (STB) and Service Request Enable Register (SRE)", on page 803.
- **Standard Event Status**, i.e. the Event status Register (ESR) and the Event Status Enable (ESE), see Chapter A.1.5.4, "Event Status Register (ESR) and Event Status Enable Register (ESE)", on page 804.
- **Questionable Status** and **Operation Status**, the (SCPI status registers, see Chapter A.1.5.2, "Structure of a SCPI Status Register", on page 801, Chapter A.1.5.5, "Questionable Status Register (STATus:QUEStionable)", on page 805 and Chapter A.1.5.6, "Operation Status Register (STATus:OPERation)", on page 805.
- **Output-Queue**
  The output queue contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the `MAV` bit in the `STB` and thus is represented in the overview.
- **Error- /Event-Queue**
  The error-/event-queue contains all errors and events that have occurred in the past. When reading the queue, the instrument starts with the first occurred error/ event.

All status registers have the same internal structure.

SRE, ESE

The service request enable register `SRE` can be used as `ENABle` part of the `STB` if the `STB` is structured according to SCPI. By analogy, the `ESE` can be used as the `ENABle` part of the `ESR`.

A.1.5.2 Structure of a SCPI Status Register

Each standard SCPI register consists of 5 parts. Each part has a width of 16 bits and has different functions. The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is valid for all five parts. Bit 15 (the most significant bit) is set to zero for all parts. Thus the contents of the register parts can be processed by the controller as positive integers.

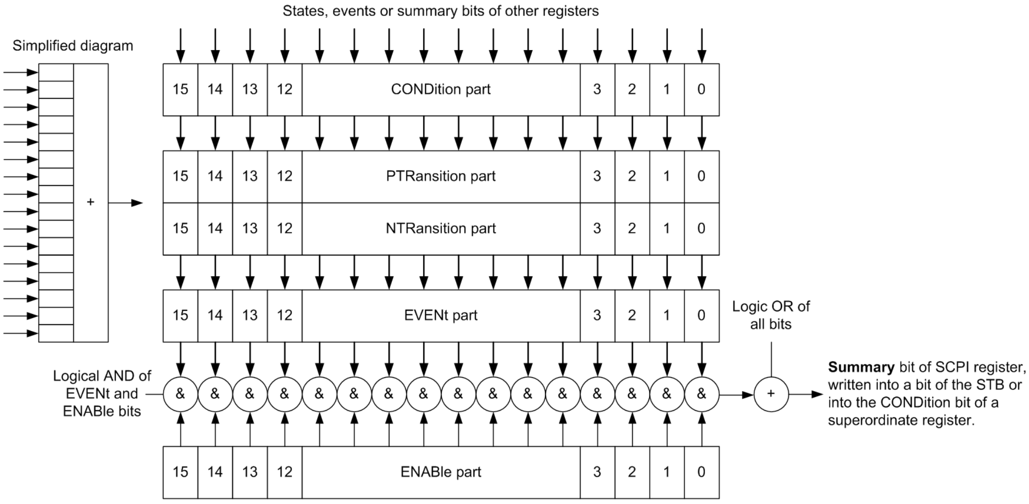


Figure A-2: The status-register model

Description of the five status register parts

The five parts of a SCPI register have different properties and functions:

- **CONDition**
  The `CONDition` part is written into directly by the hardware or the sum bit of the next lower register. Its contents reflect the current instrument status. This register part can only be read, but not written into or cleared. Its contents are not affected by reading.
- **PTRansition / NTRansition**
  The two transition register parts define which state transition of the `CONDition` part (none, 0 to 1, 1 to 0 or both) is stored in the `EVENt` part.
  The **Positive-TRansition** part acts as a transition filter. When a bit of the `CONDition` part is changed from 0 to 1, the associated `PTR` bit decides whether the `EVENt` bit is set to 1.
  – PTR bit =1: the `EVENt` bit is set.
  – PTR bit =0: the `EVENt` bit is not set.

  This part can be written into and read as required. Its contents are not affected by reading.
  The **Negative-TRansition** part also acts as a transition filter. When a bit of the `CONDition` part is changed from 1 to 0, the associated `NTR` bit decides whether the `EVENt` bit is set to 1.
  – NTR bit =1: the `EVENt` bit is set.
  – NTR bit =0: the `EVENt` bit is not set.

  This part can be written into and read as required. Its contents are not affected by reading.
- **EVENt**
  The `EVENt` part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the transition filters. It is permanently updated by the instrument. This part can only be

read by the user. Reading the register clears it. This part is often equated with the entire register.

- **ENABle**
  The ENABle part determines whether the associated EVENt bit contributes to the sum bit (see below). Each bit of the EVENt part is "ANDed" with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an "OR" function (symbol '+').
  ENABle bit = 0: the associated EVENt bit does not contribute to the sum bit
  ENABle bit = 1: if the associated EVENt bit is "1", the sum bit is set to "1" as well.
  This part can be written into and read by the user as required. Its contents are not affected by reading.

Sum bit

The sum bit is obtained from the EVENt and ENABle part for each register. The result is then entered into a bit of the CONDition part of the higher-order register.

The instrument automatically generates the sum bit for each register. Thus an event can lead to a service request throughout all levels of the hierarchy.

A.1.5.3 Status Byte (STB) and Service Request Enable Register (SRE)

The STatus Byte (STB) is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.

The STB is read using the command *STB? or a serial poll.

The STatus Byte (STB) is linked to the Service Request Enable (SRE) register. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a service request (SRQ) is generated. The SRE can be set using the command *SRE and read using the command *SRE?.

Table A-5: Meaning of the bits used in the status byte

Bit No.	Meaning
0...1	Not used
2	Error Queue not empty The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a service request. Thus an error can be recognized and specified in greater detail by polling the error queue. The poll provides an informative error message. This procedure is to be recommended since it considerably reduces the problems involved with remote control.
3	QUEStionable status register summary bit The bit is set if an EVENt bit is set in the QUEStionable status register and the associated ENABle bit is set to 1. A set bit indicates a questionable instrument status, which can be specified in greater detail by querying the STATus:QUEStionable status register.

Bit No.	Meaning
4	MAV bit (message available) The bit is set if a message is available in the output queue which can be read. This bit can be used to enable data to be automatically read from the instrument to the controller.
5	ESB bit Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting of this bit indicates a serious error which can be specified in greater detail by polling the event status register.
6	MSS bit (master status summary bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this registers is set together with its mask bit in the service request enable register SRE.
7	`STATus:OPERation` status register summary bit The bit is set if an `EVENt` bit is set in the `OPERation` status register and the associated `ENABle` bit is set to 1. A set bit indicates that the instrument is just performing an action. The type of action can be determined by querying the `STATus:OPERation` status register.

A.1.5.4 Event Status Register (ESR) and Event Status Enable Register (ESE)

The ESR is defined in IEEE 488.2. It can be compared with the `EVENt` part of a SCPI register. The event status register can be read out using command `*ESR?`.

The ESE corresponds to the `ENABle` part of a SCPI register. If a bit is set in the ESE and the associated bit in the ESR changes from 0 to 1, the ESB bit in the STB is set. The ESE register can be set using the command `*ESE` and read using the command `*ESE?`.

Table A-6: Meaning of the bits used in the event status register

Bit No.	Meaning
0	Operation Complete This bit is set on receipt of the command *OPC exactly when all previous commands have been executed.
1	Not used
2	Query Error This bit is set if either the controller wants to read data from the instrument without having sent a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is faulty and hence cannot be executed.
3	Device-dependent Error This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue.
4	Execution Error This bit is set if a received command is syntactically correct but cannot be performed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue.

Bit No.	Meaning
5	Command Error This bit is set if a command is received, which is undefined or syntactically incorrect. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the error queue.
6	User Request This bit is set when the instrument is switched over to manual control.
7	Power On (supply voltage on) This bit is set on switching on the instrument.

A.1.5.5 Questionable Status Register (STATus:QUEStionable)

This register contains information on questionable instrument states. Such states may occur when the instrument is not operated in compliance with its specifications.

To read the register, use the query commands `STAT:QUEST:COND?` or `STAT:QUEST[:EVEN]?`.

Table A-7: Meaning of the bits used in the questionable status register

Bit No.	Meaning
0–15	Not used

A.1.5.6 Operation Status Register (STATus:OPERation)

This condition part contains information on the actions currently being performed by the instrument, while the event part contains information on the actions performed by the instrument since the last readout of the register.

To read the register, use the query commands `STAT:OPER:COND?` or `STAT:OPER[:EVEN]?`.

Table A-8: Meaning 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	
4–15	Not used

A.1.5.7 Application of the Status Reporting System

The purpose of the status reporting system is to monitor the status of one or several devices in a measuring system. To do this and react appropriately, the controller must receive and evaluate the information of all devices. The following standard methods are used:

- **Service request** (SRQ) initiated by the instrument
- **Serial poll** of all devices in the bus system, initiated by the controller to find out who sent an SRQ and why
- Query of a **specific instrument status** by commands
- Query of the **error queue**

Service Request

Under certain circumstances, the instrument can send a service request (SRQ) to the controller. Usually this service request initiates an interrupt at the controller, to which the control program can react appropriately. An SRQ is always initiated if one or several of bits 2, 4 or 5 of the status byte are set and enabled in the SRE. Each of these bits combines the information of the error queue or the output buffer. To use the possibilities of the service request effectively, all bits should be set to "1" in the enable registers SRE and ESE.

Example:

Use command `*OPC` to generate an SRQ .

`*ESE 1` - set bit 0 of ESE (Operation Complete)

`*SRE 32` - set bit 5 of SRE (ESB).

After its settings have been completed, the instrument generates an SRQ.

The SRQ is the only possibility for the instrument to become active on its own. Each controller program should set the instrument such that a service request is initiated in the case of malfunction. The program should react appropriately to the service request.

Serial Poll

In a serial poll, just as with command `*STB`, the status byte of an instrument is queried. However, the query is realized via interface messages and is thus clearly faster.

The serial poll method is defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works for instruments which do not adhere to SCPI or IEEE 488.2.

The serial poll is mainly used to obtain a fast overview of the state of several instruments connected to the controller.

Query of an instrument status

Each part of any status register can be read using queries. There are two types of commands:

- The common commands `*ESR?`, `*IDN?`, `*IST?`, `*STB?` query the higher-level registers.
- The commands of the `STATus` system query the SCPI registers (`STATus:QUEStionable`...)

The returned value is always a decimal number that represents the bit pattern of the queried register. This number is evaluated by the controller program.

Queries are usually used after an SRQ in order to obtain more detailed information on the cause of the SRQ.

Error Queue

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain text error messages that can be looked up in the Error Log or queried via remote control using `SYSTem:ERRor[:NEXT]?`. Each call of `SYSTem:ERRor[:NEXT]?` provides one entry from the error queue. If no error messages are stored there any more, the instrument responds with 0, "No error".

The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

A.1.5.8 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 of `*RST` and `SYSTem:PRESet` affect the functional instrument settings. In particular, `DCL` does not change the instrument settings.

Table A-9: 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.						

A.1.6 General Programming Recommendations

Initial instrument status before changing settings

Manual operation is designed for maximum possible operating convenience. In contrast, the priority of remote control is the "predictability" of the instrument status. Thus, when a command attempts to define incompatible settings, the command is ignored and the instrument status remains unchanged, i.e. other settings are not automatically adapted. Therefore, control programs should always define an initial instrument status (e.g. using the *RST command) and then implement the required settings.

Command sequence

As a general rule, send commands and queries in different program messages. Otherwise, the result of the query may vary depending on which operation is performed first (see also Preventing Overlapping Execution).

Reacting to malfunctions

The service request is the only possibility for the instrument to become active on its own. Each controller program should instruct the instrument to initiate a service request in case of malfunction. The program should react appropriately to the service request.

Error queues

The error queue should be queried after every service request in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

A.2 Extensions for User Files

The Table A-10 lists all available file extensions for user files. The currently available files on the instrument depend on the installed options.

Table A-10: List of the automatically assigned file extensions in the instrument

Function	List type	Contents	File suffix
Instrument State	Settings	Instrument settings	`*.savrcltxt`
User Menu	Settings	User-defined favorite settings	`*.user_menu`
License Key		License Key	`*.xml`
"User Correction"	List	User-defined level correction values	`*.uco`
"List Mode"	List	User-defined frequency/level value pairs	`*.lsw`
	Settings	Response file	`*.txt`

Function	List type	Contents	File suffix
"NRP Settings"	Settings	R&S NRP Settings	*.nrp, *.rsu
SCPI command list	List	Export file containing list of SCPIs	*.iec
SCPI command script		SCPI script file formats: Plain SCPI, MATLAB, NICVI, Python3	*.txt , *.m, *.c, *.py
R&S Support Info Archive	Support File	Automatically collected support information	*.tar.gz
Tutorials	Tutorial files	Lists containing SCPIs and explanations	*.tut

B Waveform Libraries

The R&S SMCV100B supports the following waveform libraries:

Table B-1: Waveform libraries supported for R&S SMCV100B

Option	Designation	Material number
R&S SMCVB-KV10	T-DMB/DAB waveforms	1434.5340.xx
R&S SMCVB-KV11	DRM waveforms	1434.5370.xx
R&S SMCVB-KV12	DRM+ waveforms	1434.5405.xx
R&S SMCVB-KV13	HD Radio waveforms	1434.5434.xx
R&S SMCVB-KV14	XM Radio waveforms	1434.5463.xx
R&S SMCVB-KV15	DVB-T2 waveforms	1434.5492.xx
R&S SMCVB-KV16	ATSC 3.0 waveforms	1434.5528.xx
R&S SMCVB-KV17	Digital TV waveforms	1434.5557.xx
R&S SMCVB-KV18	Cable interferers	1434.5586.xx
R&S SMCVB-KV19	Satellite interferers	1434.5611.xx
R&S SMCVB-KV50	GPS predefined waveforms	1434.5770.xx
R&S SMCVB-KV51	Galileo predefined waveforms	1434.5792.xx
R&S SMCVB-KV52	GLONASS predefined waveforms	1434.5811.xx
R&S SMCVB-KV53	BeiDou predefined waveforms	1434.5834.xx

Glossary: List of the Often Used Terms and Abbreviations

Symbols

/hdd: Provided for backward compatibility with R&S SMBV in remote control; internally mapped to /var/user/.

A

Absolute file path: Complete file path

B

Base unit: This term describes a R&S SMCV100B equipped with baseband generator and R&S SMCVB-B103.

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 SMCV100B is digital.

Baseband(s) Signal: Baseband

BS: Base station

C

CFast card: CFast card is a type of removable memory storage, that can hold files with user data.
Support of this memory type is optional and requires option R&S SMCVB-B80.
Throughout this description, the CFast card is referred as a removable memory.
This memory cannot be installed if the mSata card is installed.
See also System drive.

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 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.
See also Chapter 13.5.2, "Accessing Files in the Default or in a Specified Directory", on page 521.

Computer name: An unambiguous indication of the instrument in a LAN that uses a DNS server.
The default computer name follows the syntax `SMCV100B-<serial number>`, e.g. *SMCV100B-102030*.
Synonym: Hostname
See Serial number.

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).

Full file path: Complete file path

G

Glossary: List of the often used terms and abbreviations

GUI: Graphical User Interface

H

Hostname: Computer name

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

master-slave: Setup with two or more R&S SMCV100B or one R&S SMCV100B and several other signal generators such as R&S SGT or R&S SMBV that generates synchronous and time aligned signals.
The master instrument generates and outputs a dedicated synchronization signal (Sync Out), that has to be fed into the slave instruments.

MIMO: Multiple Input Multiple Outputs

mSata: Memory that holds the operating system, the firmware, and used data.
Throughout this description, this memory is referred as an internal memory.
This memory cannot be installed if the CFast card (removable memory) is installed.

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.

product page: A designation of the R&S SMCV100B product page http://www.rohde-schwarz.com/product/SMBV100B.html

R

Remote access: Remote operation

Remote control: The operation of the R&S SMCV100B by remote control commands or programs to perform automated tests. The instrument is connected to a system controller via LAN/VXI-11 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 SMCV100B in remote operation mode, see Remote operation.
Synonyms: External controller, Client device,

Remote operation: Allows you to operate the R&S SMCV100B from a remote device via VNC.
Both the R&S SMCV100B and the remote device are connected in a LAN.
Synonym: Remote access

removable memory: General term describing mass memory that can be unmounted from the instrument.
See also CFast card.

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. `SMCV100B-102030`
See Figure 3-5.

SISO: Single Input Single Output

Smart device: A mobile, cordless device, such as a smartphone or tablet, capable of Internet browsing.
Synonyms: Smartphone, Tablet

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 is a µSD card that holds the operating system, the firmware, and the user data.
Throughout this description, the system drive is referred as an internal memory.

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.

User directory: Describes the default file storage location for user data.
In the file system, user directory is indicated as `/var/user/`
It is physically located on the internal memory or on the removable memory, if option R&S SMCVB-B80 is installed.

W

Waveform: A file with settings provided for repeatable tests with the same test signal.

List of remote commands (base unit)

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Symbols

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