R&S®SGT100A
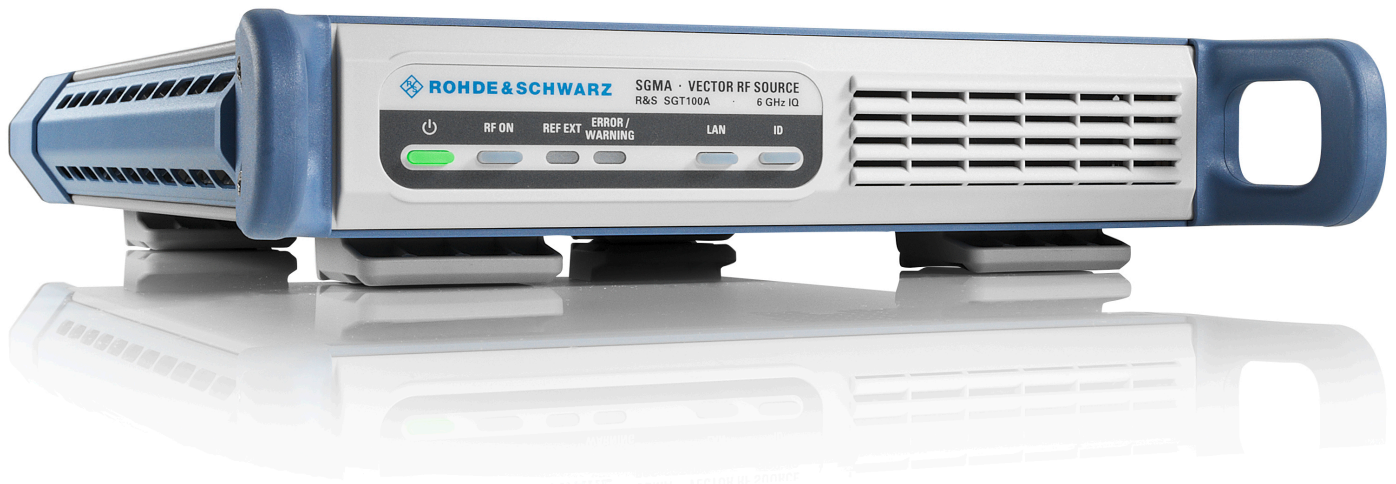# SGMA Vector RF Source
User Manual

ROHDE&SCHWARZ

Make ideas real

This manual describes the following R&S®SGT100A, stock no. 1419.4501.02 and its options.

- R&S®SGT-B1, Reference Oscillator OCXO (1419.5608.02)
- R&S®SGT-B88, Extension Unit (1419.8207.02)
- R&S®SGT-KB106, Frequency extension to 6 GHz (1419.5708.02)
- R&S®SGT-K16, Diff. analog I/Q outputs
- R&S®SGT-K18, Digital baseband connectivity (1419.6240.02)
- R&S®SGT-K22, Pulse modulation (1416.6279.02)
- R&S®SGT-K62, Additive White Gaussian Noise (AWGN) (1419.6304.02)
- R&S®SGT-K90, Phase Coherent Input/Output (1419.6333.02)
- R&S®SGT-K510, ARB baseband generator (1419.7500.02)
- R&S®SGT-K511/512, ARB memory extension (1419.6362.02/1419.6391.02)
- R&S®SGT-K521/522, ARB bandwidth extension (1419.6247.02/1419.6456.02)
- R&S®SGT-K523, Baseband Extension to 240 MHz (1419.7952.02)
- R&S®SGT-K540, Envelope Tracking (1419.7800.02)
- R&S®SGT-K541, AM/AM AM/PM Predistortion (1419.7852.02)
- R&S®SGT-K543, Envelope ARB (1419.7900.02)
- R&S®SGT-K548, Crest Factor Reduction (1419.8471.02)
- R&S®SGT-K200, Waveform package for signals from R&S®WinIQSIM2™ (1419.5850.71/72/75)
- R&S®SGT-K110/-K111/-K112-/K113/-K114/-K115-/K116/-K117/-K118/-K119/-K120/-K121/-K122/-K151, Waveform Libraries for ARB Generator

This manual describes firmware version FW 5.00.232.xx and later of the R&S®SGT100A.

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 following chapters.

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 11. 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.

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

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

Lifting and carrying the product

The maximum weight of the product is provided in the data sheet. You can lift or carry the product by yourself, if you can manage the weight on your own. Alternatively, you can use lifting or transporting equipment. Follow the instructions provided by the equipment manufacturer.

Choosing the operating site

Only use the product indoors. The product casing is not waterproof. Water that enters can electrically connect the casing with live parts, which can lead to electric shock, serious personal injury or death if you touch the casing. If Rohde & Schwarz provides accessories designed for your product, e.g. a carrying bag, 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. Connect the product to a fixed installation used to supply energy-consuming equipment such as household appliances and similar loads. Keep in mind that electrically powered products have risks, such as electric shock, fire, personal injury or even death. Replace parts that are relevant to safety only by original parts, e.g. power cables or fuses.

Take the following measures for your safety:
● Before switching on the product, ensure that the voltage and frequency indicated on the product match the available power source. If the power adapter does not adjust automatically, set the correct value and check the rating of the fuse.
● Only use the power cable delivered with the product. It complies with country-specific safety requirements. Only insert the plug into an outlet with protective conductor terminal.

- Only use intact cables and route them carefully so that they cannot be damaged. Check the power cables regularly to ensure that they are undamaged. Also ensure that nobody can trip over loose cables.
- If you connect the product to an external power supply, use the one delivered with the product or recommended in the product documentation. The external power supply must conform 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 connection protects you against electric shock if an electric problem occurs.

1.2 Labels on R&S SGT

Labels on the casing inform about:

- Personal safety, see "Connecting to power" on page 12.
- 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 SGT 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 14, "Maintenance, storage and disposal", on page 586.

1.3 Warning messages in the documentation

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

WARNING

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

CAUTION

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

NOTICE

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

1.4 Korea certification class A

이 기기는 업무용(A급) 전자파 적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

2 Welcome

The R&S SGT is a signal generator intended for the generation of IQ-modulated signals and the playback and output of externally calculated modulation signals in the form of waveforms.

Optimized for use in automated test equipment (ATE), the instrument offers fast settling times in an exceptionally small form factor and low power consumption. The R&S SGT is equipped with an active electronic step attenuator and can be equipped optionally with a high stability reference oscillator.

2.1 Key features

The key features of the R&S SGT include the following:

* Compact size and low power consumption
* Remote connection via PCI Express, minimizing the setup time
  Alternatively, LAN or USB connections available
* Coherent LO input and output connectors, also usable as MIMO input/output and phase coherent I/Q demodulation
* Linux operating system
* Graphical user interface R&S SGMA-GUI to set up and control one or more R&S SGT instruments simultaneously from one remote computer, available for Windows and Linux systems

2.2 What's new

This manual describes firmware version FW 5.00.232.xx and later of the R&S®SGT100A.

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

* Peak cancelation algorithm added for crest factor reduction (R&S SGT-K548):
  – Background information on the algorithm, see "Peak cancellation algorithm" on page 136.
  – Algorithm settings, see "Algorithm" on page 138, "Cancellation Pulse Bandwidth" on page 141 and "Transition Bandwidth" on page 141.
* Instrument security settings for LAN interface and LAN services added:
  – LAN interface added, see "LAN Interface" on page 285.
  – Remote commands for LAN service states added, see Chapter 10.16, "SYSTem subsystem", on page 533.
* Editorial changes

2.3   Documentation overview

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

www.rohde-schwarz.com/manual/sgt100a

2.3.1   User manual 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 SGT is not included.

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

2.3.2   Data sheets and brochures

The data sheet contains the technical specifications of the R&S SGT. 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/sgt100a

2.3.3   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/sgt100a

2.3.4   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/sgt100a.

2.4 Typographical conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
[Keys]	Key and knob names are enclosed by square brackets.
`Filenames, commands, program code`	Filenames, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

2.5 Notes on screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as many as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

3 Getting started

3.1 Preparing for use

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

3.1.1 Lifting and carrying

See also "Lifting and carrying the product" on page 12.

► Use the carrying handles at the side for lifting and carrying the R&S SGT.
The handles at the front are only for pushing and pulling the instrument when mounting in a rack, see Chapter 3.1.4.2, "Mounting the R&S SGT in a rack", on page 20.

3.1.2 Unpacking and checking

1. Unpack the R&S SGT carefully.

2. Retain the original packing material. Use it to protect the control elements and connectors when transporting or shipping the R&S SGT later.
See also Chapter 13, "Transporting", on page 585.

3. Using the delivery notes, check the equipment for completeness.

4. Check the equipment for damage.

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

3.1.3 Choosing the operating site

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

For safety information, see "Choosing the operating site" on page 12.

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.

- 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 SGT

See also:

- "Setting up the product" on page 12
- "Intended use" on page 11

3.1.4.1 Placing the R&S SGT 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. **WARNING!** A stack of products can fall over and cause injury. Never stack more than three products on top of each other. Instead, mount them in a rack.

   Stack as follows:

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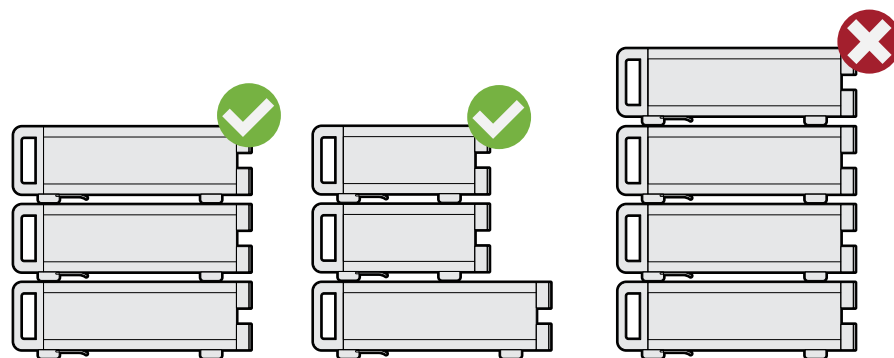
Left   = Stacked correctly, same dimensions
Middle = Stacked correctly, different dimensions
Right = Stacked incorrectly, too many products

3.   **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 SGT in a rack

To prepare the rack

1.   Observe the requirements and instructions in

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 SGT in a rack

1.   Use an adapter kit that fits the dimensions of the R&S SGT to prepare the instru-
     ment for rack mounting.

     a)   Order the rack adapter kit designed for the R&S SGT. For the order number,
          see data sheet.
     b)   Mount the adapter kit. Follow the assembly instructions provided with the
          adapter kit.

2.   Push the R&S SGT onto the shelf until the rack brackets fit closely to the rack.

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

To unmount the R&S SGT from a rack

1.   Loosen the screws at the rack brackets.

2.   Remove the R&S SGT from the rack.

3.   If placing the R&S SGT on a bench top again, unmount the adapter kit from the
     R&S SGT. Follow the instructions provided with the adapter kit.

3.1.5 Considerations 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:
  - SMA/SMB
    Double-shielded SMA/SMB cables.
    How to: Chapter 3.1.8, "Connecting to RF 50Ω", on page 22
  - USB
    Double-shielded USB cables.
    How to: Chapter 3.1.13.4, "Connecting a controller via USB", on page 31.
  - LAN
    At least CAT6 STP cables.
    How to: Chapter 3.1.7, "Connecting to LAN", on page 22
- Always terminate open cable ends.
- Ensure that connected external devices comply with EMC regulations.
- Use cables of the same type and equal length for connection to the I/Q and I/Q Bar interfaces of the instrument.
- Use the cable R&S SMU-Z6 for connection to the "DIG I/Q" interface of the instrument. The cable is available under material number 1415.0201.02.

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 SGT and connected devices.

Preventing electrostatic discharge (ESD)

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

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

Ground yourself to prevent electrostatic discharge damage:

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

3.1.6 Connecting to power

For safety information, see "Connecting to power" on page 12.

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 SGT.

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.

There is no need to set the voltage manually or change fuses.

3.1.7 Connecting to LAN

Network environment

Before connecting the product to a local area network (LAN), consider the following:

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

To connect to LAN

The connector is on the rear panel.

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

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

3.1.8 Connecting to RF 50Ω

The connector is on the rear panel.

Option R&S SGT-B88: The RF output connector is on the front panel.

To prepare for connecting to RF 50Ω

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

   Before connecting to the port, inspect the RF connector visually to check that it is clean, undamaged and mechanically compatible.
   See the application note 1MA99 for information on how to handle and maintain the RF port, to minimize measurement deviations and ensure its longevity.

2. **NOTICE!** Risk of instrument damage. Excessive reverse power or DC voltage at the RF 50Ω connector can damage the instrument.

   Make sure that the values do not exceed the reverse power and DC limits as given in the data sheet.

3. If switched-on, deactivate the RF output of the R&S SGT, before connecting an RF cable to the RF 50Ω connector.
   On the front panel, press the [RF ON] key.

To connect to screwable connectors

Additional to the RF 50Ω connector, the following procedure holds for all screwable connectors of the R&S SGT. Screwable connectors include connector types as listed in Table 3-1.

1. Use a high-quality cable that matches the connector type.
    See "Cable selection and electromagnetic interference (EMI)" on page 20.

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

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

    a) Carefully align the connector of the cable and the connector along a common axis.
    b) Mate the connectors along the common axis until the male pin of the inner connector engages with the female socket of the outer connector.
    c) Turn the nut of the outer connector until the connectors are firmly coupled.
    d) Torque the nut to the specified limit using a calibrated torque wrench. Hold the opposite connector part stationary with a spanner.
        For torque limits of the most relevant connector types, see Table 3-1. For more information, see chapter "Handling" of the application note 1MA99.

3. Torque the nut to the specified limit using a calibrated torque wrench. Hold the opposite connector part stationary with a spanner.

Table 3-1: Connector types and torque limits

Type	Torque limit		Nut opening	
	lb-Inch	Nm	Inch	mm
N	13.3	1.5	3/4	20
SMA SMB	5	0.56	5/16	8

To prevent RF output switch-off

▶   **NOTICE!** If you set a too high output level without a load connected to the instrument, the reverse power can exceed a limit forcing the R&S SGT to switch off the RF output.

    Connect a load with sufficient return loss.

3.1.9   Connecting to non-screwable connectors

Non-screwable connectors of the R&S SGT are BNC type connectors on the rear panel.

▶   To connect the RF cable with the RF 50Ω connector, proceed as follows:

    a) Carefully align the connector of the cable and the RF 50Ω 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 50Ω connector.

3.1.10 Switching on or off

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

Table 3-2: Overview of power states

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

To switch on the R&S SGT

The R&S SGT is off but connected to power. See Chapter 3.1.6, "Connecting to power", on page 21.

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

   The LED of the [POWER ON/STANDBY] key is orange.

2. If equipped with an oven-controlled oscillator (OCXO), option R&S SGT-B1, wait until the OCXO warms up.
   For the warm-up time, see data sheet.

3. Press the [POWER ON/STANDBY] key.
   Key and LED are on the front panel.

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

   When starting for the first time, the R&S SGT starts with the default settings. When restarting the instrument, the settings depend on the instrument configuration before shut-down.
   See Chapter 5.1.1, "File menu", on page 54.

To perform functional checks

When the instrument is switched on, it automatically monitors main functions. You can query erroneous functions.

See Chapter 12, "Error messages and troubleshooting", on page 581.

In addition to the automatic monitoring, the R&S SGT offers the following capabilities to ensure correct functioning:

- Internal adjustments
  In the R&S SGMA-GUI, select the "Instrument > Setup > Internal Adjustments" dialog to access the dialog for performing and configuring the adjustments settings. A maximum level accuracy can be obtained, for instance.

- Selftest
  A selftest is provided for service purposes ("SGMA-GUI > Instrument > Diagnostic/Test > Self Test").

To switch between standby and ready state

► Press the [POWER ON/STANDBY] key briefly to switch the instrument from the standby to ready state or vice versa.

In ready state, the button is green. The instrument is ready for operation. All modules are power-supplied and the R&S SGT initiates its startup procedure.
In standby state, the button is orange. The standby power only supplies the power switch circuits and built-in oscillator to keep it at its operating temperature. The remote control system is **not** active.

To start up and boot

The instrument boots the operating system and starts the instrument firmware. During the booting process, the green [POWER ON/STANDBY] key blinks. If the previous session was terminated regularly, the instrument uses the last setup with the relevant instrument settings.

Once the startup procedure has been terminated, the instrument is ready for operation.

In the R&S SGMA-GUI, select "Instrument > Preset" function to return the instrument to its defined reset/preset state, if the current setup is no longer relevant.

To customize the start settings, use the "SGMA-GUI > File > Save As/Open" function.

To shut down the product

The product is in the ready state.

► Press the [POWER ON/STANDBY] key.

The operating system shuts down. The LED changes to orange.

In 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 SGT 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 [POWER ON/STANDBY] key is switched off.

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

3.1.11 Checking default settings

When the instrument is switched on, it is not the preset state that is active, but rather the instrument state that was set before the instrument was switched off. It is recommended that you use the "SGMA-GUI > Instrument > Preset" function to return the instrument to its defined preset state every time a new configuration is required or the current setup is no longer relevant.

The R&S SGT offers a two-stage preset concept:

* Preset the instrument to a predefined state.
  The "SGMA-GUI > Instrument Name > Preset" function calls up a defined instrument setup. All parameters and switching states are preset. The default instrument settings provide a reproducible initial basis for all other settings. However, functions that concern the integration of the instrument into a measurement setup are not changed.

* Preset the instrument to its factory settings.
  The instrument can also be forced to load its default factory settings. To access the corresponding dialog box, select the "SGMA-GUI > Instrument Name > Setup > Factory Preset" function.
  For more information and an overview of the settings affected by the factory preset function, see Chapter 7.12, "Factory preset", on page 294.

User-defined instrument states can be stored and called up using the functions "SGMA-GUI > File > Save As/Open".

3.1.12 Working with Linux operating system

The instrument uses an embedded Linux operating system, optimally adapted to the instrument.

Accessing the operating system

No access to the operating system is required for normal operation.

All necessary system settings can be made in the "Setup" dialog.

3.1.13 Connecting an external PC and devices

For control and operation, the R&S SGT requires a connection to an external device. The external device, e.g. an external PC, controls the R&S SGT via remote control or manual operation via the R&S SGMA-GUI software installed on the external PC.

Both the remote control and the manual operation of the instrument require an external controller. For the prerequisites and the instructions on how to configure an external controller for remote control, refer to the user manual. A brief introduction to the remote control capabilities is provided in Chapter 9, "Network operation and remote control", on page 312.

This section gives an introduction on how to configure the external PC for manual operation. See Chapter 3.1.13.1, "Installing the R&S SGMA-GUI software", on page 27.

In addition to connecting an external controller, you can connect other external devices, e.g. a memory stick. The following interfaces are on the rear panel of the R&S SGT:

- "LAN": Chapter 3.1.13.2, "Connecting a remote PC via LAN", on page 28
- "PCIe": Chapter 3.1.13.3, "Connecting a controller via PCI Express", on page 31
- "USB IN": Chapter 3.1.13.4, "Connecting a controller via USB", on page 31

3.1.13.1 Installing the R&S SGMA-GUI software

The R&S SGMA-GUI software is a graphical user interface program for one or more instruments. It runs on a remote PC.

The R&S SGMA-GUI software is provided as separate installation package for the different operating systems. The latest version of the software together with the release notes is available for download at:

http://www.rohde-schwarz.com/product/SGT100A.html > "Downloads" > "Software"

This page always offers the latest information on your R&S SGMA-GUI.

The R&S SGMA-GUI installation package for Windows 64-bit operating system consists of the file `SGMA-GUI_<version_number>.exe`. The version number within the file name (`<version_number>=v.vv.vvv.vv`) varies with each update.

To install the R&S SGMA-GUI, check that you PC and drivers fulfill the following hardware and software requirements.

Table 3-3: Hardware and software requirements

Requirement	Remark
Operating system: Windows 10, 1607 "Anniversary Edition" and later	Install R&S SGMA-GUI on one of the supported operating systems. Also, make sure that Microsoft offers support for the version of the operating system. **Note:** Any other Windows version or other operating systems are not supported. During installation, the operation system is checked. The installation is terminated if this requirement is not fulfilled.
System type: • 64-bit operating system • x64-based or x86-based processor	You can only run the latest software on a 64-bit operating system.
R&S VISA	VISA drivers can be obtained on the Rohde & Schwarz website: http://www.rohde-schwarz.com/rsvisa
CPU	At least Pentium or compatible, as from 1 GHz (recommended).
VGA color display resolution	At least 800*600 pixels

Installing a new software version

1. Download the R&S SGMA-GUI software.

2. In Windows Explorer, navigate to the download folder of the installation file
   `SGMA-GUI_V.VV.VVV.VV.exe` (`<version_number>=v.vv.vvv.vv`).

3. Open the installation file using administrator rights.

4. Follow the instructions in the installation wizard.

After the installation of the R&S SGMA-GUI software, two icons will be shown in your Windows menu: one is the standard version and one for which the remote command of the software through SCPIs is disabled. The SCPI disabled version allows you to install and use the R&S SGMA-GUI on other instruments, without interfering with the remote control of the host instrument.
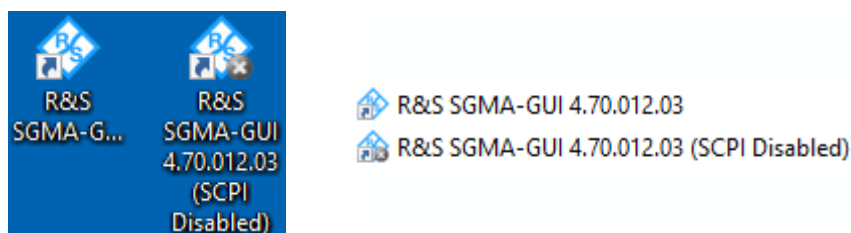
Start the version that is required for your application.

Uninstalling an old software version

You can uninstall a previous version of the software before the installing a new software version, but this step is not mandatory.

1. To uninstall this version, go to "Start > Settings > Control Panel > Add/Remove Programs".

2. Select the entry `SGMA-GUI_V.VV.VVV.VV`.

   The script file identifies and removes all currently installed R&S SGMA-GUI software items.

3.1.13.2 Connecting a remote PC via LAN

The R&S SGT is equipped with a network interface and can be connected to an Ethernet LAN (local area network). The interface can be used, for example:

- To connect an external computer for manual control of the instrument by the R&S SGMA-GUI software.
- To operate the device by a remote control program.
  See Chapter 9, "Network operation and remote control", on page 312.

This section describes how to configure the LAN interface. It covers the following topics:

Connecting to the network

There are two methods to establish a LAN connection to the instrument:

- A non-dedicated network (Ethernet) connection from the instrument to an existing network.
- A dedicated network connection (Point-to-point connection) between the instrument and a single computer.

In both cases, an IP address has to be assigned to the instrument and the computer, see "Assigning the IP address" on page 29.

Setting up a non-dedicated network (LAN) connection

► See Chapter 3.1.7, "Connecting to LAN", on page 22.

Setting up a dedicated network connection

If your network does not support DHCP, set a dedicated network connection between a stand-alone PC and a R&S SGT.

Prerequisite: The external PC and the R&S SGT are turned on and running.

1. Start the R&S SGMA-GUI.

2. Connect the computer and the R&S SGT with a LAN network cable.

3. Wait for about one minute for the automatic assignment of IP addresses to complete.

4. R&S SGMA-GUI main panel, select "Setup > Instruments".

5. In the "Configure Instruments" dialog, click "Scan".

   The new instrument appears with a Zeroconf IP address 169.254.xx.yy.

6. To assign a static IP address to the instrument, see "Assigning a static IP address to the R&S SGT" on page 30.

7. To assign a static IP address to the PC, see "Assigning a static IP address to your Windows-PC network card" on page 30.

Assigning the IP address

Depending on the network capacities, the TCP/IP address information for the instrument can be obtained in different ways.

- If the network supports dynamic TCP/IP configuration using the Dynamic Host Configuration Protocol (DHCP), all address information can be assigned automatically.
- If the network does not support DHCP, 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, see "Setting up a dedicated network connection" on page 29.

(i) The R&S SGT uses the Zeroconf IP addresses 169.254.xxx.yyy, where xxx takes values from 1 to 254 and yyy the values from 1 to 255. The subnet mask is always 255.255.0.0. The IP address of the host must be within the same address area for Zeroconf.

Assigning a static IP address to the R&S SGT

Prerequisites: A connection is established between the R&S SGT and the controller with installed SGMA-GUI.

For how to set up a LAN connection, see "Connecting to the network" on page 29.

For how to set up a USB connection, see "Setting up a USB connection from a PC to the R&S SGT" on page 32.

1. Open "SGMA-GUI > Instrument > Setup > Network Settings" dialog.

2. Set the "Address Mode" to "Static".

3. Enter the "IP Address", for example *192.168.0.1.*.

4. Enter the "Subnet mask", for example *255.255.255.0*.

5. Enter the "Default Gateway", for example *192.168.0.1*.

Assigning a static IP address to your Windows-PC network card

1. Obtain the IP address and subnet mask for the R&S SGT and the IP address for the local default gateway from your network administrator. If necessary, also obtain the name of your DNS domain and the IP addresses of the DNS and WINS servers on your network. If you use more than one LAN connector, you need separate address information for each connector.

2. Press the "Windows" key to access the operating system.

3. Open the "Control Panel" by selecting "Start > Settings > Control Panel".

4. Select "Network and Sharing Center".

5. In the left panel, click "Change adapter settings".

6. Select the network adapter that you want to change. Click "Change settings of this connection".

7. On the "Networking" tab, click "Internet Protocol Version 4 (TCP/IPv4)". Select "Properties".

8. Select "Use the following IP address".

9. Enter the address information as obtained from the network administrator.

10. If necessary, you can also select "Use the following DNS server addresses" and enter your own DNS addresses.

    For more information, refer to your Windows system help.

Adding instruments to R&S SGMA-GUI

For information on how to install the R&S SGMA-GUI software, refer to Chapter 3.1.13.1, "Installing the R&S SGMA-GUI software", on page 27.

1. For each new instrument perform the following steps:
    a) Connect the instrument to the network.
    b) Press the [POWER ON/STANDBY] key to switch on the instrument.
    c) Wait until the [POWER ON/STANDBY] LED is green and not blinking.
    d) Press the [ID] key on the front panel of the instrument.

2. Start the SGMA-GUI on a computer connected to the same network.

3. Open the "Instruments" dialog.

4. Select "Scan".

    Note: This step is performed automatically on the first start and can also be omitted for instruments with a direct LAN connection to the computer.

    All instruments are added automatically to the main panel of the SIGMA-GUI.

3.1.13.3 Connecting a controller via PCI Express

Using the "PCIe" interface for remote control of the R&S SGT requires extended knowledge. See Chapter 9.3, "Advanced remote control using PCIe", on page 322.

3.1.13.4 Connecting a controller via USB

The USB interface on the rear panel of the R&S SGT allows you to connect either a USB device or use the R&S SGT as a device and connect it to a controller.

Connecting a controller (host PC or compatible signal generator)

If you connect a controller (host PC or compatible signal generator) to the R&S SGT, the R&S SGT acts as a USB device.

To connect the controller to the USB interface of the R&S SGT, always connect the **USB type Micro-B** connector to the R&S SGT. Refer to the documentation of the controller to find out which USB connector type you can connect to the controller.

The Figure 3-1 illustrates schematically the required connector type to emphasize on the different connector shape.
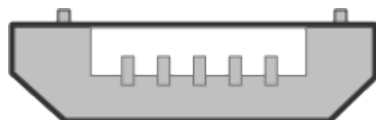
Figure 3-1: USB type Micro-B connectors

An external PC with installed R&S SGMA-GUI is required for manual operation of the R&S SGT.

Setting up a USB connection from a PC to the R&S SGT

If your network does not support DHCP, you can set a USB connection between a PC and a R&S SGT.

Prerequisite: the computer and the R&S SGT are turned on and running.

1. Start the R&S SGMA-GUI.

2. Connect the computer and the R&S SGT with a USB cable.

    In the "Setup > Instruments > Configure Instruments" table, the new instrument appears automatically.
    If it does not appear, open the "Setup > Instruments > Configure Instruments" dialog and select "Scan".

3. If your network does not support DHCP, you can now set a static IP address to your computer.

    a) To assign a static IP address to the instrument, see "Assigning a static IP address to the R&S SGT" on page 30.
    b) To assign a static IP address to the PC, see "Assigning a static IP address to your Windows-PC network card" on page 30.

Connecting a USB device

If you connect a USB device (memory stick, CD-ROM, an instrument) to the R&S SGT, the R&S SGT acts as a host.

To connect a USB device to the interface of the R&S SGT, always connect the **USB type Micro-A** connector to the R&S SGT. Refer to the documentation of the USB device to find out which USB connector type you can connect to the USB device.

The Figure 3-2 illustrates schematically the required connector type to emphasize on the different connector shape.
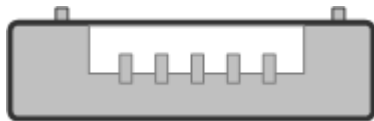
Figure 3-2: USB type Micro-A connectors

3.2 Instrument tour

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

The meanings of the labels on the R&S SGT are described in Chapter 1.2, "Labels on R&S SGT", on page 13.

3.2.1 Front panel tour

This section provides an overview of control elements on the front panel of the R&S SGT. The front panel contains LEDs to inform you about the status of the instrument, in particular for remote control of the R&S SGT.

The connectors of the R&S SGT are on the rear panel.
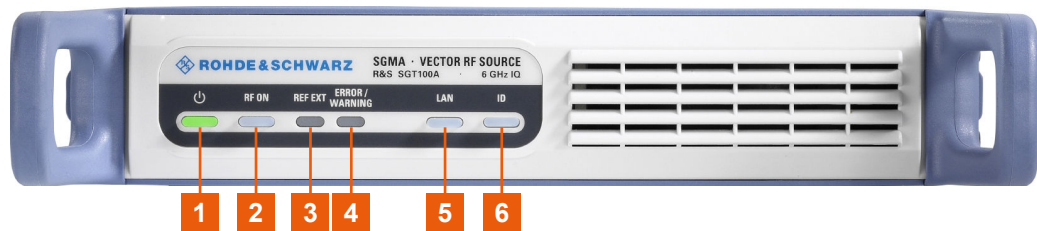
Figure 3-3: R&S SGT front panel controls

1 = [POWER ON/STANDBY]
2 = [RF ON]
3 = [REF EXT]
4 = [ERROR / WARNING]
5 = [LAN]
6 = [ID]

[POWER ON/STANDBY]
The [POWER ON/STANDBY] key switches the instrument from the standby to the ready state or vice versa.

The LED above the [POWER ON/STANDBY] key indicates the instrument state, see Table 3-2.

How to:
- Chapter 3.1.10, "Switching on or off", on page 24
- "To switch between standby and ready state" on page 25

[RF ON]
The [RF ON] key switches the RF signal on or off. If activated, the key is green.

Table 3-4: Overview of RF signal states

[RF ON] state	LED	Remark
On	● green	RF signal output at the RF 50Ω connector.
Off	● gray	No RF signal output.

How to: Chapter 3.1.8, "Connecting to RF 50Ω", on page 22

[REF EXT]
The [REF EXT] key activates synchronization to an external reference signal.

Use the "USER 1/2" on the rear panel for input of the external reference signal.

Table 3-5: Overview of external reference signal states

[REF EXT] state	LED	Remark
Synchronized	🟢 green	R&S SGT synchronizes to the external clock signal.
Error	🔴 red	R&S SGT cannot synchronize to the external clock signal.
Off	⚪ gray	The internal reference signal is used.

[ERROR / WARNING]

The [ERROR / WARNING] LED indicates the status of the R&S SGT.

Table 3-6: Overview of [ERROR / WARNING] key states

[ERROR / WARNING] state	LED	Remark
Error	🔴 red	Error occurred, e.g. temperature exceeded or power failure.
Running process	☀ blinking orange	Indicates a running process (e.g calibration, self-test).
No error	⚪ gray	No errors or warnings occurred.

See also Chapter 12, "Error messages and troubleshooting", on page 581.

[LAN]

The [LAN] key indicates the LAN connection state.

Pressing the [LAN] key resets the network settings, e.g., "IP Adress Mode" is reset to "DHCP".

Table 3-7: Overview of LAN connection states

[LAN] state	LED	Remark
Connected	🟢 green	Connected to the network.
Running process	☀ blinking orange	Resets the network settings, applies the default settings.
Error	🔴 red	Network error occurred.
Off	⚪ gray	Disconnected from the network.

How to:
- Chapter 3.1.7, "Connecting to LAN", on page 22
- Chapter 3.1.13.2, "Connecting a remote PC via LAN", on page 28

[ID]

The [ID] key allows you to identify your R&S SGT, e.g. in complex test setups with more instruments.

The following applies if the R&S SGT is connected to a remote controller with R&S SGMA-GUI installed:
- Press the [ID] key identify your R&S SGT on the remote controller. In the dialog "SGMA-GUI > Setup > Instruments > Configure Instruments > Edit Instrument", the R&S SGT is active.

- Set "Edit Instrument > Device Identify > On" to identify your R&S SGT from the remote controller. The LED of the [ID] key is orange and blinking.

Table 3-8: Overview of [ID] key states

[ID] state	LED	Remark
Identification	☀ blinking orange	Identification of the R&S SGT.
Off/Inactive	⚪ gray	No identification.

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.
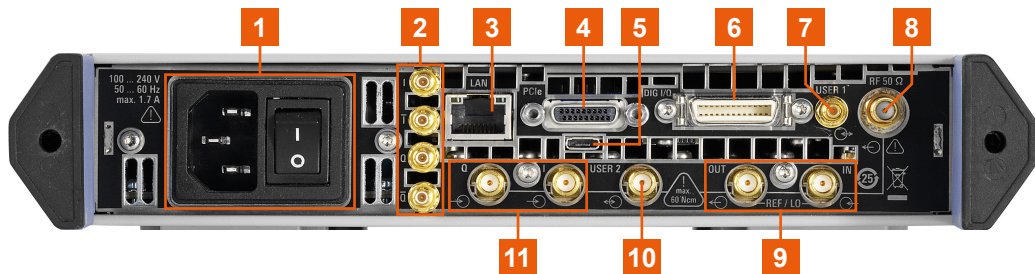
Figure 3-4: R&S SGT rear panel controls and connectors

```
1      = AC power supply connector and power switch
2      = I/Q, I/Q Bar
3      = LAN
4      = PCIe
5      = USB IN
6      = DIG I/Q
7, 10  = USER 1/2
8      = RF 50Ω
9      = LO IN, LO OUT, REF IN, REF OUT
11     = I/Q
```

AC power supply connector and power 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 21

I/Q, I/Q Bar

SMB male connectors for output of direct (single-ended) or analog I/Q signals.

How to: Chapter 3.1.8, "Connecting to RF 50Ω", on page 22

LAN

RJ-45 connector to connect the R&S SGT to a LAN for remote control.

How to:
- Chapter 3.1.7, "Connecting to LAN", on page 22

PCIe

PCIe (Peripheral Component Interconnect Express) single lane interface for remote control with optimized speed.

How to: Chapter 9.3.4, "Connecting the controller and the instrument", on page 326.

USB IN

USB (universal serial bus) type Micro-B connector for remote control via various external devices.

How to: Chapter 3.1.13.4, "Connecting a controller via USB", on page 31

DIG I/Q

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

USER 1/2

"USER 1" is an SMB connector, "USER 2" is an SMA female connector.

Both connectors are multipurpose connectors for input signals and output signals, e.g., for the following signals: "Trigger", "Marker 1/2", "Clock In/Out", "Sync In/Out". Also, use the "USER 2" connector for input of an external pulse modulator signal.

How to: Chapter 3.1.8, "Connecting to RF 50Ω", on page 22

RF 50Ω

SMA female connector for output of the RF signal.

How to: Chapter 3.1.8, "Connecting to RF 50Ω", on page 22

LO IN, LO OUT, REF IN, REF OUT

SMA female type connectors, for reference or local oscillator signals, and alternatively also in MIMO setups.

Reference input and output:
● "REF IN": Input for external reference signal.
● "REF OUT": Output of internal reference signal.

Local oscillator input and output connectors:
● "LO IN": Input for external LO signals
● "LO OUT": Output of internal LO signals.

How to: "To connect to screwable connectors" on page 23

I/Q

SMA female connectors for input of external I/Q signals. The signals are fed directly into the I/Q modulator.

How to: "To connect to screwable connectors" on page 23

3.2.3 Connector extension unit (R&S SGT-B88)

This chapter provides an overview of control elements and connectors of the R&S SGT connector extension unit.

Order the R&S SGT connector extension unit R&S SGT-B88 together with a new R&S SGT instrument.

You cannot extend an existing R&S SGT unit.

3.2.3.1 Front panel

This section provides an overview of the connectors on the front panel of the extension unit. For an overview of the front panel connectors of the R&S SGT, refer to Chapter 3.2.1, "Front panel tour", on page 33.
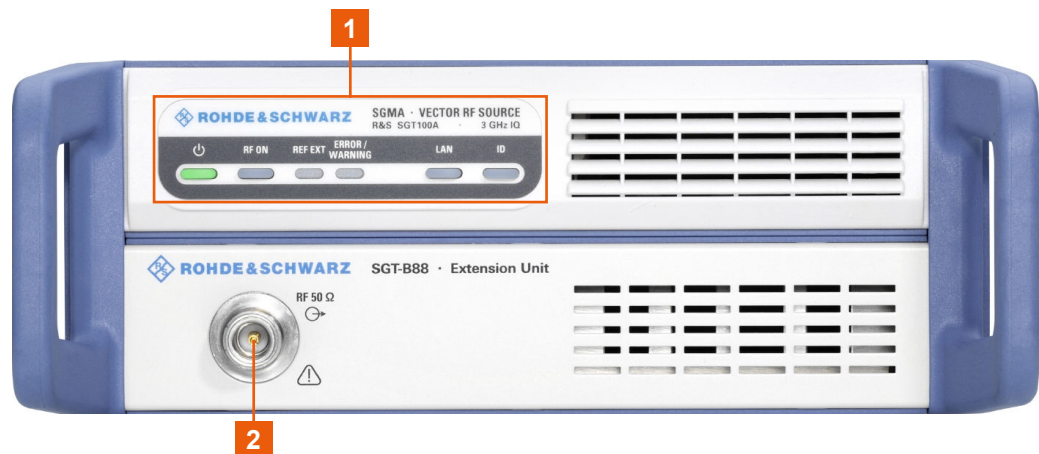
Figure 3-5: R&S SGT connector extension unit: controls and connectors

1 = R&S SGT front panel controls, page 33
2 = RF 50Ω, page 37

RF 50Ω
N-type connector for a 50 Ohm RF signal output.

How to: Chapter 3.1.8, "Connecting to RF 50Ω", on page 22

3.2.3.2 Rear panel

This section provides an overview of the connectors on the rear panel of the extension unit.

For an overview of the connectors of the rear panel of R&S SGT, refer to Chapter 3.2.2, "Rear panel tour", on page 35.
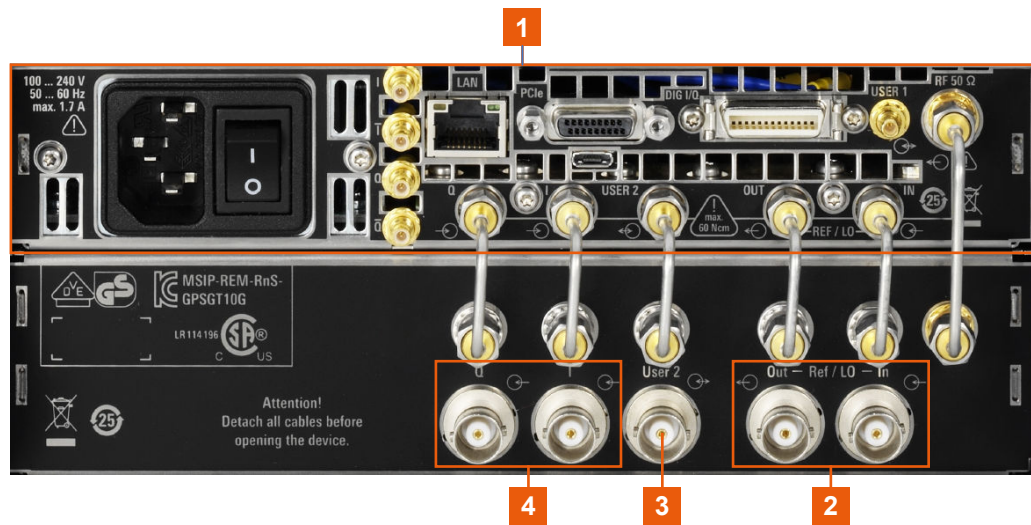
Figure 3-6: Rear panel view of the R&S SGT and the connector extension unit

1 = R&S SGT rear panel, page 35
4 = REF IN, REF OUT, LO IN, LO OUT, page 38
3 = User 2, page 38
2 = I/Q, page 38

REF IN, REF OUT, LO IN, LO OUT

BNC type connectors, for reference signals or local oscillator signals, and alternatively also in MIMO setups.

Reference input and output:
● "REF IN": Input for external reference signal.
● "REF OUT": Output of internal reference signal.

Local oscillator input and output connectors:
● "LO IN": Input for external LO signals
● "LO OUT": Output of internal LO signals.

How to: "To connect to screwable connectors" on page 23

User 2

BNC multipurpose connector for input and output signal, e.g., for the following signals: "Trigger", "Marker 1/2", "Clock In/Out", "Sync In/Out".

Also, use the connector for input of external pulse modulator signal.

How to: Chapter 3.1.9, "Connecting to non-screwable connectors", on page 23

I/Q

BNC connectors for input of an external I/Q modulator. The signal is fed directly into the I/Q modulator.

How to: Chapter 3.1.9, "Connecting to non-screwable connectors", on page 23

3.3   Trying out the instrument

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

Prerequisites

Before you try out the following tasks, connect the R&S SGT to a remote PC. Install the R&S SGMA-GUI software on this PC and add the R&S SGT to the list of "Available Instruments".

For information on how to fulfill these requirements, refer to:
- "Connecting to the network" on page 29
- Chapter 3.1.13.1, "Installing the R&S SGMA-GUI software", on page 27
- "Adding instruments to R&S SGMA-GUI" on page 31

3.3.1   How to generate a CW signal

Configuring the R&S SGT to generate a CW signal
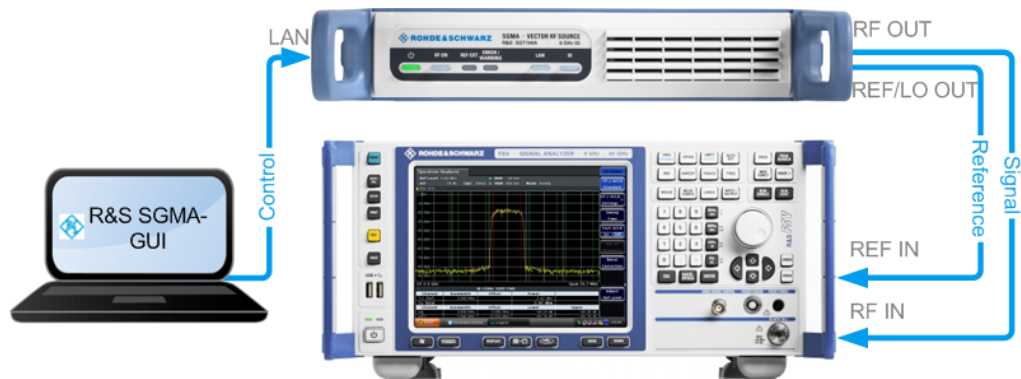
Figure 3-7: Example of the setup

1. Check, that [POWER ON/STANDBY] key is green.
   The key is on the front panel of the R&S SGT.

2. On the connected remote PC, start the R&S SGMA-GUI software application.

   The main panel of the application opens. The panel provides a quick access to the main settings of the configured and activated instruments. The display shows one row per instrument with the instrument-specific settings. The rows comprise the instrument, the connection state, the used frequency and power level, the state of the RF output and the modulator and the used reference frequency source.
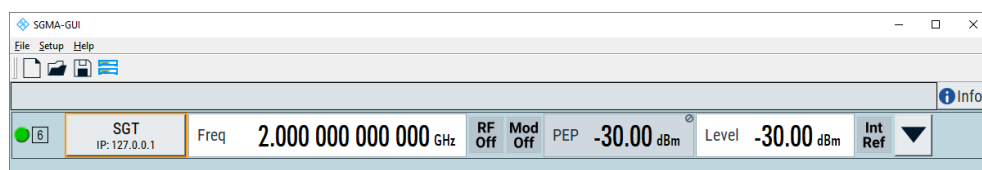
3. In the R&S SGMA-GUI main panel, the green indicator in front of the name of the
    instrument confirms an active connection.
    The software recognizes the instrument and displays the connection state between
    the instrument and the remote PC.

4. In the R&S SGMA-GUI main panel, select the row of the instrument, that you want
    to configure.

5. Select "Instrument Name > Preset" to restore the predefined instrument's settings.
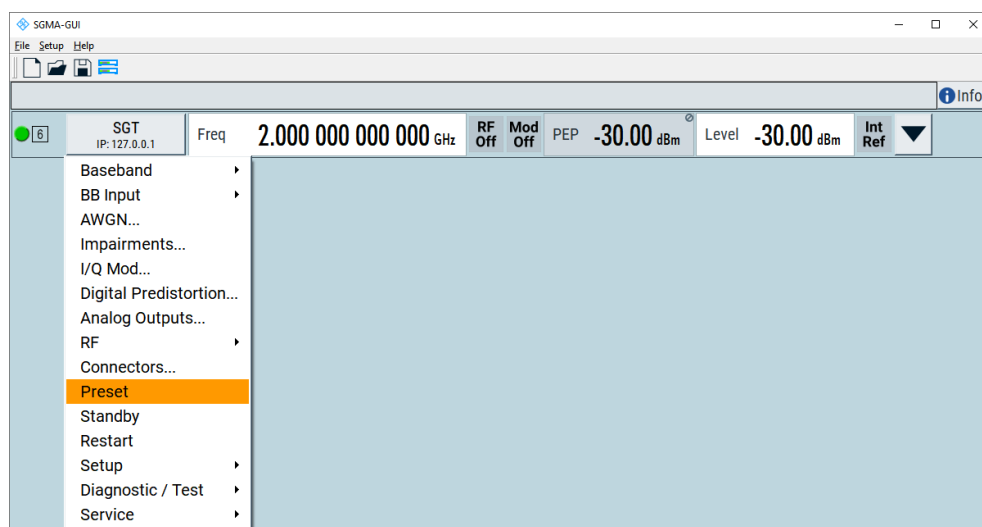
6. In the R&S SGMA-GUI main panel, select the row of the instrument that you want
    to configure.

7. Set the "Frequency" as required.

8. Select "SGMA-GUI > RF On" to enable the output of the CW signal.
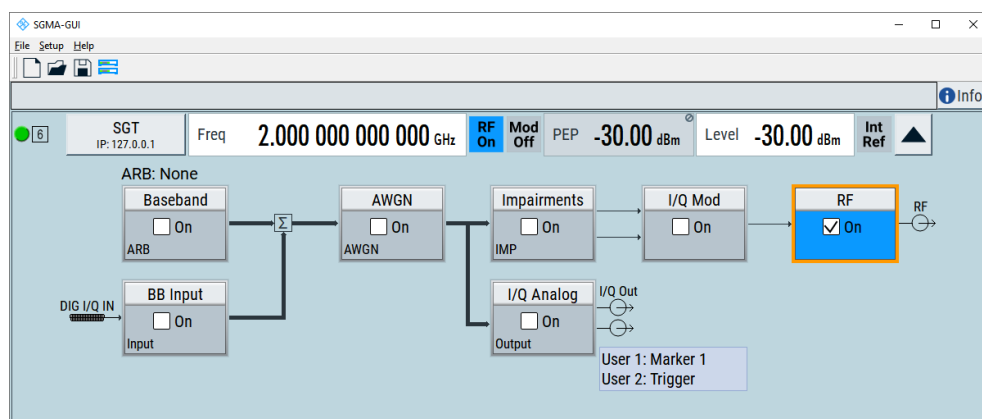
The 2 GHz signal is output at the [RF OUT] connector at the rear panel of the R&S SGT.

3.3.2   How to create and load a waveform file

The following is an example of how to use the R&S WinIQSIM2 to generate a waveform and load it in the ARB of the R&S SGT.

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

ⓘ 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 "software manual R&S WinIQSIM2".

ⓘ You cannot remotely control the instrument via the R&S SGMA-GUI and R&S WinIQSIM2 from the same controller computer, if the instrument is connected to the computer through USB.

You can connect the R&S SGT and the computer via LAN and assign different SCPI socket port numbers for the remote control through the two software applications.

To configure the R&S SGT 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 SGT.

The general instrument settings of the destination instrument affect various functions, like, the maximum size of the file the waveform is stored in. It is recommended 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 > Config > Instruments".

Instruments...
Remote Desktop...
Remote Control (SCPI)...
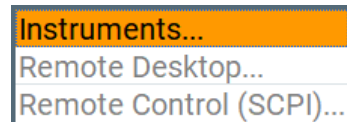
The "Configure Instruments" dialog opens. The list of configured instruments is empty.

3. Select "Configure Instruments > Scan".
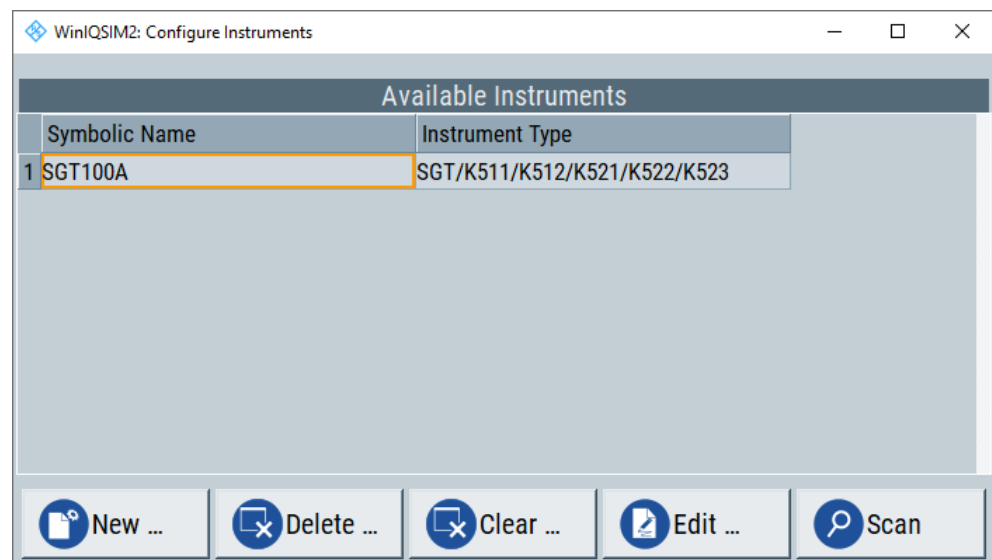
The software scans the network for connected and active instruments. Alternatively, use the "New" function to add the R&S SGT manually to the list of instruments.

4. Close the dialog.

5. In the block diagram, select "Vector Sig Gen" block and select the R&S SGT form the list.

6. In the block diagram, select "Arb Sig Gen" block and select the R&S SGT form the list.
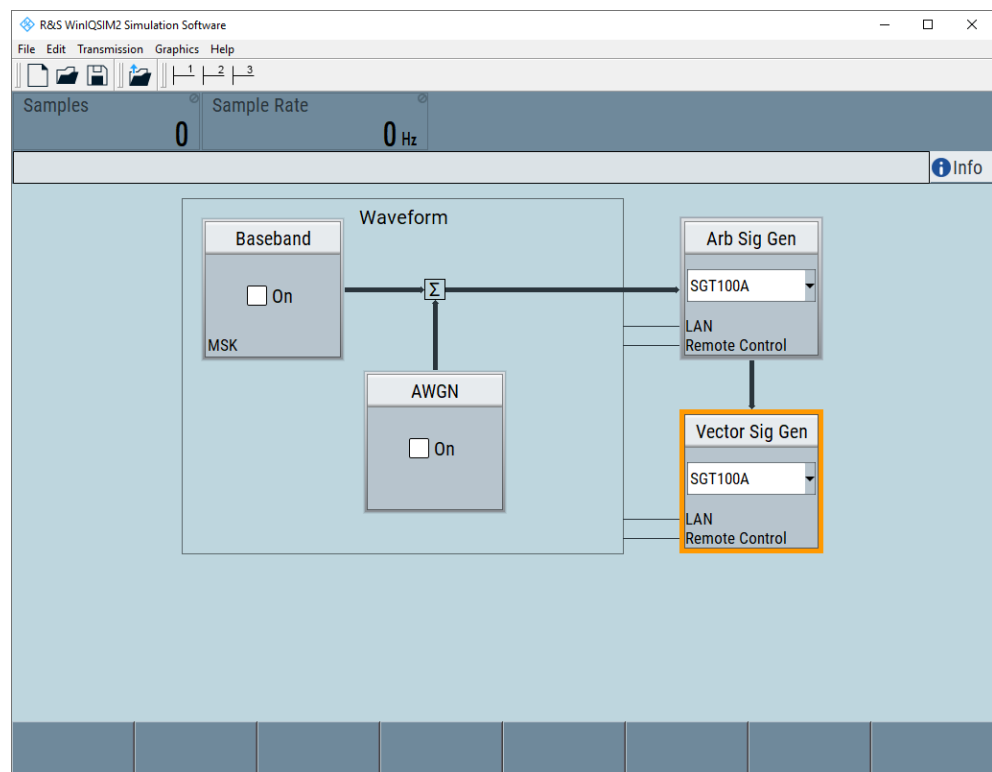
The two lines to the "Vector Sig Gen" and "Arb Sig Gen" blocks on the block diagram confirm that a remote connection to the R&S SGT is established.

To generate an LTE example waveform file with the R&S WinIQSIM2

1. In the R&S WinIQSIM2, select "Block diagram > Baseband > Config. > EUTRA/LTE".

2. Adjust the settings as required, for example:
   a) Select "Link Direction > Downlink"
   b) Select a predefined test model, "Test Setups/Models > E-TM1_1__10MHz".

3. Enable "EUTRA/LTE > State > On".
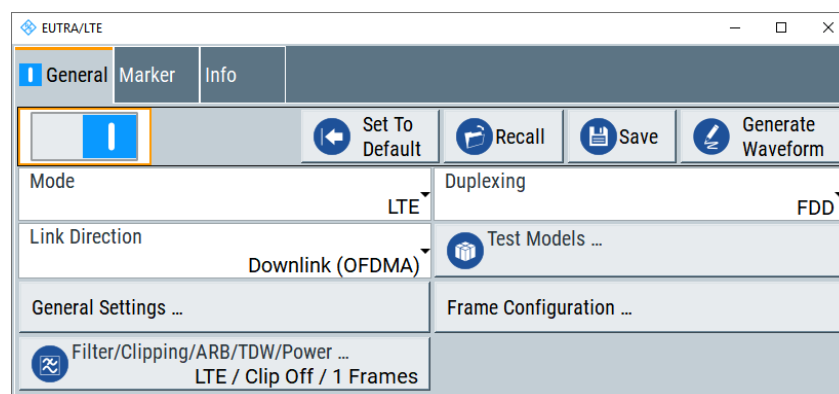
The R&S WinIQSIM2 calculates the signal and displays important signal parameters, like the used "Sample Rate" and "Number of Samples".

Use "Graphics > Graphic 1" view to retrieve more information on the generated signal.
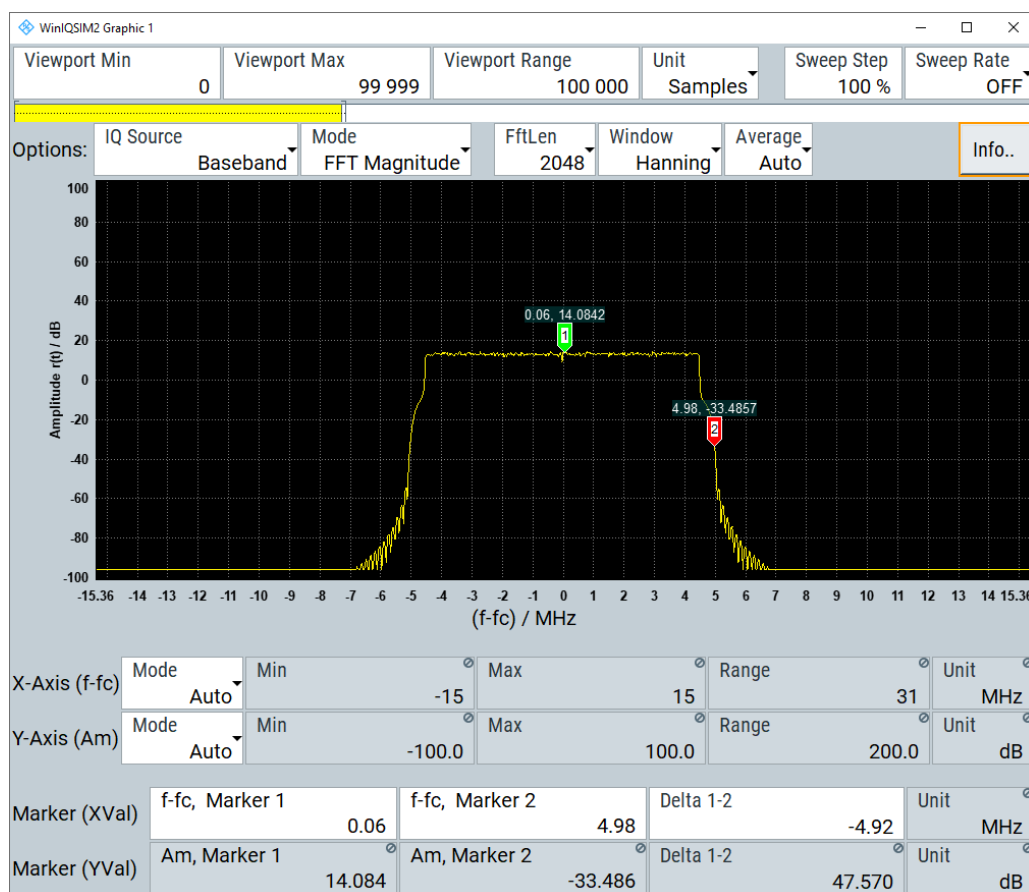
The display confirms the expected EUTRA/LTE 10 MHz spectrum.

To transfer the generated file to the R&S SGT

1. In the R&S WinIQSIM2, select "Transmission > Transmit".

2. In the "Waveform Transmission to Arbitrary Waveform Generator" dialog, select:

    a) "Source > Internal (WinIQSIM2)"
    b) "Destination > Instrument" and define the file name for the transmitted file.
    c) Enable "Automatically Load and Start Waveform > On".
    d) Select the required baseband, e.g. "Path A".
    e) Add a comment to the waveform.
    f) Select "Transmit".
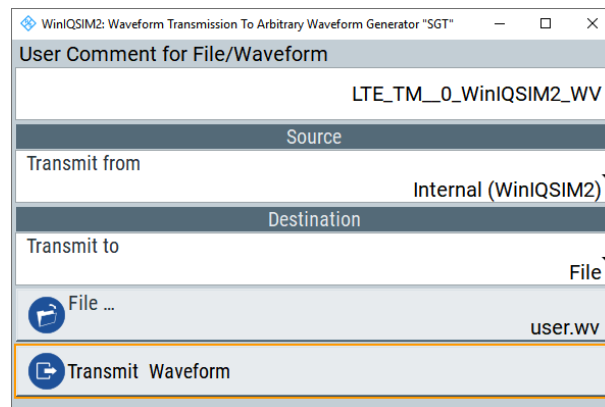
The waveform is transmitted to the default directory of the R&S SGT.

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

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

3.4 Instrument control

As a rule, the R&S SGT is operated exclusively via programmatic remote control from a connected PC. For service and diagnostic tasks, and for manual configuration, a graphical user interface (R&S SGMA-GUI) is provided which runs on the remote PC.

Also, some basic functionality is provided via the keys on the front panel of the instrument (see Chapter 3.2.1, "Front panel tour", on page 33).

3.4.1 Manual operation via R&S SGMA-GUI

The R&S SGMA-GUI software application can be installed on a PC with Windows or Linux operating system. This program allows you to control several devices of the SGMA product family at the same time and to monitor the device status during remote control. R&S SGMA-GUI requires one of the external interfaces described in Chapter 3.1.13, "Connecting an external PC and devices", on page 26.

3.4.1.1 Introduction to the user interface

After the start of R&S SGMA-GUI, the main dialog of the application is displayed.
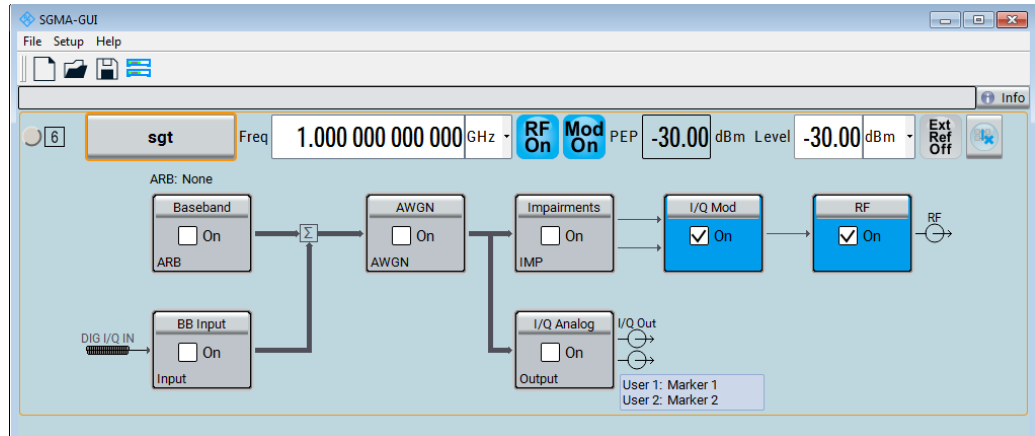
The main dialog with an overview of the configured instruments is the operating and control interface for the whole program. From here, all program functions are accessible.

The menus and dialogs are built using elements like selection lists, check boxes, and entry fields. A blue frame indicates that the selected item is active. Entries can be made in the highlighted element.

The main dialog comprises two main areas:

- On the top of the main panel, there are bars: the menu bar, the tool bar and the info bar with the corresponding "Info" button.
  The menu bar provides access to the functions related to the software application itself, like saving current configurations, retrieving information about the installed software version or configuring the connected instruments.
  The messages displayed in the info line indicate information, warnings, and errors. They are displayed in different colors depending on their importance and display duration. Use the "Info" button to open a dialog with information on the messages in greater detail.

- The central part of the R&S SGMA-GUI main dialog is the main panel that shows the list of all active instruments.
  The main panel is the core element for the manual operation and provides quick access to the main settings of the configured instruments. The display shows one row per active instrument. Each row comprises the instrument's name and state, the used frequency and level, the state of the RF output and the modulator and the kind of used frequency reference.
  The buttons with the instrument's symbolic name on it provides access to menus and dialogs for further instrument configuration. Refer to the user manual for a detailed description of all parameters and functions provided for configuration.

A detailed description of the R&S SGMA-GUI, in-depth information on how to work with the application and on how to operate the R&S SGT is provided in the user manual.

3.4.1.2 How to use the help system

The R&S SGMA-GUI is equipped with a context-sensitive help function. A help page is available for each parameter and can be called anytime during instrument operation.

Calling context-sensitive and general help

► To display the general help dialog box, select the "SGMA-GUI > Help > Contents" or use the F1 key.

The help dialog is displayed. A topic containing information about the current menu or the currently opened dialog box and its function is displayed.
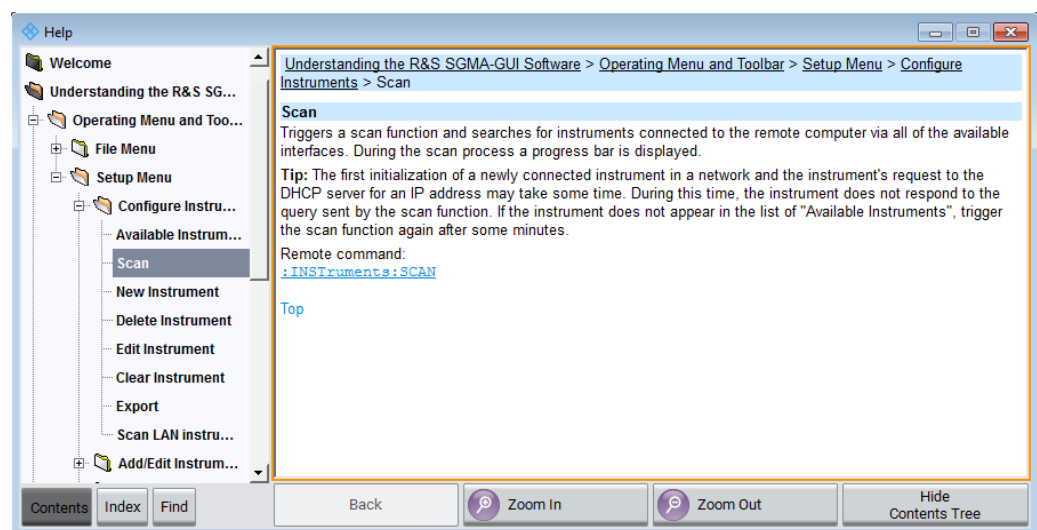
Contents of the help dialog box

The help dialog box contains two main areas:

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

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

Navigating in the table of contents and in the help topics

1. To move through the displayed contents entries, use the mouse or the [Up/Down] keys. Entries that contain further entries are marked with a plus sign.

2. To display a help topic, double click on the topic name or press the [ENTER] key.

3. To jump to the linked topic, press the link text.

4. Use the "Previous" or "Next" links to jump to the corresponding topic.

5. Use the "Scroll Right" or "Scroll Left" buttons to shift the indicated area of the navigation window to the left or right.

Using the index

1. Select "SGMA-GUI > Help > Index" or use the "Go to Index" button in the "Help" display.

2. Enter the first characters of the topic that you are interested in. The entries starting with these characters are displayed.

3. Press the [ENTER] key to display the help topic.

    The corresponding help topic is displayed.

4 System overview

The R&S SGT RF Source is a vector signal generator intended for the generation of IQ-modulated signals and the playback and output of externally calculated modulation signals in the form of waveforms.

Optimized for use in automated test equipment (ATE), the instrument offers fast settling times in an exceptionally small formfactor and low power consumption. The R&S SGT is equipped with an active electronic step attenuator and can be equipped optionally with a high stability reference oscillator.

4.1 Setups for instrument control

The R&S SGT is an instrument designed for the automated test equipment (ATE) needs. To maintain the small size, the instrument is not equipped with a display and hence additional equipment is required to control the instrument.

This section provides an overview of the possible configuration setups for controlling the R&S SGT.

4.1.1 Manual operation from the R&S SGMA-GUI

The following example represents a basic configuration of the R&S SGT, operated manually by the configuration software R&S SGMA-GUI. The configuration software is installed on a remote PC and controls several instruments. The instruments are connected to the remote PC over different remote control interfaces. Any combination of the used interfaces is possible.
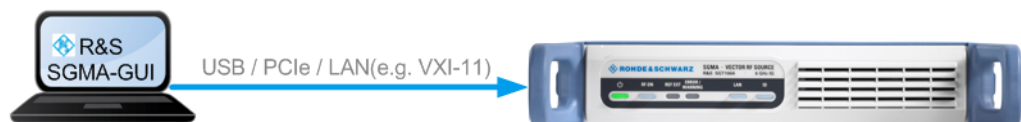
Figure 4-1: Configuration example: manual control from R&S SGMA-GUI

For information about the manual control, refer to:
- Chapter 5, "Understanding R&S SGMA-GUI", on page 53
- Chapter 6, "Signal generator settings", on page 85
- Chapter 7, "General instrument settings and instrument setup", on page 270

4.1.2 Remote control from a controller

The remote control provides access to the instrument's settings from a remote computer (external controller) by remote commands. To automate often repeating settings

and sequences, these settings are grouped in the remote control programs, i.e. application programs.

An instrument can be connected to the controller via any of the supported interfaces LAN, USB or PCIe.
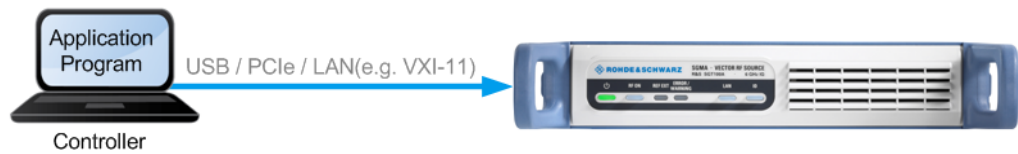
Figure 4-2: Configuration example: remote control from a controller

For information about remote control, refer to Chapter 9, "Network operation and remote control", on page 312.

4.2 Managing files on the R&S SGT

The R&S SGT has internal memory, where you can store waveforms, lists etc. You can also access these files and manage them as required.

To access files on the R&S SGT

1. Connect the R&S SGT and a Windows PC to the same network.

2. On the PC, open a Windows Explorer window.

3. To connect to the R&S SGT, enter the name of the instrument or its IP address in the Windows address bar.
   For example, enter `\\rssgt100a101840`:
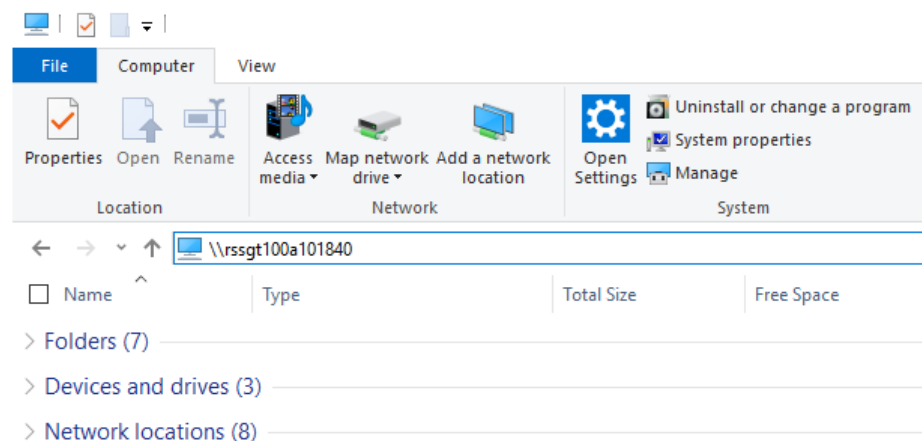
4. Enter the user name and password to connect to the R&S SGT. The default user name is *instrument* and the password is *instrument*.
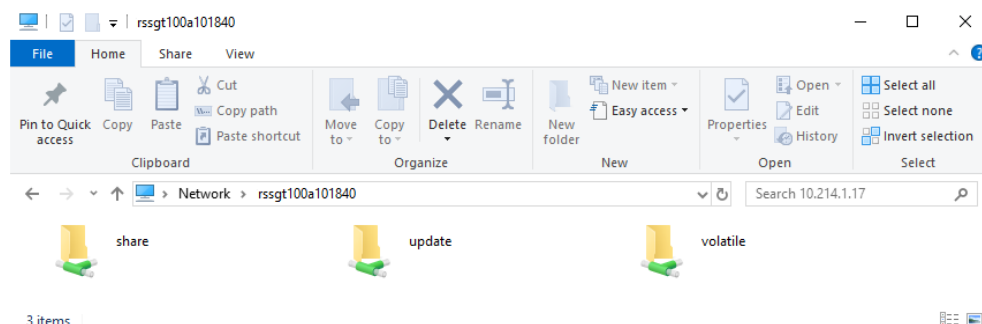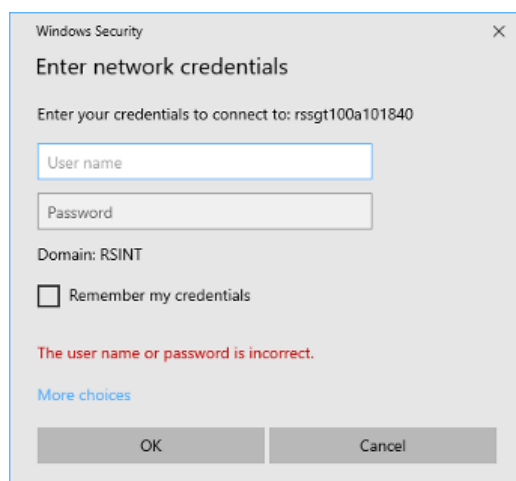
A folder opens, containing the `share` and the `update` folder.

The `share` folder contains the user files, e.g. waveforms, lists. You can copy, delete and rename the files contained in this folder.

The `update` folder allows you to start an update of the instrument's firmware. If you copy a firmware update file in this folder, the update starts automatically.

Types of user data

The **user data** includes saved instrument settings, lists for the list mode and the user correction, and the waveforms for the arbitrary waveform generator.

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.
- Externally or internally generated *lists*, e.g. user correction lists, or data lists can be loaded in the instrument.
- Externally generated *waveforms* can be loaded in the "Arbitrary Waveform Generation" dialog.

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 SGT is switched off.

File storage location

Without any additional measures, the R&S SGT stores user files on the internal memory, the removable memory, or if connected, on a memory stick.

Both, the user directory `/var/user/` on the internal memory or the `usb` directory on the memory stick, can be used to **preserve** user-defined data. Any directory structure can be created.

The `/var/volatile` directory serves as a RAM drive and can be used to protect sensitive information. The data is available **temporarily**.

5 Understanding R&S SGMA-GUI

This section gives a detailed description of the R&S SGMA-GUI user interface and information on how to work with it. The main panel with the overview of the configured instruments is the operating and control interface for the whole program. From here, all program functions are accessible. This panel is displayed after the start of R&S SGMA-GUI. The software always loads the previously used settings, so you can continue your work in the next session.
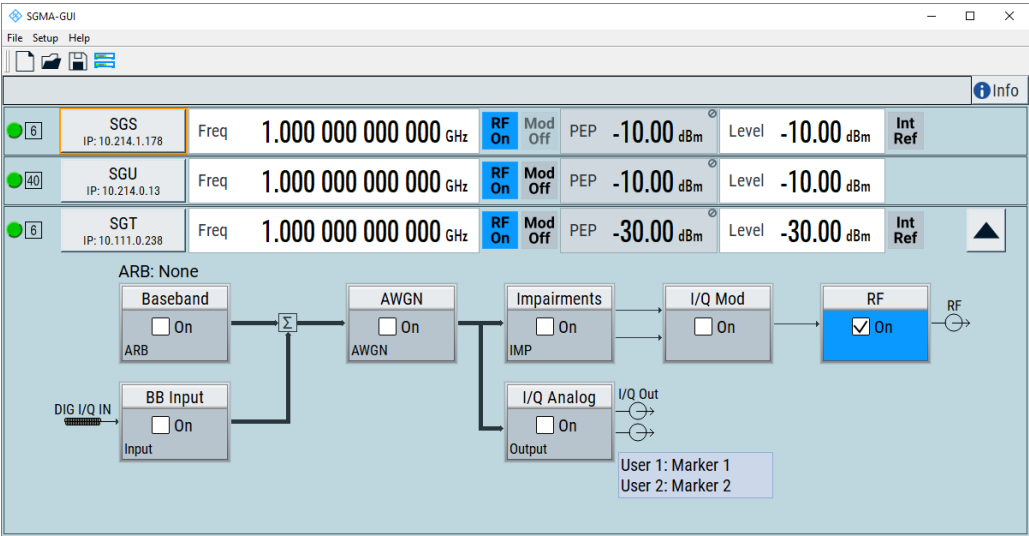
5.1 Operating menu and toolbar

On the top of the main panel, there is the menu bar, the toolbar and the info bar with the corresponding "Info" key. Some of the functions are accessible via the toolbar with its icons below the menu selection line.

The dialogs are built using elements, e.g., selection lists, checkboxes, and entry fields. A blue frame indicates that the selected item is active. In a highlighted element, entries can be made.

Table 5-1: Content of the operating menu

File	Setup	Help
New	Instruments	About
Open	Software	Contents

File	Setup	Help
Save	Reset SGMA-GUI	Index
🖫 Save as	For R&S SGS/R&S SGT: Protection	
Exit	For R&S SGS/R&S SGT: Remote	
Shut down instruments and exit		

5.1.1 File menu

The R&S SGMA-GUI employs the standard Save/Recall file management function and allows you to save and reload settings in/to a file with a user-defined name and location (see also Chapter 5.5.1, "Saving and loading settings", on page 70).

In the following, the "File" menu of the R&S SGMA-GUI is described in detail. It incorporates standard functions.

New
Resets R&S SGMA-GUI and all connected instruments to their preset settings.

Open
Opens the standard file open browser for loading a saved R&S SGMA-GUI file (`*.savrcl`). The file contains the user-specific settings of a session, such as instruments configured in the software. The complete settings of a session can be saved and loaded.

Only files of this type are selectable.

Note: Instrument-specific settings, e.g. frequency and level settings, are saved locally on the particular instrument itself. These instruments settings are saved automatically in a predefined directory and loaded by default when starting the instrument again. The files with instrument settings are not accessible.

Save
Standard quick save of the settings of the current session if a filename previously has been applied. If not, the "Save As" dialog is opened.

Save as
Opens the standard file save browser for saving the settings of the current session. R&S SGMA-GUI files have the file extension `.savrcl` so the name typed in is equipped with this extension. The complete settings of a session are saved.

Exit
Quits the R&S SGMA-GUI. The current settings of the instrument's session are saved and loaded by default when starting the software again.

Note: The instruments configured in the R&S SGMA-GUI are not shut down.

Shut down instruments and exit
Quits the R&S SGMA-GUI and switches the connected instruments to the standby state (see also Chapter 8.7, "How to switch between operating states", on page 306).

5.1.2 Setup menu

Access:

► Select "SGMA-GUI" > "Setup".
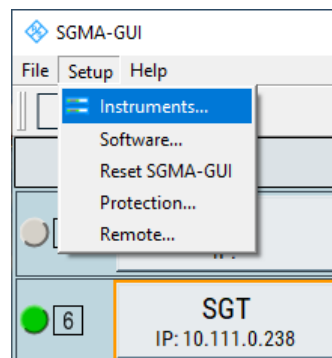
The setup menu provides access to general settings of the software, like dialogs for managing the connected instruments or dialogs providing information about the installed options.

Settings:

5.1.2.1 Configure instruments

Access:

► Select "Setup" > "Instruments".
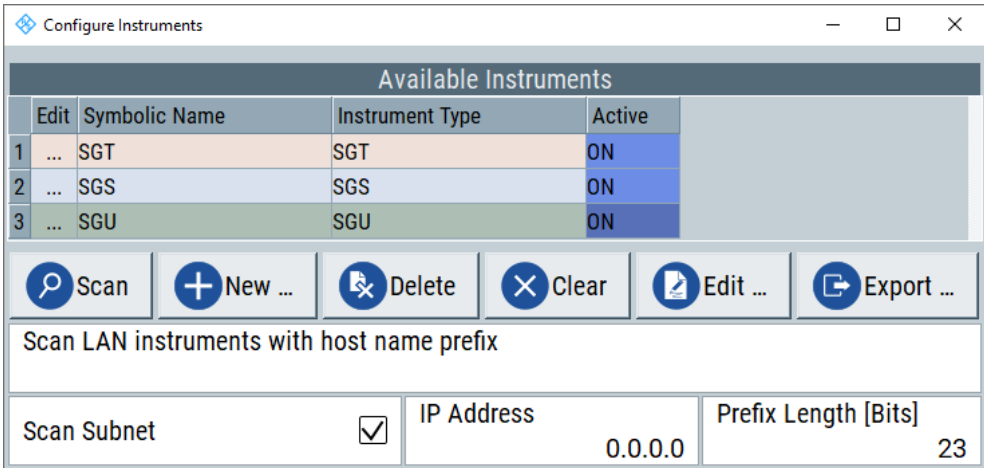
The dialog provides settings to manage connections of SGMA instruments via the R&S SGMA-GUI software. You can add new instruments, remove instruments or edit instrument connection settings.

Also, you can search for instruments in your network:
- Select "Scan" to search for instruments in the whole network.
- Select "Scan LAN instruments with host name prefix" to fine-tune the search for instruments via their hostnames.
- Select "Scan Subnet" and enter the IP address to search for instruments within a subnet of the network.

How to: Chapter 5.5.2, "Managing instruments with R&S SGMA-GUI", on page 71

Settings:

Available Instruments

This section comprises a list of configured instruments. Each instrument is represented by a "Symbolic Name" which is also displayed in the main panel and an "Instrument Type". It is also displayed whether the instrument is activated in the R&S SGMA-GUI and hence displayed in the main panel or not.

Remote command:

`:INSTruments:COUNt?` on page 80

`:INSTruments:NAME` on page 81

`:INSTruments:TYPE` on page 83

`:INSTruments:ACTive[:STATe]` on page 79

Scan

Triggers a scan function and searches for instruments connected to the remote computer via all the available interfaces. During the scan process, a progress bar is displayed.

Tip: The first initialization of a newly connected instrument in a network and the instrument's request to the DHCP server for an IP address may take some time. During this time, the instrument does not respond to the query sent by the scan function. If the instrument does not appear in the list of "Available Instruments", trigger the scan function again after some minutes.

Remote command:

`:INSTruments:SCAN` on page 82

New

Calls the Add/Edit instrument dialog.

Delete

Removes the selected instrument from the list of Available Instruments.

Clear

Removes all instruments from the list of Available Instruments.

Edit

Calls the Add/Edit instrument dialog.

Export

Opens the standard file save browser for saving the list of the available instruments in a mapping file. The mapping files have the file extension `.map` so the filename typed in is automatically equipped with this extension.

A mapping file provides a cross-reference between the instruments' symbolic names and their respective remote control parameters. The information in the mapping file is grouped in rows, where one row corresponds to one configured instrument. The rows have the following structure:

```
<InstrumentType> <SymbolicName> <IP_Address/Hostname>
<RemoteChannel> <SerialNumber>
```
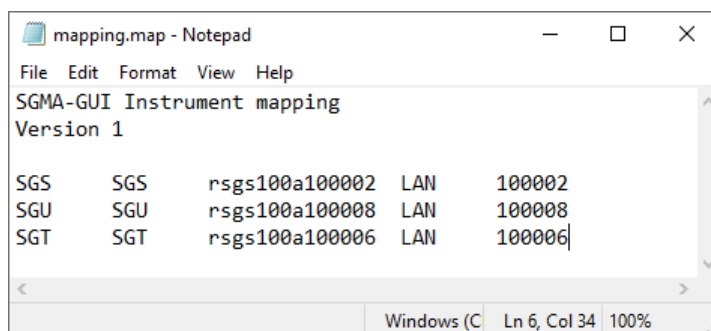
Figure 5-1: Mapping file example

Tip: In a remote control application program, address the instruments by their symbolic names and retrieve the remain required settings from the mapping file. This workflow is especially useful for frequent exchange of instruments.

Remote command:

:INSTruments:MAPPing:FILE on page 81

Scan LAN instruments with host name prefix
Sets the prefix the searched host names begin with. Use this function to limit the amount of the searched instruments and to speed up the scan process.

For example, set this field to "RsSGS, RsSGU, RsSGT", if you want to search for all available instruments.

If your instrument is not listed in the "Avalable Instruments" dialog, leave the field empty and execute another scan.

Remote command:
:INSTruments:SCAN:HNPRefix on page 82

Scan Subnet
Activates scanning of the subnet.

If you click "Scan" the scanning procedure includes instruments detected in the subnet.

Remote command:
:INSTruments:SCAN:SNET[:STATe] on page 83

IP Address
Sets the IP address with the subnet.

Remote command:
:INSTruments:SCAN:SNET:IPADdress on page 82

Prefix Length
Sets the prefix length in bits.

Remote command:
:INSTruments:SCAN:SNET:PLENgth on page 83

5.1.2.2   Add/Edit instrument

Access:

► Select "Setup" > "Instruments" > "New"/"Edit".

The dialogs provide settings to add or edit an instrument.

How to: Chapter 5.5.2, "Managing instruments with R&S SGMA-GUI", on page 71

Settings:

Instrument Nr.
Automatically assigned number that indicates the instrument's index in the list of "Available Instruments".

Symbolic Name
Selects the alias name of the instrument.

Remote command:
:INSTruments:NAME on page 81

Instrument Type
Selects the instrument's family.

Remote command:
:INSTruments:TYPE on page 83

Active
Activates control of the instrument and displays the instrument in the main panel.

Note: You can only control active instruments via R&S SGMA-GUI.

Remote command:
:INSTruments:ACTive[:STATe] on page 79

Exclusive Access
Checks whether the instrument is locked by another user and if not locks the instrument.

When an instrument is locked, it is reserved for manual and remote operation. Locking means, that you can operate the instrument **exclusively** from the remote PC on which the R&S SGMA-GUI is running or from which the SCPI command is sent.

For interfaces using VISA, i.e. for LAN and USB, enabling the "Exclusive Access" triggers the standard viLock request. For remote control over PCIe or Socket, the lock request is performed on a higher application level.

Tip: We recommend that you lock the instrument before further configuration. Locked instruments are not found by the scan function. Unlock the instrument to allow operation from another remote PC.

Note: The two functions "Exclusive Access" and monitoring are mutually exclusive. Disable "Exclusive Access" if the instrument is monitored by an external PC.

Remote command:
:INSTruments:EACCess[:STATe] on page 80
:LOCK? on page 353
:UNLock on page 353

Device Identity
Triggers the device identification function. The [LAN] LED on the front panel of the selected instrument blinks.

See also Chapter 5.5.4, "Bidirectional instrument identification", on page 74.

Hardware Channel

Selects the hardware interface used by the remote channel.

Remote command:

`:INSTruments:REMote:CHANnel` on page 81

Instrument Name / IP Address

Enters the IP address or the host name of the connected instrument.

See also Chapter 5.5.3, "Finding out the default hostname of the instrument", on page 74.

Remote command:

`:INSTruments:REMote:NAME` on page 82

GPIB Address

Enters the GPIB address of the connected instrument.

See also Chapter 9.1.5, "GPIB interface (IEC/IEEE bus interface)", on page 320.

Remote command:

`:INSTruments:GPIB:ADDRess` on page 80

Board Number

Identifies the GPIB bus card of the controller to that the adapter is connected.

See also Chapter 9.1.5, "GPIB interface (IEC/IEEE bus interface)", on page 320.

Remote command:

`:INSTruments:GPIB:BOARd` on page 81

Serial Number

Enters the serial number as instrument's identification while using the USB or PCIe interfaces for remote control.

Remote command:

`:INSTruments:SERial` on page 83

Ok

Confirms the settings and closes the dialog.

Apply

Confirms the settings.

Cancel

Discards settings and closes the dialog.

5.1.2.3 Software

To find out the software version and installed options

► Select "Setup > Software".

The dialog provides information on the software opens showing program information.
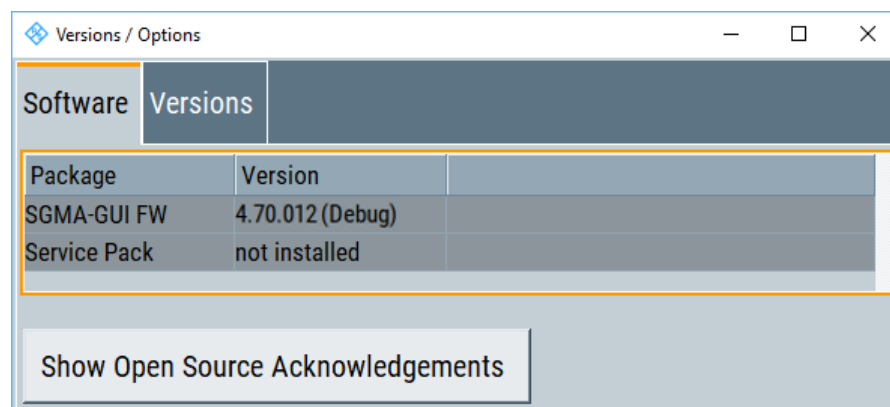
Software
Displays information on:

"Package"   Installed software packages.

"Version"   Release of the software package.

Show Open Source Acknowledgments
Accesses the list of the used open source software packages and the corresponding verbatim license texts.

Versions
Shows the installed software platform and its version.

5.1.2.4 Reset SGMA-GUI

Resets R&S SGMA-GUI to its factory preset settings.

The connected instruments are not affected by this preset.

To preset one specific instrument to its factory preset settings, select "SGMA-GUI > Instrument Name > Setup > Factory Preset". Refer to Chapter 7.12, "Factory preset", on page 294 for an overview of the settings affected by this function.

5.1.2.5 Protection

The "Protection" dialog is available for R&S SGS and R&S SGT. It provides settings to unlock protected service functions (authorized personnel of Rohde & Schwarz service departments only).

Unlocking of protected service functions

1. Select "SGMA-GUI > Setups > Protection".

   After the instrument has been switched on, the protection levels 1 to 4 are auto-matically activated.

2. To deactivate the protection, enter the correct password.
   Enter "Protection Level 1" > "Password" > "123456".

   Protection Level 1 is activated.

Protection Level / Password

"Protection Level 1" can be activated to expand the functionality of the internal adjust-ment. The password is *123456*.

The other protection levels 2 to 4 provide access to protected service functions. Only the authorized personnel of Rohde & Schwarz service departments can access these functions.

5.1.2.6 Remote

Access: "SGMA-GUI" > "Setup" > "Remote".

SCPI Port

Sets the port number of the LAN interface for remote control with TCP/IP socket proto-col.

Set different port numbers to control different software from the same application, e.g. R&S SGMA-GUI and R&S WinIQSIM2.

Remote command:
: SYSTem:COMMunicate:SOCKet:PORT on page 543

5.1.3   Help menu

The R&S SGMA-GUI software is equipped with a context-sensitive help function. A help page can be called anytime during software operation.

The context-sensitive page which is opened with the [F1] key is part of a comprehensive help system.

It is possible to move from this context-sensitive page to any page of the help system. An overview of the contents of the online help can be reached via the menu "SGMA-GUI > Help > Contents".

A search for keywords within the help function is available via menu item "SGMA-GUI > Help > Index".

5.2   Info dialog and messages in the info bar

A few operating states and the current messages are displayed in the info line. For information on messages in greater detail and their management, an "Info" dialog can be opened.

5.2.1   Info dialog

The "Info" dialog provides a list of currently active permanent messages and a detailed description of each message. The messages are color-coded according to their level.

To access the info dialog

► In the main panel, select the "Info" key.

The "Info" dialog opens.
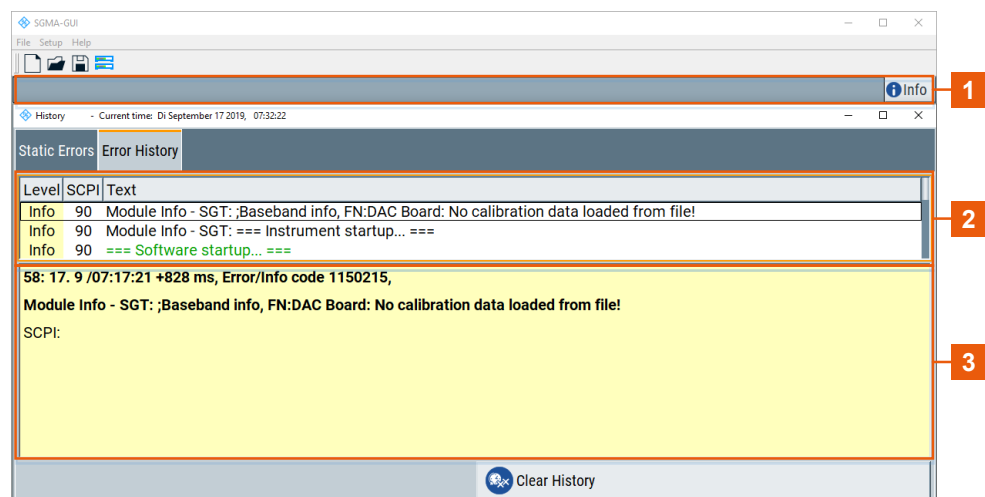
1 = Info line
2 = List of current messages with short description
3 = Detailed description of a selected message

The upper part of the "Info" dialog lists the currently active permanent messages. See the following table for explanation of the displayed information.

Parameter	Description
"LEV"	Message level. Messages referring to a logical component of R&S SGMA-GUI, e.g., Unicode, are marked in red color, info messages are marked in black color. The following level messages can occur: • Err: Error message • Info: Information message • Sys: System message • Crit: Critical message For detailed information on the message types, see Chapter 5.2.2, "Understanding the messages in the info bar", on page 65.
"SCPI"	Indicates the SCPI error code.
Text	A list of all currently permanent messages in the order of their occurrence, i.e., the most recent message is displayed first.

The keys in the lower part of the "Info" dialog provide quick access to some functions for managing these messages. For a detailed description on how to clear error messages or display a history of all messages, refer to Chapter 5.5.5, "Managing messages in the info dialog", on page 75.

Function	Description
"Delete"	Clears the highlighted message. This key is available only if the history of the messages is displayed.
"Delete All"	Clears all messages. This key is available only if the history of the messages is displayed.
"Del. volatile"	Clears all brief messages. This key is available only if the history of the messages is displayed.
"Show History/Static"	Calls the list of all messages that have occurred since instrument switch-on. The most recent messages are displayed at the top of the list. When the key is pressed again, the list of current messages is displayed.

How to: Chapter 5.5.5, "Managing messages in the info dialog", on page 75

5.2.2 Understanding the messages in the info bar

Messages indicate information, warnings, and errors. They are displayed in the info line in different colors depending on their importance and display duration. The following messages are displayed:

• Error

  There are two options:

  – Critical errors are errors that prevent the instrument from working, e.g. an HW failure. Critical errors are displayed in red color.

  – System errors are errors that concern the operating system, e.g., wrong file path. System errors are displayed in black color.

• Information

The information, e.g., file not found, is displayed in black color.

● Warning
A warning indicates a less significant error and is displayed in black color.

● Brief message
Brief messages report automatic settings in the program, e.g. switching on illegal entries that are not accepted by the program, 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.
Brief messages usually do not demand user actions and disappear automatically after a short period of time. They are saved in the history, however.

● Permanent messages
Permanent messages are displayed if an error occurs that impairs further program operation. The error signaled by a permanent message must be eliminated before correct software operation can be ensured.
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.

5.3 Main panel

The main panel of the R&S SGMA-GUI software provides quick access to the main settings of the configured instruments. The display shows one row per instrument and comprises the instrument name and state. It also shows the used frequency and power level, the states of the RF output and modulator and the used reference source.

Click one of the keys with an instrument name on it to access the menu tree with further settings for the corresponding instrument. For a detailed description of the provided settings, see:

● Chapter 7, "General instrument settings and instrument setup", on page 270 for general settings

● Chapter 6, "Signal generator settings", on page 85 for R&S SGT settings.
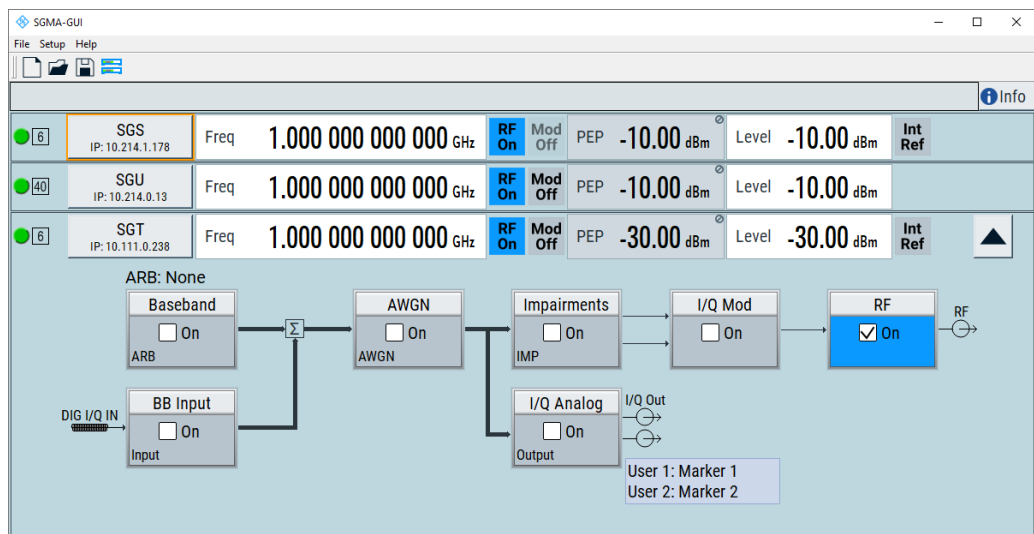
Settings:

Instrument/Connection State
The three colors of the state indicator in front of the instrument's name distinguish between the following states:
● Gray: the instrument is configured and activated in the R&S SGMA-GUI software but there is no connection to the instrument.
● Green: the instrument is active, the connection is working and the instrument can be manually and remotely operated.
● Red: the instrument is in one of the following states:
– Standby state
To operate the instrument manually, it has to be switched to ready state (see "To return the instrument from standby to ready state" on page 307).
– Instrument locked
The red state indication together with the message "Instrument Locked" in the "Info" line indicates that the instrument is locked for Exclusive Access from another R&S SGMA-GUI software or controller.
– The instrument is performing a time consuming operation, e.g. a selftest.

Maximum Frequency
The numbers in the rectangular box 6 on the left of the instrument's name indicate the maximum frequency of the instrument.

Pulse Modulation
A Π sign on the left of the instrument's name indicates that the pulse modulation is switched on.

Instrument Name / IP Address
Displays the alias name of the instrument and the IP address, as set by the parameters in "SGMA-GUI > Setup > Instruments > Add/Edit Instruments" dialog.

Click the key to access a menu tree for configuring the available instrument's settings, e.g. "Level" settings.

Freq
(Offs) **Freq/Freq (Offs)**
For R&S SGT, sets the RF frequency, incl. enabled frequency offset.

The following apples:

"Freq" = Frequency + Offset

The value of the parameter "SGMA-GUI main panel > instrument name > Frequency/ Phase > Frequency" is the RF frequency at the RF output without the frequency offset.

The icon "Freq (Offs)" indicates that a frequency offset is applied.

Remote command:
[:SOURce]:FREQuency[:CW|FIXed] on page 390

RF On/Off

Activates and deactivates the RF output signal.

The current state of the RF output (activated and deactivated) is indicated in the main panel by the different block color (blue or grey) and the status "On/Off".

Remote command:
:OUTPut[:STATe] on page 374

I/Q Mod State

Switches the I/Q modulation on and off.

The following functions have the same effect:
- The "Mod On/Off" icon in the SGMA-GUI.
- The "I/Q Mod > On/Off" in the I/Q Mod block in the block diagram.
- The "I/Q Modulator" > State parameter.

Remote command:
[:SOURce]:IQ:STATe on page 480

Level/Level Offset

Sets the RF level at the RF output connector of the selected instrument.

If you set a digital attenuation, while "I/ Q Mod > Modulation Source > Internal Base-band" and "I/ Q Mod > Modulation State > ON", it will be indicated in the R&S SGMA-GUI main panel by a change in the name of this parameter from "Level" to "Level Off-set".

Level **-30.00** dBm	Level (Offs) **-30.10** dBm

Note: The SCPI command [:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] sets the level of the "Level" display, that means the level containing off-set while [:SOURce]:POWer:POWer sets the level at the RF output connector.

Remote command:
[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] on page 526
[:SOURce]:POWer:POWer on page 523

Ref. Oscillator Source/Ext Ref On/Off

Determines whether the internal built-in oscillator (TXCO or OXCO) is used as a reference source or if an external reference is used.

The internal reference oscillator OCXO requires the additional option R&S SGT-B1.

To feed in an external instrument reference, use the input connector "REF/LO IN". To output the reference frequency at the output "REF/LO OUT", select "SGMA-GUI > Instrument Name > RF > Ref. Oscillator > REF/LO Output > REF".

"Int"   The internal reference signal of 10 MHz is used.

"Ext"   An external reference signal is used. The frequency of the external reference signal must be selected with the parameter "SGMA-GUI > Instrument Name > RF > Ref. Oscillator > Ex. Ref. Input Frequency".

Remote command:
[:SOURce]:ROSCillator:SOURce on page 527

LO Scr Ext
This icon indicates that the internal local oscillator is switched off.

See "Source" on page 220.

5.4   Block diagram

For R&S SGT, the block diagram, shows provided options, signal configuration and the currently selected signal flow of the generator with inputs and outputs used. Signal generation can be operated from the block diagram.

To display the block diagram, click the ▣ key next to the instrument's name.

5.4.1   Function blocks in the block diagram

Each block represents a function of signal generation. The function is indicated in the headline of the block. In the checkbox, the respective function can be quickly activated/deactivated. After activation, the block is displayed in blue. Status information is displayed below the checkbox. It is different for the different blocks.

Example: Baseband block
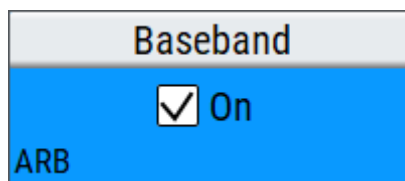
In this block, the arbitrary waveform generation and trigger, marker and clock are set.

5.4.2 Signal flow and input/output symbols in the block diagram

The input/output symbols in the block diagram show the currently used inputs and outputs of the signal generator. Unused inputs and outputs are not shown. The lines indicate the signal flow.

Symbols and labels refer to the corresponding inputs and outputs on the front and rear panel of the signal generator. The direction - input or output - is indicated by an arrow.

Example:
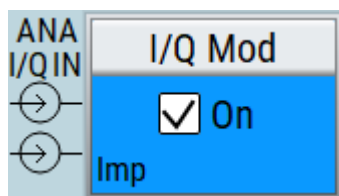
The symbols indicate the inputs for the analog I and Q signal.

Symbols and lines are displayed in different colors depending on their function.

- The baseband signal is indicated by a three line arrow, the I- and Q-components of the signal by a single-line arrow.
- Connections are indicated by a "solder point".
- Black is used for the generated signal.
- Green is used for control signals.

5.5 Working with R&S SGMA-GUI

This section explains how to work with the R&S SGMA-GUI software and perform configuration tasks for manual operation of the instruments.

5.5.1 Saving and loading settings

To proceed work with a particular configuration of the instruments in the R&S SGMA-GUI software, it is useful to save the used settings and load them again later.

To save and load settings

1. Select "SGMA-GUI main panel > File > Save As".

2. Navigate to the desired directory.

3. Enter the filename.
   The software adds the file extension `*.savrcl` automatically.

4. Select "Save".

   The current settings of the software are saved to the selected file.

5. To load settings from a file, select "SGMA-GUI main panel > File > Open"

6. Navigate to the storage directory of the saved file.

7. Select this file.

   Loads the saved settings to the R&S SGMA-GUI software and the main panel displays the saved configuration of the instrument.

5.5.2 Managing instruments with R&S SGMA-GUI

This section provides information on how to configure and manage instruments in the R&S SGMA-GUI software.

It covers the following topics:
- "To add instruments automatically" on page 71
- "To add instruments manually" on page 71
- "To scan for new instruments" on page 72
- "To activate instruments for control" on page 72
- "To reserve an instrument" on page 72
- "To edit instruments" on page 73
- "To delete an instrument" on page 73
- "To delete all instruments" on page 73

To add instruments automatically

1. Connect the instrument to the network.

2. Switch on the instrument.

3. Press the [ID] key on the front panel of the instrument.

4. Start the R&S SGMA-GUI software on a computer connected to the same network.

   All instruments are added automatically to the main panel of the R&S SGMA-GUI software.

To add instruments manually

1. In the main panel, select "Setup" > "Instruments".

   The Configure Instruments dialog opens.

2. Select "New".

   The Add Instrument dialog opens to register a new instrument.

3. In the "Symbolic Name" field, enter an alias name of your choice, e.g. SGT-100021.

4. In the "Instrument Type" field, select the device family to connect to.

5. To select the hardware interface, select "Remote Control > Hardware Channel".

6. For LAN or Socket interfaces, select "Remote Control > Instrument Name / IP Address".

7. Enter the IP address or the hostname of the connected instrument, e.g. rssgt100a100021.
See also Chapter 5.5.3, "Finding out the default hostname of the instrument", on page 74.

8. For USB or PCIe interfaces, select "Remote Control > Serial Number".

9. Enter the serial number of the connected instrument, e.g., *100021*.

10. Set "Active > On" to activate the instrument. Only active instruments are displayed in the main panel.

11. To apply the settings, you have two options:
    ● Click "OK".
      The dialog also closes.
    ● Click "Apply".
    ● The dialog remains opened.

12. Click the "Cancel" key to discard settings and to close the dialog.

To scan for new instruments

1. In the main panel, select "Setup" > "Instruments".

   The Configure Instruments dialog opens.

2. Select "Scan" to scan all remote channel interfaces for connected instruments.

   Tip: To limit the amount of the searched instruments and to speed up the scan process, select "Configure Instruments > Scan LAN instruments with hostname prefix" and enter the prefix the searched hostnames begin with.
   The scan function searches only for instruments whose hostnames begin with the selected prefix.

   The "Available Instruments" list all instruments that are connected to one of the available interfaces, switched on and not locked by a control instrument.
   The R&S SGMA-GUI software obtains all information for connecting to the instrument, so further configuration is not necessary.

To activate instruments for control

1. In the main panel, select "Setup" > "Instruments".

   The "Available Instruments" in the Configure Instruments dialog lists all instruments configured in the software.

2. Select the new or deactivated instrument.

3. To activate the instrument, select "Active > On".

   Tip: The main panel only displays active instruments.

To reserve an instrument

1. Open the "SGMA-GUI > Setup > Instruments > Configure Instruments" dialog.

2. Select the instrument in the list of "Available Instruments".

3. Select "Edit".

4. In the "Edit Instrument" dialog, enable "Exclusive Access".

5. Alternatively, send the SCPI command `:INSTruments:EACCess[:STATe]` from the external PC that has an R&S SGMA-GUI software installation.

   The instrument is reserved for control from this external PC and cannot be accessed from any other controller. A scan function started from another controller finds the instrument but the instrument is indicated as locked.

The two functions "Exclusive Access" and monitoring are mutually exclusive.

The "Exclusive Access" must be disabled to remote control or monitor the instrument form another external PC (see Chapter 9.7, "Monitoring remote control operation with R&S SGMA-GUI", on page 345).

To edit instruments

1. In the R&S SGMA-GUI main panel, select "Setup > Instruments".

   The Configure Instruments dialog opens and lists the "Available Instruments".

2. Select the instrument, that you want to edit.

3. Click the "Edit" key.

   The Edit Instrument dialog opens.

4. Change the settings.

5. Confirm with "Ok".

   The edited settings are applied.

To delete an instrument

1. In the R&S SGMA-GUI main panel, select "Setup > Instruments".
   The Configure Instruments dialog opens.

2. Select the instrument, that you want to delete.

3. Click the "Delete" key.

   The selected instrument is deleted from the list of "Available Instruments".

To delete all instruments

1. In the R&S SGMA-GUI main panel, select "Setup > Instruments".
   The Configure Instruments dialog opens.

2. Click the "Clear" key.

   All instruments are deleted from the list of "Available Instruments".

5.5.3   Finding out the default hostname of the instrument

The default hostname of the instrument is a non-case-sensitive string built as follows:

- `hostname = <instrument name><serial number>`
- `<serial number>` is the individual serial number of the instrument.
- `<instrument name>` is the complete name of the instrument, written without spaces.

To query the hostname of the instrument

1. Find the individual serial number on rear of the instrument, e.g. 100021.

2. Build the default hostname.

   For the R&S SGT with serial number 100021, the default hostname is `rssgt100a100021`.

For instructions on how to change the default hostname, see Chapter 8.8, "How to use computer names", on page 308.

5.5.4   Bidirectional instrument identification

In practice, instruments are integrated into a large network or placed in racks together with several other instruments of the same kind. It can be difficult to find out, which of the instruments configured in the R&S SGMA-GUI corresponds to which physical instrument. Also, localizing all instruments operated by the current controller.

The R&S SGMA-GUI and the instrument provide the "Device Identification" function for this purpose.

To find an instrument in the R&S SGMA-GUI

► If you activate several instruments in the R&S SGMA-GUI, press the [ID] key on the instrument's front panel to trigger device identification.

   The "Edit Instrument" dialog of this instrument opens.
   Field "Edit Instrument > Symbolic Name" displays the name of the instrument as shown in the R&S SGMA-GUI main panel.

Dialog "Edit Instrument" does not appear

If this dialog does not open, perform the following:

● Check whether the instrument is correctly connected to the external PC on which you work with the R&S SGMA-GUI.

● Check if the instrument is configured in the R&S SGMA-GUI and perform, if necessary, the steps described in Chapter 5.5.2, "Managing instruments with R&S SGMA-GUI", on page 71.

● Select "SGMA-GUI > Setup > Instruments", check the state of the instrument in the "Configure Instruments > Available Instruments" table and activate it, if disabled.

		Available Instruments			
	Edit	Symbolic Name	Instrument Type	Active	
1	...	SGT	SGT	ON	
2	...	SGS	SGS	ON	
3	...	SGU	SGU	ON	

Scan | New ... | Delete | Clear | Edit ... | Export ...

Scan LAN instruments with host name prefix

Scan Subnet	☑	IP Address	0.0.0.0	Prefix Length [Bits]	23
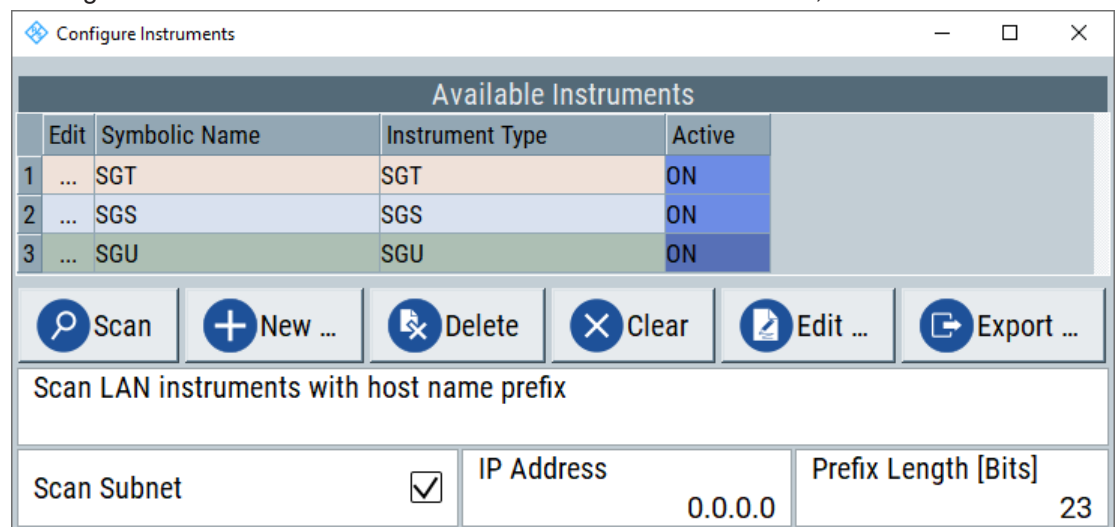
To identify an instrument in an instrument set

1. To identify the instrument in an instrument set, use one of the device identification functions:

   ● Select "SGMA-GUI > Setup > Instruments > Available Instruments > Instrument > Edit > Edit Instrument".
   ● Select "SGMA-GUI > Instrument Name > Setup > Remote > Remote Channels".
   ● Select "SGMA-GUI > Instrument Name > Setup > LXI Status".

2. Select "Device Identify" to trigger identification.

   The green [LAN] LED on the front panel of the instrument blinks.

5.5.5 Managing messages in the info dialog

To get additional information on the message

► In the "Info" dialog, click a message to select it.

In the lower section of the dialog, additional information on the highlighted message is displayed.

To display all messages

► In the "Info" dialog, click the "History" key.

A history of all messages that have occurred since the R&S SGMA-GUI software was started is listed in the upper dialog pane. The most recent message is displayed first.

To delete an error message

1. In the "Info" dialog, select the highlighted message and

2. Click the "Delete" key.

   Tip: This key is available only when the history of the messages is displayed.

   The highlighted message is cleared.

To delete all error messages

► In the "Info" dialog, click the "Delete All" key.

   Tip: This key is available only when the history of the messages is displayed.

   All messages are cleared.

To delete all brief messages

► In the "Info" dialog, click the "Del. volatile" key.

   Tip: This key is available only when the history of the messages is displayed.

   All brief messages are cleared.

To call the history

1. In the "Info" dialog, click the "History" key.

   A list of all messages that have occurred since the instrument switch-on is displayed. The most recent messages are displayed at the top of the list.

2. Click the "History" key once more.
   The history lists current instrument messages.

5.6 Remote control of R&S SGMA-GUI

This section focuses on remote control of the R&S SGMA-GUI software. Also, all remote-control commands are presented in detail with their parameters and the ranges of numerical values.

Prerequisites for remote control of R&S SGMA-GUI

Remote control of R&S SGMA-GUI requires the following:

- A remote PC is connected to the SGMA instrument.
- The remote PC and the SGMA instrument are switched on.
- A connection between remote PC and the SGMA instrument is established
- The security setting "System Config > Setup > Security > SCPI over LAN" is enabled.

For more information, see Chapter 3.1.13, "Connecting an external PC and devices", on page 26.

For general information on remote control of Rohde & Schwarz products via SCPI, refer to www.rohde-schwarz.com/rc-via-scpi.

5.6.1 Programming examples

The corresponding sections of the same title provide simple programming examples for the R&S SGT. 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 programs, an instrument preset/reset is recommended to set the R&S SGT 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.

The programming examples address the following tasks:

- Example"Searching for SGMA instruments" on page 77
- Example"Scanning a subnet for SGMA instruments" on page 78
- Example"Evaluating scan results" on page 78
- Example"Configuring SGMA instruments" on page 79

Example: Searching for SGMA instruments

```
// Search for SGMA instruments using the scan function. It detects instruments
// that are connected to the remote computer via all of the available interfaces.
INSTruments:SCAN 1
*OPC?

// Query the number of available instruments.
INSTruments:COUNt?
// Response: 3
// Query instrument types.
INSTruments:TYPE?
```

```
// Response: SGU,SGS,SGT
// Query the symbolic names.
INSTruments:NAME?
// Response: SGU-100002,SGS-100006,SGT-100008
// Query the serial numbers.
INSTruments:SERial?
// Response: 100002,100006,100008
// Query the remote channel used.
INSTruments:REMote:CHANnel?
// Response: LAN,USB,PCIe
// Query the hostname/IP address.
INSTruments:REMote:NAME?
// Response: rssgu100a100002, rssgs100a100006, rssgt100a100008

// You can also define a hostname prefix to filter detected SGMA instruments.
:INSTruments:SCAN:HNPRefix "rssg"
// The scan returns only instruments with hostname beginning with "rssg".
:INSTruments:SCAN 1
```

Example: Scanning a subnet for SGMA instruments

```
// Set the IP address of an instrument of the subnet.
INSTruments:SCAN:SNET:IPADdress 10.111.1.11
// Set the prefix length of the subnet.
INSTruments:SCAN:SNET:PLENgth 20
// Higher prefix lengths accelerate the scan but lower the ability to detect all
// instruments within the subnet.
INSTruments:SCAN 1
```

Example: Evaluating scan results

```
// Check the instrument state and activate instruments, if required.
INSTruments:ACTive:STATe?
// Response: 0,1,1
INSTruments:ACTive:STATe ON,OFF,OFF
// Activates the first instrument in the list, i.e. the instrument SGS-100006.

// Export the configuration into a mapping file.
INSTruments:MAPPing:FILE "d:\mapping_files\mapping.map"
// Enable exclusive access for the selected instrument.
INSTruments:EACCess:STATe?
// Response: 0,0,0
INSTruments:EACCess:STATe ON,OFF,OFF
// Locks the first instrument.
```

Example: Configuring SGMA instruments

```
// Clear the device list and add new instruments manually.
INSTruments:CLEar
INSTruments:NAME "MYSGT100A","MYSGS100A","MYSGU100A"
// Define the instrument types.
INSTruments:TYPE "SGT","SGS"
// Specify the remote interface and name or address for the instruments in the
// device list.
INSTruments:REMote:CHANnel LAN,USB,GPIB
INSTruments:REMote:NAME "10.124.1.247","RSSGS100A1000025",
INSTruments:USB:SERial 0,0,100025
INSTruments:GPIB:ADDRess 0,0,28
INSTruments:GPIB:BOARd 0,0,0
```

5.6.2　R&S SGMA-GUI commands

This section comprises the SCPI commands provided for remote control of the R&S SGMA-GUI software.

:INSTruments:ACTive[:STATe] <State>

Enables/disables the instrument for the R&S SGMA-GUI. The main panel of this software displays only activated instruments.

Parameters:

<State>	List of BOOL-values
	<StateInstr#1>,<StateInstr#2>,... 0, 1, ON, OFF
Example:	See Example"Evaluating scan results" on page 78.

Manual operation: See "Available Instruments" on page 57
                         See "Active" on page 60

:INSTruments:CLEar

Clears all instruments in the device list.

Parameters:

<Count>   float

                         Range: 0 to 12

Example: See Example"Configuring SGMA instruments" on page 79.

Usage: Event

:INSTruments:COUNt?

Queries the number of the currently available instruments.

Return values:

<Count>   float

                         Range: 0 to 12

Example: See Example"Searching for SGMA instruments" on page 77.

Usage: Query only

Manual operation: See "Available Instruments" on page 57

:INSTruments:EACCess[:STATe] <State>

"Locks" the instruments, meaning the instrument is reserved and can be operated exclusively from the remote PC that sent this SCPI command.

Tip: It is recommended to lock the instrument prior to further configuration.

Parameters:

<State>   List of BOOL-values

                         <LockInstr#1>,<LockInstr#2>,...
                         0,1,OFF,ON

Example: See Example"Evaluating scan results" on page 78.

Manual operation: See "Exclusive Access" on page 60

:INSTruments:GPIB:ADDRess <Serial>

Sets the GPIB address of the connected instrument.

Parameters:

<Serial>   List of Numbers

Example: See Example"Configuring SGMA instruments" on page 79.

Manual operation:	See "GPIB Address" on page 61

:INSTruments:GPIB:BOARd \<Board\>

Identifies the GPIB bus card the controller uses.

Parameters:

\<Board\>	List of Numbers
Example:	See Example"Configuring SGMA instruments" on page 79.
Manual operation:	See "Board Number" on page 61

:INSTruments:MAPPing:FILE \<File\>

Saves the list of the available instruments in a mapping file. Mapping files are stored with the predefined file extension `.map`; the file extension may be omitted.

The file is saved in the default directory. Use the command `MMEM:CDIRectory` to change the default directory or specify the complete path.

Parameters:

\<File\>	string
Example:	See Example"Evaluating scan results" on page 78.
Manual operation:	See "Export" on page 57

:INSTruments:NAME \<Name\>

Selects the alias name of the instruments, i.e. sets the "Symbolic Name".

Parameters:

\<Name\>	\<SymbolicNameInstr#1\>,\<SymbolicNameInstr#2\>,...
Example:	See Example"Searching for SGMA instruments" on page 77.
Manual operation:	See "Available Instruments" on page 57 See "Symbolic Name" on page 60

:INSTruments:REMote:CHANnel \<Channel\>

Sets the hardware interface used by the remote channel.

Parameters:

\<Channel\>	List of CHAR-Data
	\<ChannelInstr#1\>,\<ChannelInstr#2\>,... The available interfaces are: `LAN`, `USB`, `SOCKET`, `PCIe`, `GPIB`, `HiSLIP`
Example:	See Example"Searching for SGMA instruments" on page 77.
Manual operation:	See "Hardware Channel" on page 61

:INSTruments:REMote:NAME <Name>

Enters the IP Address or the host name of the connected instrument.

Parameters:

<Name>   <Hostname/IP-AddressInsr#1>,<Hostname/IP-Addres-
                               sInsr#2>,...

Example: See Example"Searching for SGMA instruments" on page 77.

Manual operation: See "Instrument Name / IP Address" on page 61

:INSTruments:SCAN <State>

Triggers a scan function and searches for instruments connected to the remote com-
puter via all of the available interfaces.

Parameters:

<State>   number

                               1 = triggers the scan function, 0 = aborts the running scan proc-
                               ess
                               The query command returns 1 as long as scan is running; 0 indi-
                               cates completed scan process.

Example: See Example"Searching for SGMA instruments" on page 77.

Manual operation: See "Scan" on page 57

:INSTruments:SCAN:HNPRefix <Prefix>

Sets the prefix the searched host names begin with.

Parameters:

<Prefix>   string

Example: See Example"Searching for SGMA instruments" on page 77.

Manual operation: See "Scan LAN instruments with host name prefix" on page 58

:INSTruments:SCAN:SNET:IPADdress <Address>

Sets the IP address of an instrument within a subnet.

Use the IP address to optimize scanning for instruments within a subnet.

Parameters:

<Address>   string

Example: See Example"Scanning a subnet for SGMA instruments"
                               on page 78.

Manual operation: See "IP Address" on page 58

:INSTruments:SCAN:SNET:PLENgth <Number>

Sets the prefix length of the subnet mask.

Use the prefix length to optimize scanning for instruments within a subnet. A higher value accelerates the scanning procedure but lowers the ability to detect all instruments within the subnet.

Parameters:

<Number>   integer

                               Range: 18 to 30
                               *RST: 18
                               Default unit: bit

Example: See Example"Scanning a subnet for SGMA instruments"
                               on page 78.

Manual operation: See "Prefix Length" on page 58

:INSTruments:SCAN:SNET[:STATe] <State>

Activates scanning of a subnet with given IP address and prefix length of the subnet.

Parameters:

<State>   1 | ON | 0 | OFF

                               *RST: n.a. (no preset. default: OFF)

Example: See Example"Scanning a subnet for SGMA instruments"
                               on page 78.

Manual operation: See "Scan Subnet" on page 58

:INSTruments:SERial <Serial>

Enters the serial number as instrument's identification while using the USB interface for remote control.

Parameters:

<Serial>   <SerialNumberInstr#1>, <SerialNumberInstr#2>,...

Example: SeeExample"Configuring SGMA instruments" on page 79.

Manual operation: See "Serial Number" on page 61

:INSTruments:TYPE <Type>

Sets the instrument type.

Parameters:

<Type>   List of CHAR-Data

                               <TypeInstr#1>,<TypeInstr#2>,...

Example: See Example"Configuring SGMA instruments" on page 79.

Manual operation: See "Available Instruments" on page 57
See "Instrument Type" on page 60

5.6.3   List of R&S SGMA-GUI commands

6 Signal generator settings

This section summarizes the settings necessary to configure the instrument for signal generation. The description in this section follows the menu tree structure of the graphical user interface.

6.1 Baseband

6.1.1 System configuration

Access:

► Select "SGMA-GUI > Instrument Name > Baseband > System Configuration".
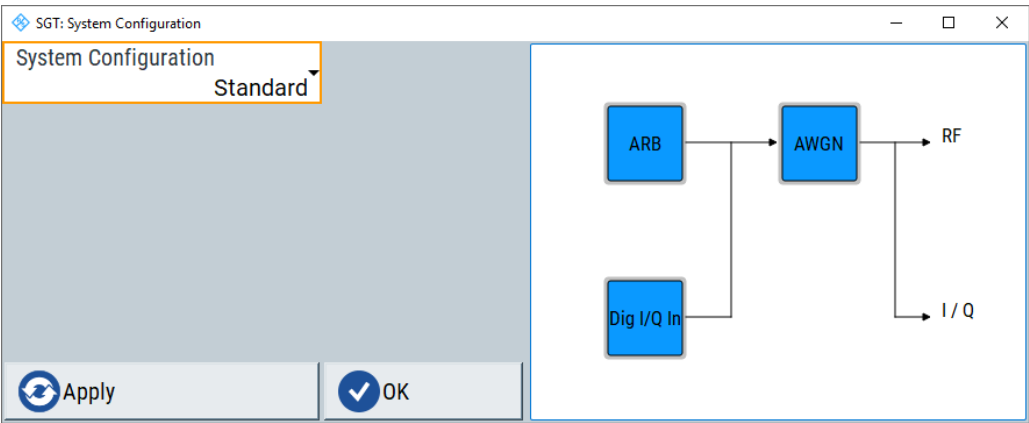
In the "System Configuration" dialog, you can select the signal settings. Depending on the selected settings the signal flow block diagram can look different, see Table 6-1.

Table 6-1: System configuration modes

"Standard"		
"ARB for Envelope Tracking"		

When the "ARB for Envelope Tracking" mode is selected, a second ARB for the enve-
lope tracking is generated, which is output at the analog I/Q output. The ARB of the
first "Baseband" is then output at the [RF] output.

You can configure the envelope tracking signal in the "Arbitrary Waveform for ET" dia-
log. To access this dialog, click on the "Baseband 2" block or select "SGMA-GUI >
Instrument Name > Baseband > ARB for Envelope Tracking". For a description of the
settings, see Chapter 6.1.2, "ARB", on page 87.
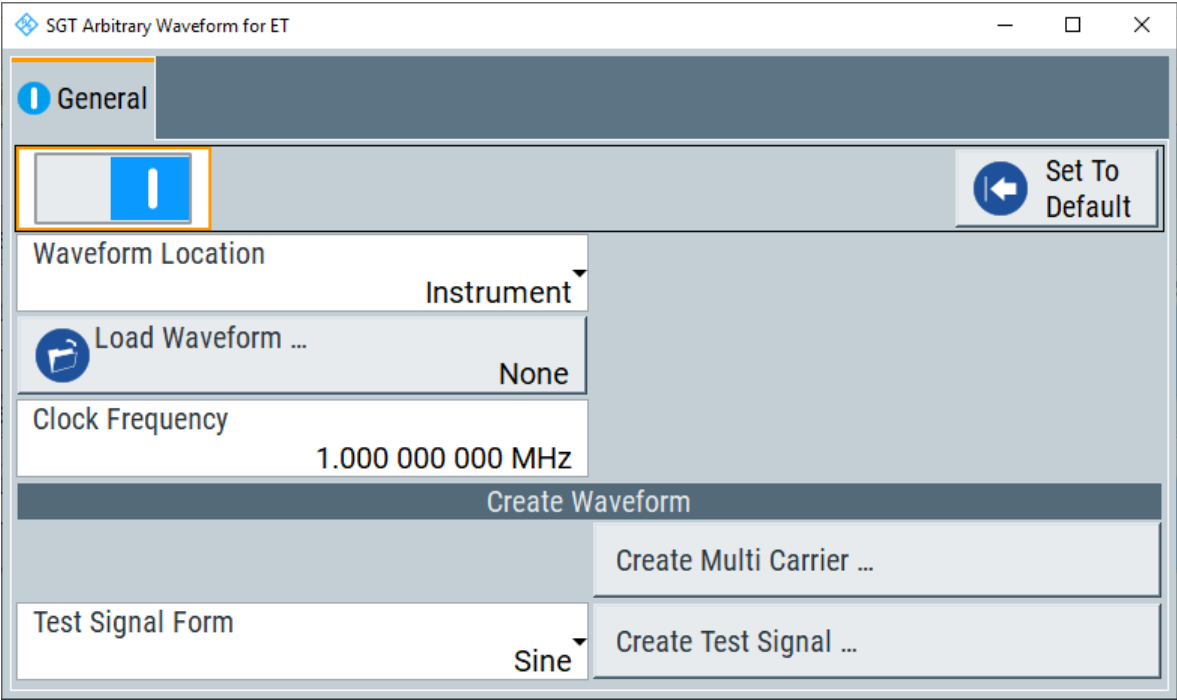
The ARB waveform for the envelope tracking ("Baseband 2") uses the same trigger,
marker and clock settings as the first ARB waveform ("Baseband").

For more information on the envelope tracking, see Chapter 6.5, "Generation of enve-
lope tracking signals", on page 165.

Settings

System Configuration
Selects the signal flow settings.

"Standard"   Selects the standard mode for the signal generator.

"ARB for Envelope Tracking"

When this mode is enabled, a second ARB signal is generated, which
is output at the analog output connectors. This ARB can be only used
for envelope tracking.

Remote command:
`:SCONfiguration:MODE` on page 374

Apply

Triggers the instrument to adopt the selected configuration.

OK

Applies the configuration and exits the dialog.

6.1.2 ARB

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

The ARB generator requires option R&S SGT-K510.

6.1.2.1 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 and multi-segment wave functions, refer to:

- Chapter 6.1.2.4, "Multi-carrier waveforms", on page 104
- Chapter 6.1.2.3, "Multi-segment waveforms", on page 93

Waveform file sources

In ARB mode, the R&S SGT uses ARB waveform files to obtain the digital I/Q data of the baseband signal. The R&S SGT can replay any waveform file stored on its solid-state drive (SSD) but it can also generate and replay simple waveforms for test purposes.

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 created by the R&S SGT, the instrument inserts a tagged waveform header at the beginning of each created ARB file. For more information, refer to Chapter 11, "Waveform and list format", on page 565.

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

- Internally generated waveforms
  The ARB generator enables calculation and generation of multi-segment and multi-carrier waveform files. Also, it provides a built-in function to create a test waveform (e.g. a sine or rectangle signal) and keep it as a file or in the RAM.
- Externally generated waveforms
  The ARB can process externally generated waveform files. For example, waveform files generated by software, such as R&S WinIQSIM2, R&S ARB Toolbox, the

R&S Pulse Sequencer. Besides, waveform files can also consist of signals calculated using a mathematical program such as Matlab.
Generation of waveform files and their transfer from R&S WinIQSIM2 or R&S Pulse Sequencer to the R&S SGT is menu-guided.
The externally generated waveform files can be loaded into the instrument via one of the available interfaces (USB, LAN or PCIe). For a detailed description, see Chapter 8.5, "How to load and play waveform files", on page 305.

For more information on generation and transfer of waveform files, see:

* R&S WinIQSIM user manual
* R&S Pulse Sequencer software user manual

Required options

Two types of software options are relevant in this context:

* **R&S SGT-K2xx/-K4xx:**
  These options are required to process a waveform file generated with R&S WinIQSIM2.
  Multi-segment waveform files require the options for *all* included digital standards.
  For some of the R&S SGT-K2xx/-K4xx options, Rohde & Schwarz provides also a library containing some already generated waveform files.
* **R&S SGT-KVxx:**
  Additional waveform libraries are offered as R&S SGT-KVxx options. Such an option allows you to process all waveform files included in the library.

If your instrument order includesR&S SGT-KVxx options, the related waveform libraries are pre-installed on your instrument.

For more information, see:

* R&S SGT product page for required options (Chapter 2.3, "Documentation overview", on page 16).
* Application note 1MA028 "IQWizard - I/Q Signal Measurement and Conversion" for IQ data management.

ARB test signals

The following test signals are available:

* **Sine test signal:** Two sine wave signals with a selectable (but equal) number of samples per period and equal frequencies. When the generation is triggered, the number of samples per period, together with the frequency of the test signal, determine the ARB clock frequency: "Clock Frequency" = "Frequency" * "Samples per Period".
  Note: Because the resulting clock rate must not exceed the maximum ARB clock rate (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)).
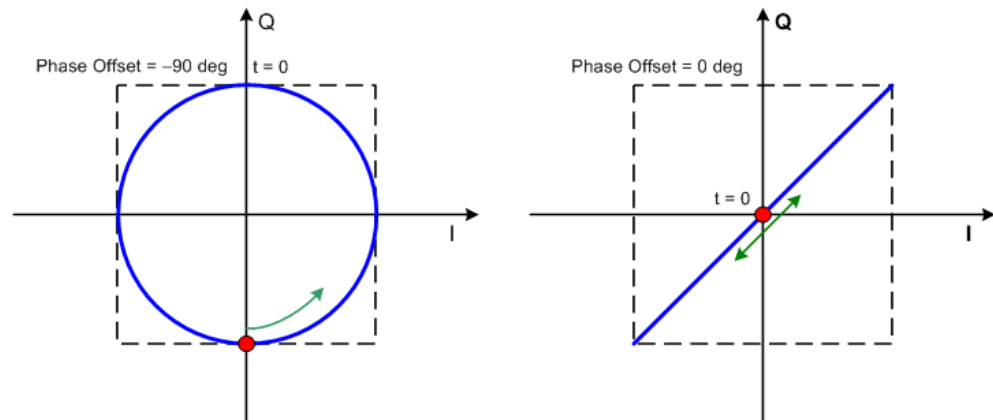
In general, the I/Q samples are located on a deformed circle which is confined to the dashed square in the upper diagrams.

- **Rectangular test signal:** Rectangle signal with selectable but equal On and Off periods and amplitude. The period is defined by the selected frequency: <Period> = 1 / "Frequency".
  The signal is mapped on both the I and Q samples. The mapping results in two distinct points in the I/Q plane. The "Offset DC" shifts both points along the diagonal I(t) = Q(t).
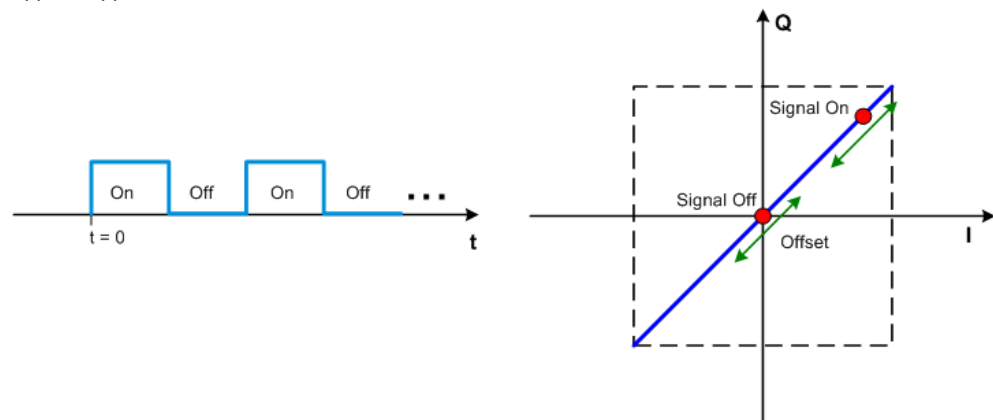
- **Constant I/Q test signal:** Continuous test signal with constant IQ and constant clock frequency of 10 KHz. The values for each I and Q components are selectable but constant. They are defined as a decimal number, which is decimal-to-binary converted internally. The signal is provided as a 16-bit wide digital signal for both I and Q channels.
  After converting to an analog signal, the signal is output directly at the BNC connectors [I] and [Q] outputs of the instrument.

6.1.2.2   General settings

Access:

► Select "SGMA-GUI > Instrument Name > BB > ARB > General".
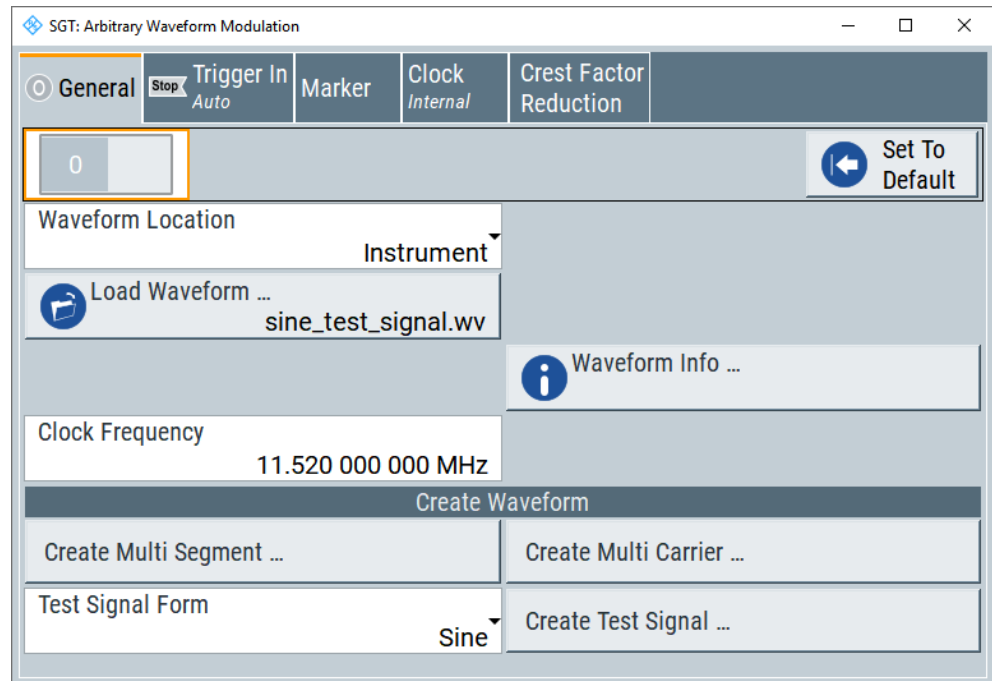
The "Arbitraty Waveform Modulation" menu provides settings for enabling the ARB and calling further dialogs for selecting and configuring a waveform.

Settings:

State

Enables/disables ARB modulation.

The output is based on the waveform file that is loaded. The name of the waveform file is displayed next to "Load Waveform".

If a multi-segment waveform is loaded, the section "Multi Segment Waveform Options" is indicated. In this section, the segment to be output is selected.

If no waveform file is loaded, ARB modulation cannot be powered up. "None" is displayed next to "Load Waveform". An error message asks you to load a waveform file:

"No waveform file loaded. ARB MOD state remains off. Please select a waveform file to load, before switching on ARB MOD state."

Remote command:
[:SOURce<hw>]:BB:ARBitrary:STATe on page 402

Set To Default
Calls default settings. The values are shown in Table 6-2.

Table 6-2: Default settings

Parameter	Value
"State"	Off
"Clock Frequency"	1 MHz
"Trigger Mode"	Auto
"Trigger Source"	Internal
"Marker State"	Off
"Marker Mode"	Unchanged
"Clock Source"	Internal

Remote command:
[:SOURce<hw>]:BB:ARBitrary:PRESet on page 401

Waveform Location
Selects the location of the waveform that you want to load.

"Instrument"   The waveform file is located on the instrument's internal memory.

"Local file system"

The waveform file is located on the local computer. In this case, the waveform is first automatically copied on the instrument's internal memory and then selected.

Note: To load a waveform from a USB memory stick (or external hard disk) plug the stick into the controller PC, select "Waveform Location > Local file system" and in the "Load Waveform" >"File Select" dialog navigate to the external drive.

Load Waveform
Calls the "File Select" menu for loading the waveform file.

The files last used are listed in the "Recent Data Sets" section. The directory can be selected from the center left section. All waveform files (file extension *.wv) available from the selected directory are listed on the right side. The file info (tag contents and multi-segment state) for the selected file is displayed below the file section.

The "Select..." button selects the marked file. This file is loaded when the ARB modulation is enabled ("State On").

For a description on how to manage the waveform files, refer to Chapter 4.2, "Managing files on the R&S SGT", on page 50.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect on page 437

Waveform Info

Opens a dialog with detailed information about the currently selected waveform.

The waveform information displayed in this dialog depends on whether the selected waveform file is a multisegment one or not. All parameters are read-only.
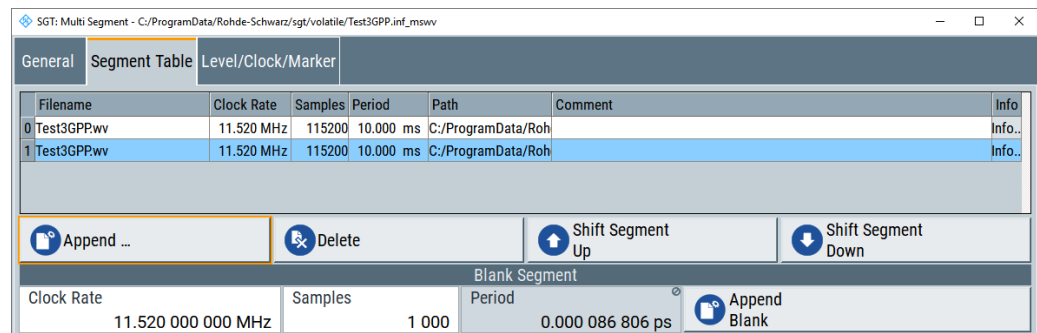
For non-multi-segment waveform files, the values of the settings can be queried by the tag commands (see Chapter 11, "Waveform and list format", on page 565).

Remote command:
n.a.

Clock Frequency

Displays or enters the ARB output clock rate.

When the waveform file is loaded, this value is automatically set to the clock rate defined in the file (clock tag). If necessary, you can change the value later.

When intending to work with an external clock source, the frequency to be applied must be entered here.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CLOCk on page 403

Multi Segment

Calls the menu for calculating multi-segment waveforms (seeChapter 6.1.2.3, "Multi-segment waveforms", on page 93).

Remote command:
n.a.

Multi Carrier

Calls the dialog for calculating multi-carrier waveforms (see Chapter 6.1.2.4, "Multi-carrier waveforms", on page 104).

Remote command:
n.a.

Create Test Signal...

Selects the form of the test signal and calls the menu for generating it. A sinusoidal, rectangular or test signal with constant I/Q can be selected.

See the corresponding section for detailed description of the parameters for the selected test signal:

- Chapter 6.1.2.5, "Sine test signal", on page 117
- Chapter 6.1.2.6, "Rect Test Signal", on page 118
- Chapter 6.1.2.7, "Const I/Q Test Signal", on page 120

Remote command:
n.a.

6.1.2.3 Multi-segment waveforms

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 SGT provides the functionality to generate multi-segment wave-form files.

This section introduces the concept of the multi-segment waveform files, together with description of the provided settings and some typical configuration examples.

Introduction

A multi-segment waveform is a composed signal containing multiple independent waveforms called segments. Each segment represents an independent waveform that can be output with its own marker and clock settings.

The Figure 6-1 shows the principle of building a multi-segment waveform.
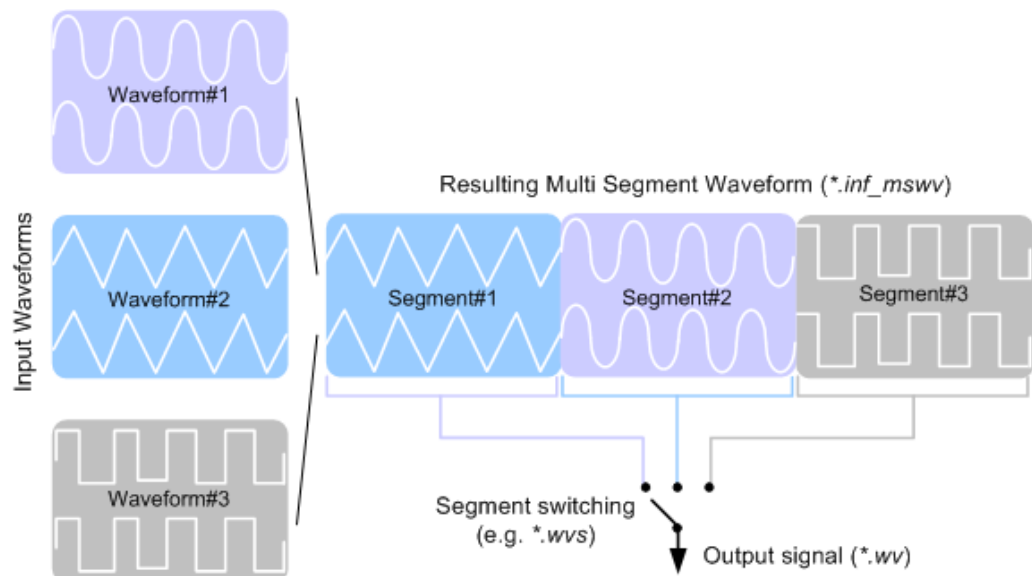
Figure 6-1: ARB multi-segment waveform concept

It is also possible to create and output a blank segment, i.e. segments containing a zero signal.

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.

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 SGT 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 SGT 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.

Multi-segment waveform settings

Access:

► Select "SGMA-GUI > Instrument Name > Baseband > ARB > Multi Segment".

To create multi-segment waveform file

1. Select "New List" to create an empty list.

   The "Create Multi Segment Waveform List" dialog opens.
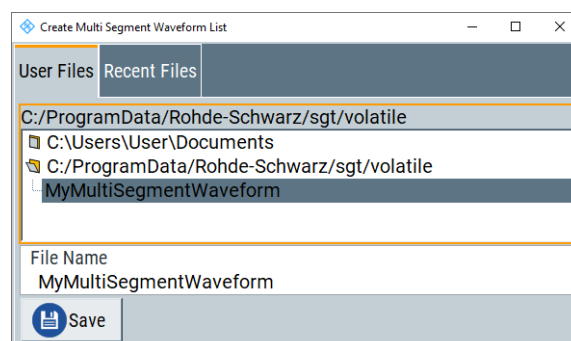
   Store the list in the default directory, e.g. with filename
   `MyMultiSegmentWaveform`:
   `C:/ProgramData/Rohde-Schwarz/sgt/volatile`

2. Use the "Append" function to add two or more waveform files.

3. Adjust the "Level", "Clock" and "Segment Marker" settings.

4. Select the "Output File".

5. Enter a filename.

6. Select "Save" to save the configuration.

7. Select "Create" or "Create and Load" to create and save the multi-segment waveform.

General settings

Access:

► Select "SGMA-GUI > Instrument Name > Baseband > ARB > Multi Segment.. > General".
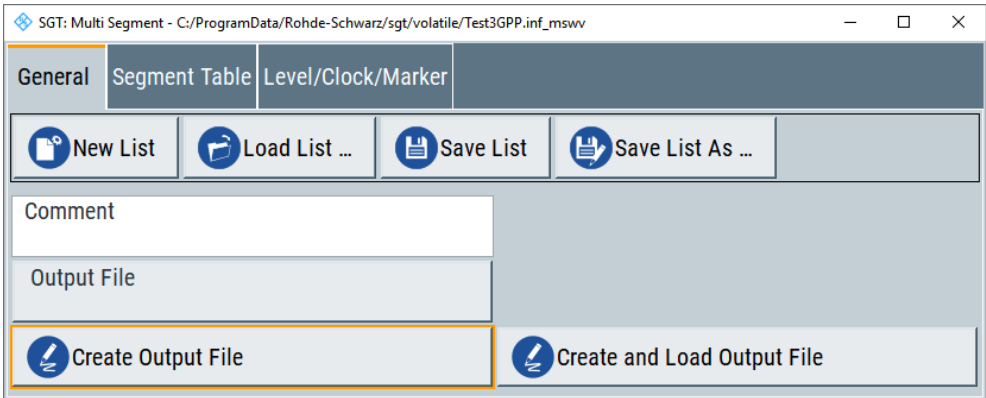
This dialog comprises the settings for managing files, lists and the possibility to add a comment.

Settings:

New List

Calls the "Create Multi Segment Waveform List" dialog to enter the name of the new file.

A new configuration table is created.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect on page 445

Load List

Opens the file menu to select the configuration file to be edited.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog? on page 440
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect on page 445

Save List

Saves the current entries of the table in a configuration file, including the level mode, clock mode, segment marker mode and output filename settings.

The filename is entered in the "File" menu. Configuration files have the file extension *.inf_mswv. They can be used later as the basis for further multi-segment wave-forms.

Before a multi-segment configuration file can be saved, a filename must be entered in "Output File". The output file is saved with the configuration file for internal purposes.

Remote command:
The configuration file to be used for the creation of the multi-segment waveform is defined with the command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate
The filename of the waveform file is always determined with the command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe

Create

Creates a multi-segment waveform using the current table entries.

This multi-segment waveform is saved with the filename specified in "Output File". As with normal waveforms, the file extension is "*.wv".

Depending on the configuration of the multi-segment waveform, calculation can take some time. A panel with a progress bar and an "Abort" button appears during creating of the multi-segment waveform.

In remote control, create or create and load the multi-segment waveform file with the following commands:
- [:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate on page 445
- [:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad on page 439.

To specify the filename, use the following command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe on page 443

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate on page 445

Create and Load

Creates a multi-segment waveform using the current table entries.

The multi-segment waveform is saved with the filename specified in "Output File". As with normal waveforms, the file extension is `*.wv`.

Depending on the configuration of the multi-segment waveform, calculation can take some time. Afterwards, the "Create Multi Segment Waveform File" submenu is closed and the new multi-segment waveform is loaded.

In remote control, create or create and load the multi-segment waveform file with the following commands:

- `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate` on page 445
- `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad` on page 439.

To specify the filename, use the following command:

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe` on page 443

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad` on page 439

Comment

Adds a comment to the multi-segment file.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent` on page 441

Output file

Opens the file menu, where the filename of the multi-segment waveform which has to be calculated can be entered. The multi-segment waveform is saved under this name by clicking the "Create" or "Create and Load" button.

Enter a name before saving the list as a configuration file ("Save List"). In this case, the name is needed for internal storage procedures. It is entered as the default name for the multi-segment waveform file when loading the list.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe` on page 443

Segment table

Access:

► Select "SGMA-GUI > Instrument Name > Baseband > ARB > Multi Segment > Segment Table".
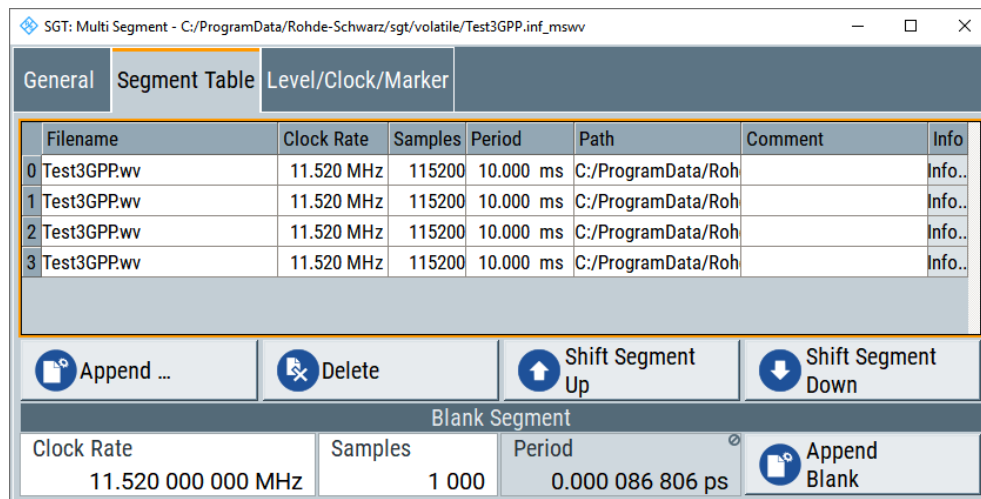
This dialog comprises the settings for creating and adjusting the contents of the multi-segment file.

Settings:

Multi Segment Table

The table lists the individual waveforms (segments) of the selected multi-segment waveform. The information about the segments is taken from the tags of the corresponding waveform files.

"Segment#"   Indication of segment index. The segment index is used to select the segment to be output.
The segment index also defines the sequence of the output during triggering in the "Next Segment" or "Next Segment Seamless".

"Filename"   Indication of the waveform filename of the segment.

"Clock Rate"   Indication of the clock rate of the segment.

"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 comment on the segment.
"Info"	Opens a dialog with detailed information about the currently selected waveform.

Remote command:

n.a.

Append

Opens the file menu to enter the filename of the waveform file to be appended.

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?` on page 444

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend` on page 444

Delete

Deletes the selected segment.

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete` on page 441

Shift Seg.# Up/Down

Shifts the selected segment up and down.

Clock Rate

Selects the clock rate of the blank segment.

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend` on page 439

Samples

Selects the number of samples for the blank segment.

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend` on page 439

Period

Displays the resulting period for the blank segment.

Remote command:

n.a.

Append Blank

Adds the blank segment to the multi-segment file.

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend` on page 439

Level/clock/marker settings

Access:

► Select "SGMA-GUI > Instrument Name > Baseband > ARB > Multi Segment.. > Segment Table".
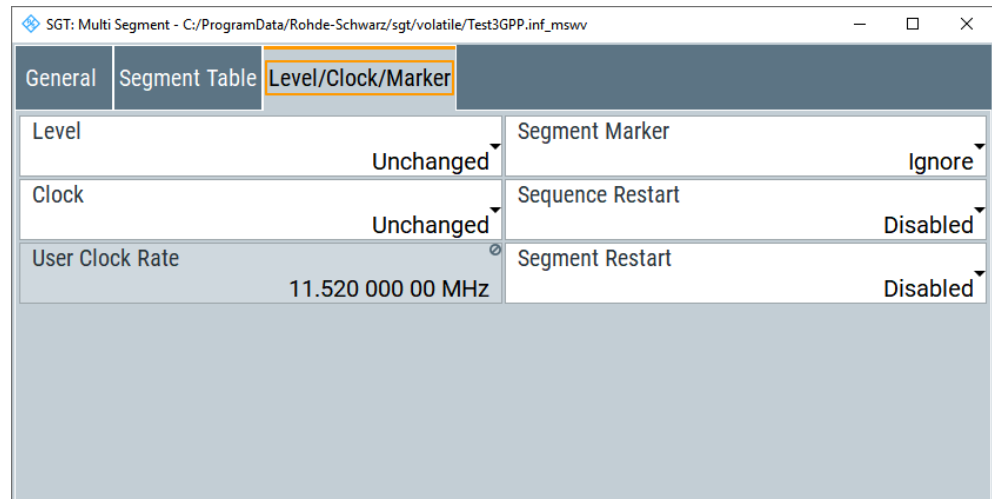
The Level/Marker/Clock section provides the parameters necessary to adjust the level, marker and clock settings for the selected multi-segment waveform file.

Settings:

Level

Defines the level mode for the multi-segment waveform.

"Unchanged"   Concerning the level settings, the segments are output exactly as defined in the files. The "Level" display applies only to the segment with the highest rms value. In some circumstances, the remaining segments are output at a lower level than displayed.

"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 442

Clock

Selects the clock rate mode for the multi-segment waveform.

"Unchanged"	A segment is output with the clock rate defined in the file.
	If segments have different clock rates, extended trigger mode "Next Segment" allows internal segment switchovers only ("Internal" trigger source).
	Extended trigger mode "Next Segment Seamless" can only be selected if all segments have the same clock rate.
"Highest"	All segments are output at the highest available clock rate.
	This mode provides short switchover times between segments.
	The time for calculating the multi-segment waveform is increased since the individual segments have to be resampled.
"User"	All segments are output at the clock rate defined in "User Clock".
	This mode provides short switchover times between segments.
	The time for calculating the multi-segment waveform is increased since the individual segments have to be resampled.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE
on page 441

User Clock Rate

Requires "Clock Mode > User".

Defines the sample rate used for multi-segment waveform output.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk on page 440

Segment Marker

Defines the way the marker information within the separate segments is processed.

"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 443

Sequence Restart

Enables/disables the generation of an additional marker restart signal in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered.

"Disable"	No additional marker is generated.
"Marker 1/2/3/4"	Generates a restart marker signal at the beginning of the first segment for the corresponding marker.
	Use this setting to generate a restart marker for the complete sequence.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment
on page 442

Segment Restart

Enables/disables the generation of an additional marker restart signal in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered.

"Disable"   No additional marker is generated.

"Marker   Generates a restart marker signal at the beginning of each segment
1/2/3/4"   for the corresponding marker.
                 The starting point of the segment is set at the low-high slope of the
                 marker. The setting applies for switching between two segments and
                 for replaying segments.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment
on page 442

Multi-segment waveform sequencing

The settings provided in the "Multi Segment Waveform Sequencing" dialog can be adjusted to crate a "play list", i.e. to define the sequence in which the waveform file segments are processed and how many times each of them is repeated. The configured play list is displayed in form of a "Sequencing Graphic".

ⓘ   All segments in a "play list" must have the same clock rate.

In the "ARB" main dialog or in the "ARB Trigger/Marker/Clock" dialog, set the "Next Segment Mode" to "Sequencer" to activate the configured "play list".

Sequencing List

Displays the name of the selected sequencing list file, i.e. the file with the "play list" settings.

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. More than one sequencing list files can be created per multi-segment waveform file.

The sequencing list file carries information only about the segment number. The corresponding waveform file names are retrieved from the assigned multi-segment waveform file. I.e., 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".

Remote command:
n.a.

Assigned to Multi Seg. Waveform

Displays the name of the multi-segment waveform file that the current sequencing list file is assigned to.

Remote command:
n.a.

Sequencing Play List

The "Sequencing Play List" table defines the sequence order that 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 pro-
                     cessed.

"Segment#"   Indicates the segment index.
                     The sequencing list file carries information only about the segment
                     index, the corresponding filenames are retrieved from the assigned
                     multi-segment waveform file.

"Waveform"   Indicates the waveform file mapped to the corresponding segment.
                     The filename is retrieved from 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 103.

Next ← Sequencing Play List

Determines the action after completing the current one, like, for instance, which seg-
ment 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 448

`[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend` on page 447

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.

Remote command:

n.a.

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 448

Save Sequencing List

Saves the current entries of the table in a play list file.

The default filename of the play list file is the same as the multi-segment waveform filename, but it can be changed.

Play list files have the file extension `*.wvs`.

Remote command:

n.a.

6.1.2.4 Multi-carrier waveforms

Multi-carrier waveforms consisting of up to 512 carriers modulated by user-selectable baseband signals can be created to simulate complex multi-carrier scenarios with different baseband signals (e.g. CDMA2000 or 3GPP FDD).

The carriers are centered toward the RF frequency or baseband DC line, respectively. The carrier spacing is adjustable within the total available baseband bandwidth. Each carrier can be separately defined in terms of power, phase and modulated input signal. Optionally, crest factor optimization can be applied.

Thus, multi-carrier waveforms can be easily configured as broadband test signals and used for such purposes as transmitter or receiver tests. Even complex multi-carrier scenarios composed of signals from different digital standards can be created and used for these tests.

Creating a multi-carrier waveform file

1. Configure general settings.

2. Configure carrier table.

3. Enter filename of the multi-carrier waveform ("Output File").

4. Save and load the multi-carrier waveform ("Create" or "Create and Load").

Accessing the multi-carrier settings

To access the "Multi Carrier" dialog, select "Baseband > ARB >General > Multi Carrier...".
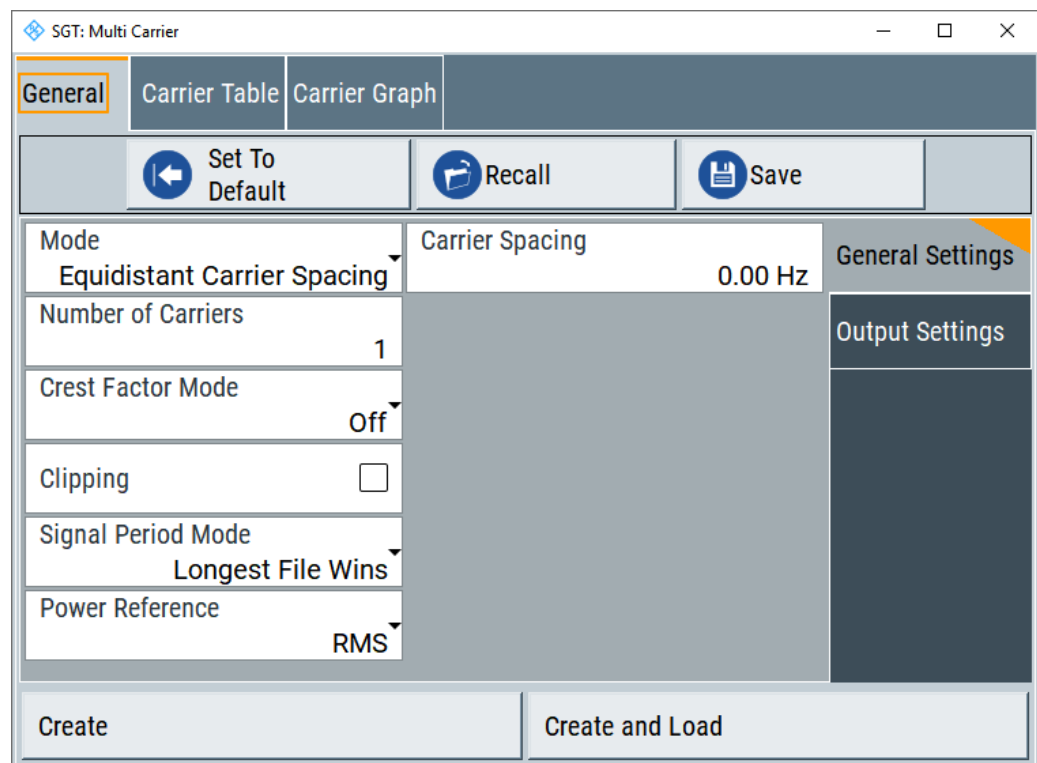
The menu can be used to create a multi-carrier waveform and save it under its own name. As with normal waveforms, the file extension is *.wv. Information on clock rate, number of samples and creation day is displayed in the file menu when a waveform is loaded.

Default settings and state

The upper part of the "General"dialog is used for calling the default settings and saving and recalling existing ARB multi carrier submenu settings.

Set to Default
Calls default settings. The values are shown in the following table.

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 430

Save/Recall Frame

Calls the "Save/Recall" dialog.

From the "Save/Recall" menu, the "File Select" windows for saving and recalling the configurations of the ARB "Multi Carrier" submenu and the "File Manager" can be called.

Multi-carrier configurations are stored as files with extension *.arb_multcarr. Filename and storage directory are user-definable. The complete settings in the "Multi Carrier" menu are saved and recalled.

"Recall Multi Carrier Settings"

Opens the "File Select" window for loading a saved multi carrier configuration.
The configuration of the selected (highlighted) file is loaded by pressing the "Select" button.

"Save Multi Carrier Settings"

Opens the "File Select" window for saving the current multi carrier signal configuration.
The name of the file is specified in the "filename" entry field, the directory selected in the "Save Into" field. The file is saved by pressing the "Save" button.
The "Fast Save" checkbox determines whether the instrument performs an absolute or a differential storing of the settings. Enable this function to accelerate the saving process by saving only the settings with values different to the default ones. "Fast Save" is not affected by the "Preset" function.

"File Manager"   Calls the "File Manager" window.
The "File Manager" is used to copy, delete, and rename files and to create directories.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog? on page 431

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD on page 431

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe:FAST on page 432

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe on page 431

General settings

The "General Settings" section is used to configure the multi carrier signal.

Settings:

Mode

Selects the carrier frequency mode.

"Equidistant Carrier Spacing"

> Sets an equidistant carrier spacing. The carrier frequency in the carrier table is not configurable.

"Arbitrary Carrier Frequency"

> Enables you to specify the carrier frequency in the carrier table. Carrier spacing is not relevant.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE on page 420

Number of Carriers

Sets the number of carriers for the multi carrier waveform.

By default the multi carrier table lists 1 carrier. When the number of carriers is increased, the multi carrier table is extended by adding further lines at the end of the table. If these carrier already have been defined before, the settings are preset according to the former settings. Otherwise the parameters are preset with the default values.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt on page 419

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" = Total Baseband Bandwidth /("Number of Carriers" - 1).

The total baseband bandwidth is 160 MHz.

Note: To avoid wrap-around problems, the effective "Carrier Spacing" is modified slightly.
The "Carrier Spacing" is rounded in that way that the carrier closest to the center RF frequency shows no phase jump assuming 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)

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing on page 420

Crest Factor Mode

Selects the mode for optimizing the crest factor by calculating the carrier phases.

The crest factor represents the ratio of the peak voltage value to the rms voltage value. The higher the crest factor and resulting dynamics of a signal, the greater the requirement for a power amplifier fed by the signal to be linear.

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 423

Clipping

Switches baseband clipping on and off.

Clipping reduces the peak power of the resulting multi carrier signal according to the input parameter "Target Crest Factor".

The resulting clipped peak power is defined by the sum of the RMS level of the unclipped multi carrier signal and the input parameter "Target Crest Factor". Note that clipping reduces also the RMS level. Hence the resulting crest factor of the clipped signal is slightly above the "Target Crest Factor".

To match unclipped parts of the clipped multicarrier signal with the unclipped multicarrier signal, reduce the RF output power. Reduce it by the difference between resulting crest factor and "Target Crest Factor".

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] on page 425

Target Crest Factor

Available only for "Clipping > On".

Sets the value of the desired crest factor.

A "Target Crest Factor" above the crest factor of the unclipped multicarrier signal has no effect.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor on page 424

Filter Cut Off Frequency

Available only for "Clipping > On"

Sets the cut-off frequency of the final lowpass filter.

If the cut-off frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multicarrier signal. As a trade-off, the resulting crest factor can increase.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff on page 424

Signal Period Mode

Selects the mode for calculating the resulting signal period of the multi carrier waveform. The carrier table provides an information button to obtain sample rate and file length data of each carrier.

The resulting period is always calculated for all carriers in the carrier table irrespective of their state (On/Off).

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 you to consider timing already when creating the input I/Q files. Also, adjust the signal duration to the carrier which is later demodulated (in this case, the other carriers are for interfering the signal only). The problems do not arise with signals of the same standard (e.g. 3GPP).

The following modes are available:

"Longest File Wins"

> The resulting signal period is defined by the longest I/Q file in the carrier table. Shorter I/Q files are periodically repeated.

"Shortest File Wins"

> The resulting signal period is defined by the shortest I/Q file in the carrier table. Only the first part of longer I/Q files is used.

"User"   The signal period can be set in the "Signal Period" field. 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 432

Signal Period

Available only for "Signal Period Mode > User"

Sets the signal period. 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 432

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.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence on page 423

Carrier Table

Calls the table for configuring individual carriers. A selectable carrier range can be set with the aid of the optional "Carrier Table Assistant" (see "Multi carrier table settings" on page 111).

The multi carrier configuration can be checked with the aid of the "Carrier Graph".

Output settings

The "Output Settings" section in the multi carrier dialog indicates the name, the size and the clock rate of the currently calculated multi carrier output file.

Settings:

Output File

Opens the "File" dialog, where the output filename of the multi carrier waveform which has to be calculated can be entered.

The multi carrier waveform is calculated and saved under this name by clicking the "Create" or "Create and Load" button.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe on page 430

Clock Rate

Displays 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.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk? on page 426

File Size

Displays the resulting number of samples of the multi carrier waveform.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles? on page 430

Create

Creates a multi carrier waveform defined by the multi carrier table and general setting entries.

This multi carrier waveform is saved with the filename specified in "Output File". If no filename is specified, the "File Manager" opens so that the filename can be entered. As with normal waveforms, the file extension is *.wv.

Depending on the configuration of the multi carrier waveform, calculation can take some time. A panel with a progress bar and an "Abort" button appears during the calculation process.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate on page 426

Create and Load

Creates a multi carrier waveform defined by the multi carrier table and general setting entries and loads it later into the "ARB" main menu.

This multi carrier waveform is saved with the filename specified in "Output File". If no filename is specified, the "File Manager" opens so that the filename can be entered. As with normal waveforms, the file extension is *.wv.

Depending on the configuration of the multi carrier waveform, calculation can take some time. A panel with a progress bar and an "Abort" button appears during the calculation process.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad on page 425

Multi carrier table settings

The "Multi Carrier Table" dialog is opened with the "Carrier Table" button in the middle part of the multi carrier waveforms menu. The carrier settings can be checked in the graphical "Carrier Graph" subdialog.

The "Carrier Table Assistant" section can be used to set a selectable carrier range. Use it to set up a multi carrier scenario within a specified carrier range.

ARB Multi Carrier Table SGT	— □ ×
Number of Carriers 1	
Carrier Start 0	**Carrier Stop** 0
Carrier State ☐	
Gain Start 0.00 dB	**Gain Step** 0.00 dB
Phase Start 0.00 deg	**Phase Step** 0.00 deg
Delay Start 0 ns	**Delay Step** 0 ns
📁 Input Waveform File …	ArbMccwDummy.wv
✓ Apply Assistant Settings	

Settings:

Number of Carriers
Sets the number of carriers for the multi carrier waveform.

By default the multi carrier table lists 1 carrier. When the number of carriers is increased, the multi carrier table is extended by adding further lines at the end of the table. If these carrier already have been defined before, the settings are preset according to the former settings. Otherwise the parameters are preset with the default values.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt on page 419

Carrier Start

Defines the start 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 429

Carrier Stop

Defines the stop index of the carrier range to which the assistant settings are intended to apply.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP on page 429

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 430

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 429

Gain Step

Sets the step width that is used to increment the gain.

The resulting carrier gain in the carrier table equals:

GainStart + n* Gain Step

Where n ranges from 0 to ("Carrier Stop" - "Carrier Start").

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP on page 429

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 428

Phase Step

Sets the step width that is used to increment the phase.

The resulting phase in the carrier table equals:

PhaseStart + n* PhaseStep

Where n ranges from 0 to (Carrier Stop – Carrier Start)

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP
on page 429

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 427

Delay Step

Sets the step width that is used to increment the delay.

The resulting delay in the carrier table equals:

DelayStart + n* DelayStep

Where n ranges from 0 to (Carrier Stop – Carrier Start).

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP
on page 426

Input Waveform File

Calls the "File" dialog for selecting the input file with 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 427

Apply Assistant Settings

Transfer the assistant settings to the carrier table.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute
on page 427

Carrier Table

The table displays the settings of all available carriers. Previously applied assistant settings can be further refined. The number of lines corresponds to the number of carriers.

Note: The phase/deg settings are only valid if optimization of the crest factor is disabled ("Crest Factor Mode" = Off).

No ← Carrier Table

Indicates the carrier index ranging from 0 to (number of carriers -1).

Individual carriers can be set using the remote control commands by specifying the index in the parameter CARR.

State ← Carrier Table

Switches On/Off a carrier.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe on page 423

Carrier Freq Offs. ← Carrier Table

Sets the carrier frequency offset.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency
on page 422

Gain ← Carrier Table

Sets the gain of a carrier.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer on page 422

Phase ← Carrier Table

Sets the starting phase of a carrier.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe on page 422

Delay ← Carrier Table

Sets the starting delay of a carrier.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay on page 421

File ← Carrier Table

Calls the "File" menu for selecting the input file with the I/Q signal to be modulated onto
the carrier.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FILE on page 421

Info ← Carrier Table

Indicates the sample rate, number of I/Q value pairs (number of samples), and the
resulting signal period of the selected I/Q input file.

Remote command:
n.a.

!!! ← Carrier Table

Indicates an occurred conflict by a red LED. A conflict arises when the carriers overlap.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?
on page 421

Carrier graph table

► To access this dialog select "Baseband > ARB > Multi Carrier... > Carrier Graph"
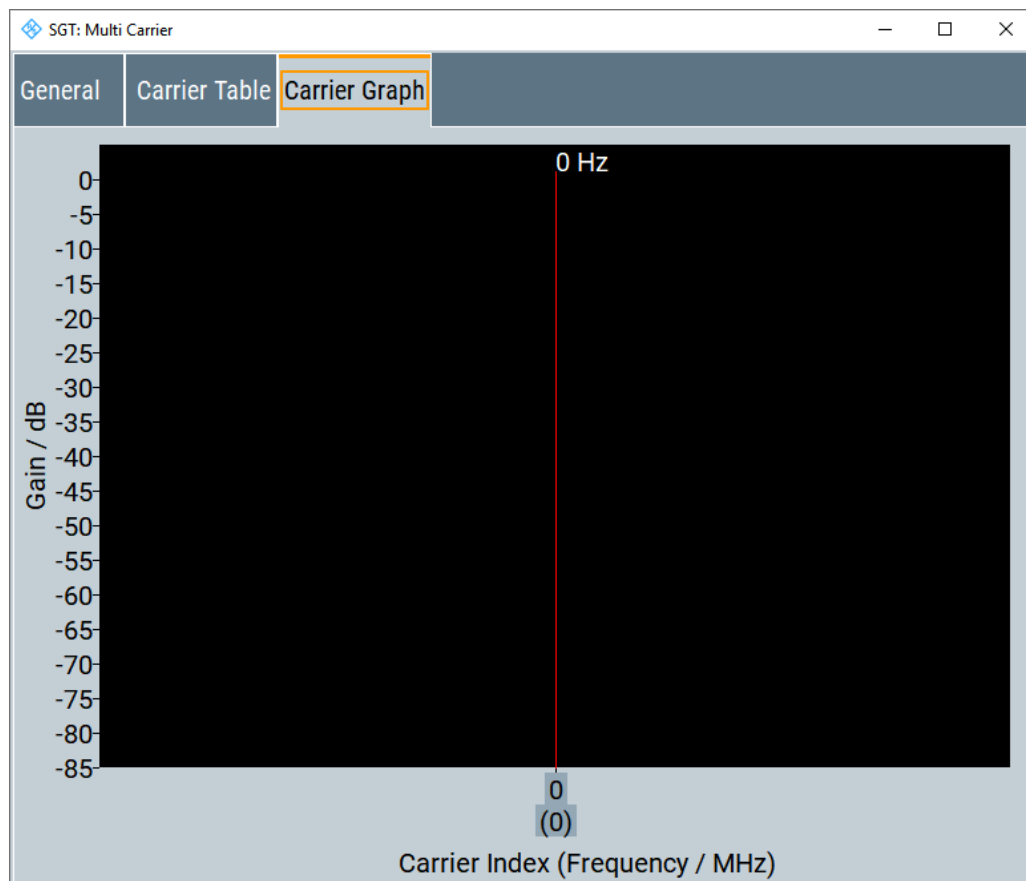
Carrier Graph

Calls a graphical representation of the current multi carrier configuration in the frequency domain.

The height of the bars corresponds to the chosen gain of each individual carrier. The bandwidth of the carriers signals is indicated by the width of the bars.

6.1.2.5 Sine test signal
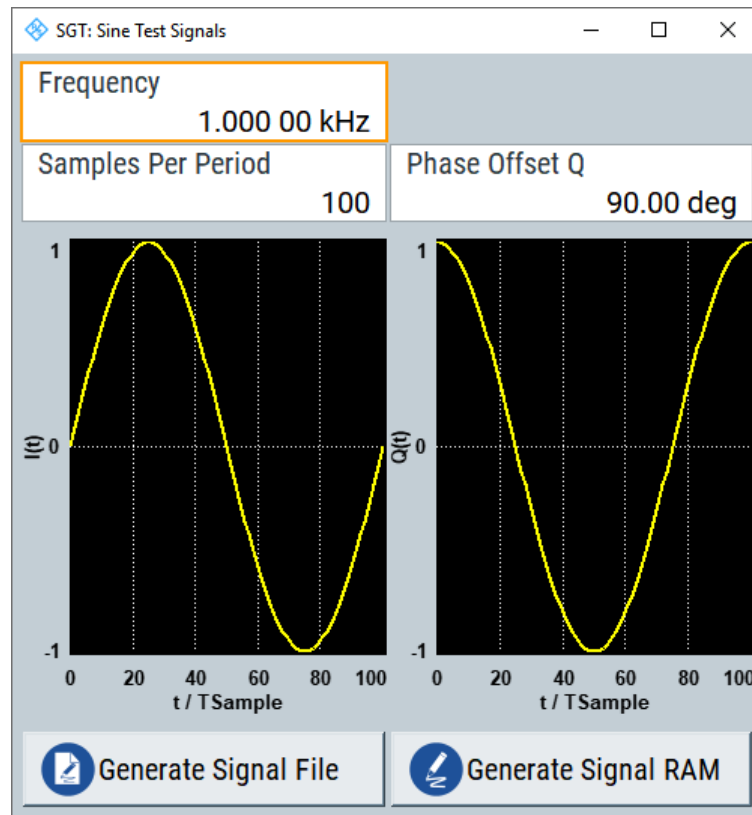
This dialog provides settings for configuration of a sinusoidal test signal. A sine wave is generated on the I path, and a sine wave of the same frequency but phase-shifted is generated on the Q path.

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 417

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 418

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 418

Generate Signal File

Generates a signal and saves it to a file.

The "File Select" window opens automatically and the signal can be stored as a waveform file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed on page 416
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed
on page 416
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed on page 416

Generate Signal RAM

Generates a signal and uses it as output straight away.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate on page 415
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate on page 415
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate on page 415

6.1.2.6 Rect 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.

Settings:

Frequency

Enters the frequency of the test signal.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency on page 417

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 417

Amplitude

Enters the digital amplitude of the rectangular wave.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude on page 416

Offset DC

Enters a DC component.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet on page 417

Generate Signal File

Generates a signal and saves it to a file.

The "File Select" window opens automatically and the signal can be stored as a wave-form file.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed on page 416
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed
on page 416
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed on page 416

Generate Signal RAM

Generates a signal and uses it as output straight away.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate on page 415
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate on page 415
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate on page 415

6.1.2.7 Const I/Q Test Signal
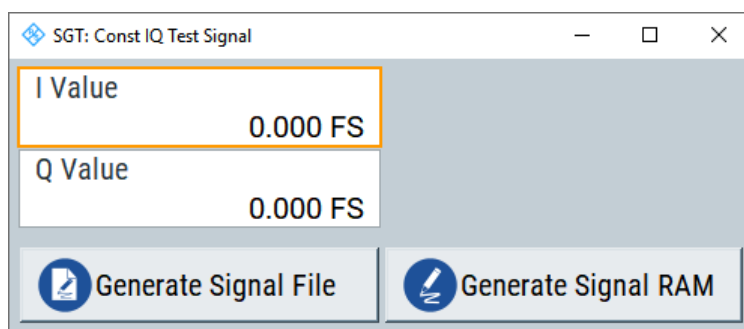
This dialog provides settings for configuration of a continuous test signal with constant IQ. The I and Q values for each path are adjustable but constant.

After converting to an analog signal, the signal is output directly at the I and Q connectors of the instrument.

Settings:

I Value

Enters the value for the I component of the test signal.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I on page 416

Q Value

Enters the value for the Q component of the test signal.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q on page 416

Generate Signal File

Generates a signal and saves it to a file.

The "File Select" window opens automatically and the signal can be stored as a waveform file.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed on page 416
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed
on page 416
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed on page 416

Generate Signal RAM

Generates a signal and uses it as output straight away.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate on page 415

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate on page 415

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate on page 415

6.1.3 Trigger, marker and clock settings

6.1.3.1 Trigger in settings

Access:

► Select "SGMA-GUI > Instrument Name > Baseband > ARB > Trigger In".
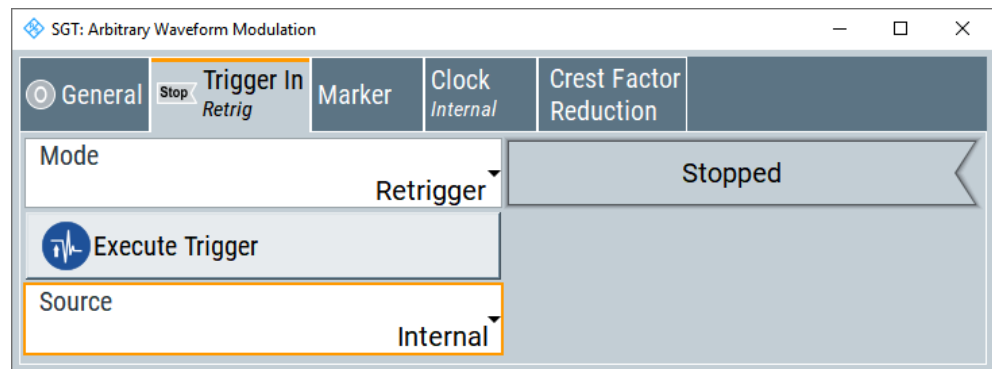
The "Trigger In" section is where the trigger for the signal is set. Various parameters are provided for the settings, depending on which trigger source - internal or external - is selected. The status of signal generation ("Running" or "Stopped") is indicated for all trigger modes.

Settings:

Trigger Mode

Selects trigger mode.

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

"Auto"   The signal is generated continuously.

"Retrigger"   The signal is generated continuously. A trigger event (internal or external) causes a restart.

"Armed_Auto"   The signal is generated only when a trigger event occurs. Then the signal is generated continuously.

"Armed_Retrigger"
                   The signal is generated only when a trigger event occurs. Then the signal is generated continuously. Every subsequent trigger event causes a restart.
                   Button "Arm" stops the signal generation. A subsequent trigger event (internal with "Execute Trigger" or external) causes a restart.

"Single"   The signal is generated only when a trigger event occurs. Then the signal is generated once to the length specified at "Signal Duration". Every subsequent trigger event (internal with "Execute Trigger" or external) causes a restart.

Remote command:
[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence on page 411

Signal Duration Unit
Available only for "Trigger Mode > Single".

Defines the unit for the entry of the length of the signal sequence to be output.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit on page 408

Signal Duration
Available only for "Trigger Mode > Single".

Defines the length of the signal sequence to be output. The unit of the entry is defined under "Signal Duration Unit". You can output just a part of the signal, an exact sequence of the signal, or a defined number of repetitions of the signal.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth on page 408

Running/Stopped
Displays the status of signal generation.

"Running"   The waveform is output; a trigger was (internally or externally) initiated in triggered mode.
                   If "Armed_Auto" or "Armed_Retrigger" have been selected, the generation of signals can be stopped with the "Arm" button. A new trigger (internally with "Execute Trigger" or externally) causes a restart.

"Stopped"   The waveform output is stopped. The instrument waits for an internal or external trigger event to restart. ARB modulation is disabled.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe? on page 407

Arm

Available only in the "Running mode" and for "Trigger Mode > Armed_Auto" or "Trigger Mode > Armed_Retrigger".

Stops the waveform output.

Signal output can be restarted by a new trigger (internally with "Execute Trigger" or externally).

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute on page 406

Execute Trigger

Executes the trigger manually. A manual trigger can be executed only when an internal trigger source and a trigger mode other than "Auto" have been selected.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute on page 406

Trigger Source

Selects trigger source.

"Internal"　　　The trigger event is executed by "Execute Trigger".

"External"　　　The trigger event is executed with the aid of the active edge of an external trigger signal.
The trigger signal is supplied via the [USER 1/2] connector.
The polarity, the trigger threshold and the input impedance of the trigger input can be set in the "Connector" dialog.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce on page 409

Sync. Output to External Trigger

Available only for "Trigger Source > External".

Enables/disables output of the signal synchronous to the external trigger event.

"On"　　　Corresponds to the default state of this parameter.
The signal calculation starts simultaneously with the external trigger event but because of the instrument's processing time that the first samples are cut off and no signal is outputted. After the internal processing time elapses, the output signal is synchronous to the trigger event.
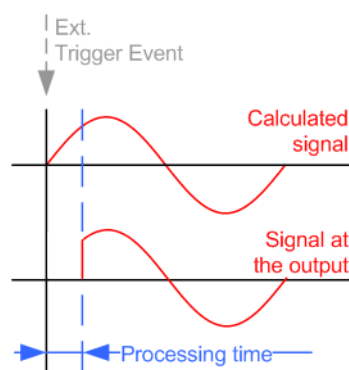
"Off"   The signal output begins after the elapsing of the processing time and
                   starts with sample 0, i.e. the complete signal is outputted.
                   This mode is recommended for triggering of short signal sequences
                   with signal duration comparable to the processing time of the instru-
                   ment.
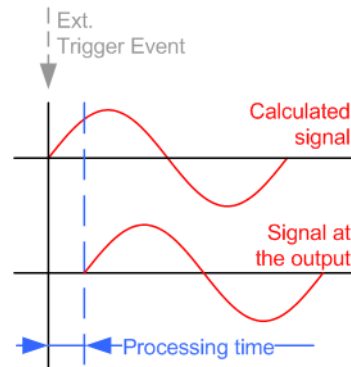
Remote command:

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut
on page 406

External Delay Unit

Determines whatever the trigger delay is expressed in samples or directly defined as a
time period (seconds).

The parameter displays the delay converted in time.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT on page 409

Trigger Delay

Sets the trigger signal delay in samples on external triggering. Setting the delay ena-
bles the R&S SGT to be synchronized with the device under test or other external devi-
ces.

The parameter displays the delay converted in time.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:DELay
on page 410
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:TDELay
on page 410

Actual Trigger Delay

Displays the time (in seconds) an external trigger event is delayed by.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:RDELay?
on page 410

Trigger Inhibit

Sets the duration for inhibiting a new trigger event after triggering. The input is to be
expressed in samples.

In the "Retrigger" mode, every trigger signal causes signal generation to restart. This restart is inhibited for the specified number of samples.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:INHibit` on page 411

6.1.3.2 Next segment trigger in settings

The section "Next Segment Trigger In" of the menu is only displayed if a multi-segment waveform is loaded.

The section comprises the settings necessary to adjust the trigger for the switch between the segments of a multi-segment waveform. The parameters displayed depend on the selected trigger source.
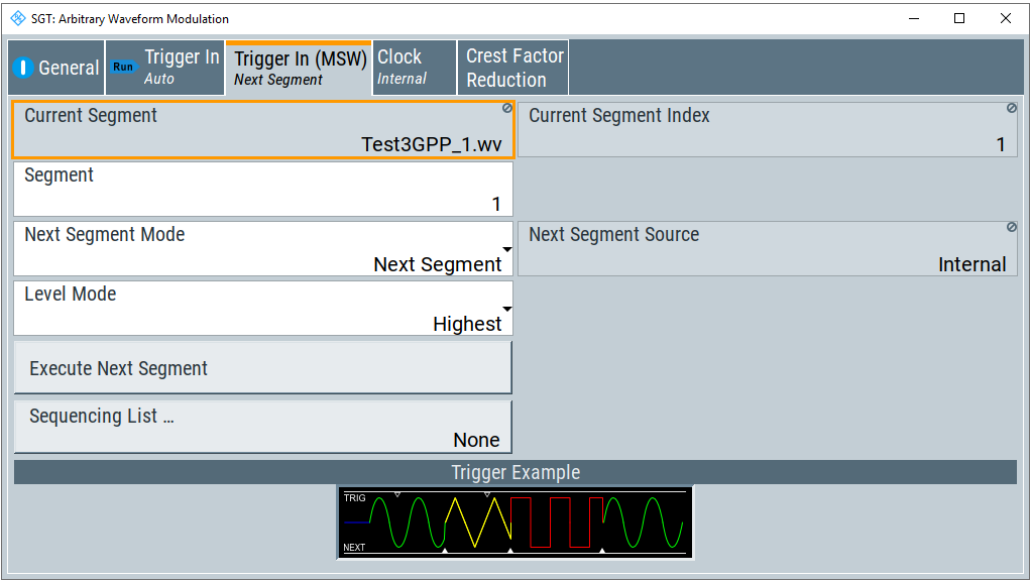
Settings:

Current Segment
Indication of the waveform segment (segment filename and index) that is output.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment?` on page 438
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME?` on page 446

Next Segment

Selects the waveform segment to be output next. It determines the start segment when switching on the ARB and enables switchover to any other segment.

The switchover is performed either after receiving an external next segment trigger event or, for the internal trigger case, by changing the segment index in the "Next Segment" field. The definition whether the new segment is generated immediately or only after the previous segment has been fully generated (wrap around) is determined by the parameter Next Segment Mode.

The segment currently being output (segment index and filename) is displayed at "Current Segment". The subsequent trigger event after the last segment causes the first segment to be output again.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT on page 446

Next Segment Mode

Sets the segmented trigger mode of a multi-segment waveform, i.e. defines the **switch over between segments** in a multi-segment waveform:

● In "Same Segment" mode, 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 segments, when receiving a trigger event.
Switching between the segments is triggered by changing the segment index in the "Next Segment" field.

● When "Next Segment" is selected, 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.
The following figure shows an example of the transition from a sine-wave signal segment to a sawtooth segment (I channel, above) for next segment external triggering (below).
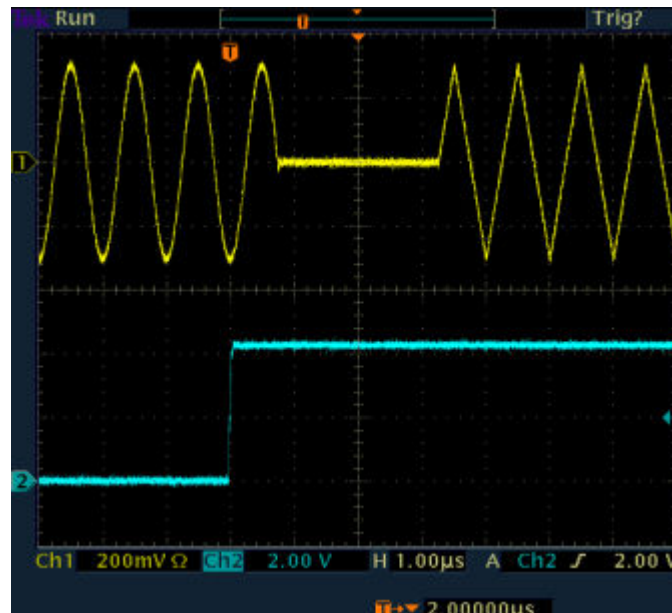
● When "Next Segment" seamless is selected and a new segment trigger event occurs, the new segment is not output until the whole of the current segment has

been output (wrap around). The signal transition is seamless. As a prerequisite for a seamless switchover, all segments must have the same sample rate.

The following figure shows an example of the seamless transition from a sine-wave signal segment to a sawtooth segment (I channel, above) for next segment external triggering (below).
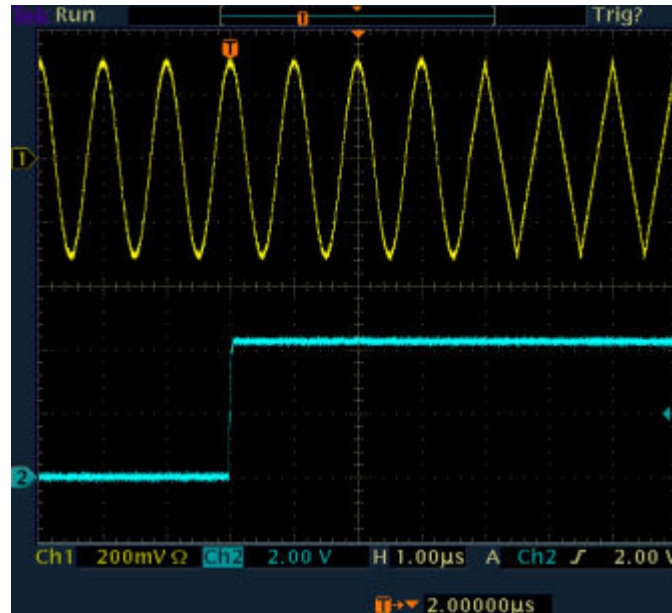
The regular trigger mode for starting the waveform generation and **triggering the whole multi-segment sequence** is set with the parameters in the "Trigger In" section of the "Trigger/Marker/Clock" dialog.

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.

"Same Segment"

Depending on the trigger setting, the currently selected segment is continuously output either immediately or after a trigger event.

Signal generation takes place differently according to the trigger selected in the "Trigger In" section:

- For "Trigger = Auto", output starts at once and the segment is generated continuously. Trigger events are ignored.
  If the segment is changed in "Next Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap (see above).
- For "Trigger = 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 "Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.
- For "Trigger = Retrigger", output starts at once and the segment is generated continuously, a trigger event causes a restart.
  If the segment is changed in "Next Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap (see above).
- For "Trigger = 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 "Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.
- For "Trigger = 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 "Next Segment", signal output is not stopped. The new segment is not output until a trigger occurs.

"Next Segment"

Depending on the trigger setting, the segment selected under "Next Segment" is output either immediately or after a trigger event.

- For "internal Trigger = Auto", output starts at once and the segment is generated continuously.
  If the segment index is changed in "Next Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
- For "internal Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment index is changed in "Next Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
- For "internal Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment index is changed in "Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.
- For "internal Trigger = 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 "Next Segment", the new segment is not output until a trigger occurs.
- For "External Trigger = Auto", output starts at once and the segment is generated continuously.
  If the segment index is changed in "Next 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.
- For "External Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment is changed in next 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.
- For "External Trigger = Single", output starts after the first trigger event. The segment is then generated once.
  If the segment is changed in "Next 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.

"Next Segment Seamless"

        The segment selected under "Next Segment" is output.

        This mode is only available if all segments have the same sample rate.

- For "Internal Trigger = Auto", output starts at once and the segment is generated continuously.
  If the segment is changed in "Next Segment", the new segment is output seamlessly after the output of the current segment is complete.
- For "internal Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment is changed in "Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.
- For "External Trigger = Auto", output starts at once and the segment is generated continuously.
  If the segment is changed in "Next Segment", the new segment is output seamlessly after the output of the current segment is complete.
- For "External Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment is changed in "Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.

        The remaining trigger modes ("Retrigger" and "Armed_Retrigger") are not available.

"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.

        Note: This feature is disabled in case the segments in the multi-segment waveform file have different clock rates.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe on page 409

Execute Next Segment

Triggers manually switchover to the subsequent segment in the multi-segment file. A manual trigger can be executed only when an internal "Next Segment Source" has been selected.

To perform a switchover to any segment within the multi-segment file, adjust the parameter "Next Segment".

This parameter is disabled, if a sequencing play list is enabled.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute on page 447

Sequencing List

Open a dialog box for defining the "play lists" (see "Multi-segment waveform sequencing" on page 102).

Remote command:

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect on page 448

Trigger Example

Displays an example of a multi-segment waveform. The currently enabled trigger and next segment mode are considered. After the instrument switch 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.

6.1.3.3 Marker settings

► To access this dialog, select "SGMA-GUI > Instrument Name > Baseband > ARB > Marker".
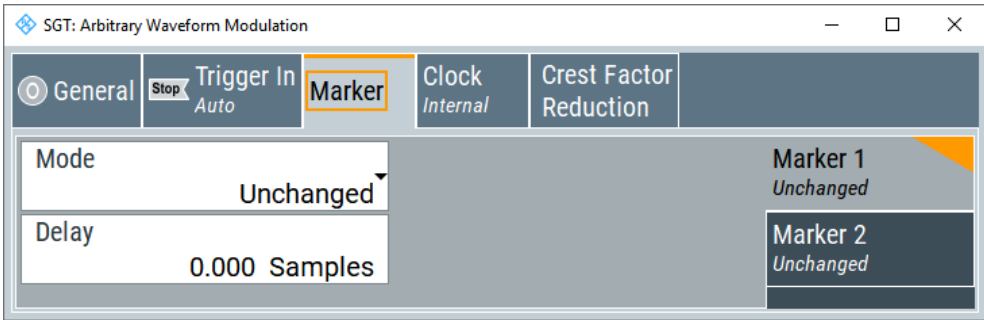
Provides the settings necessary to define the marker output signal for synchronizing external instruments and the delay of the marker signals on the [USER 1/2] connector.

Settings:

Marker Mode

Marker configuration for up to 2 marker channels. The settings are used to select the marker mode defining the shape and periodicity of the markers. The contents of the dialog change with the selected marker mode; the settings are self-explanatory.

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

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

"Restart"	A marker signal is generated at the start of each ARB sequence. This marker mode is not enabled for multi-segment waveforms.
"Pulse"	A regular marker signal is generated. The pulse frequency is defined by entering a divider. The frequency is derived by dividing the sample rate by the divider. The input box for the divider opens when "Pulse" is selected, and the resulting pulse frequency is displayed below it. The precision of the frequency setting depends on the sampling rate. The maximum pulse frequency is equal to half of the sampling rate.
"Pattern"	A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 64 bits and is defined in an input field which opens when "Pattern" is selected. The pattern bits switch the marker signal to high and low state.
"ON/OFF Period"	A regular marker signal that is defined by an ON/OFF ratio is generated. A period lasts one ON and OFF cycle.

| On time | Off time | On time | Off time |

The "ON Time" and "OFF Time" are each expressed in "Samples" and are set in an input field which opens when ON/OFF ratio is selected.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE on page 412

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider on page 413

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency? on page 414

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern on page 413

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime on page 413

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime on page 413

Marker x Delay

Enters the delay between the marker signal at the marker output and the start of the frame or slot.

If the setting "Fix marker delay to dynamic range" is enabled, the setting range is restricted to the dynamic range. In this range, the delay of the marker signals can be set without restarting the marker and signal.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay on page 415

Current Range without Recalculation

Displays the dynamic range within which the delay of the marker signals can be set without restarting the marker and signal.

The delay can be defined by moving the setting mark.

Remote command:

`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MINimum?`
on page 407
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MAXimum?`
on page 407

Fix marker delay to current range
Restricts the marker delay setting range to the dynamic range. In this range, the delay can be set without restarting the marker and signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut:DELay:FIXed` on page 414

6.1.3.4 Clock settings

Access:

► Select "SGMA-GUI > Instrument Name > Baseband > ARB > Marker".
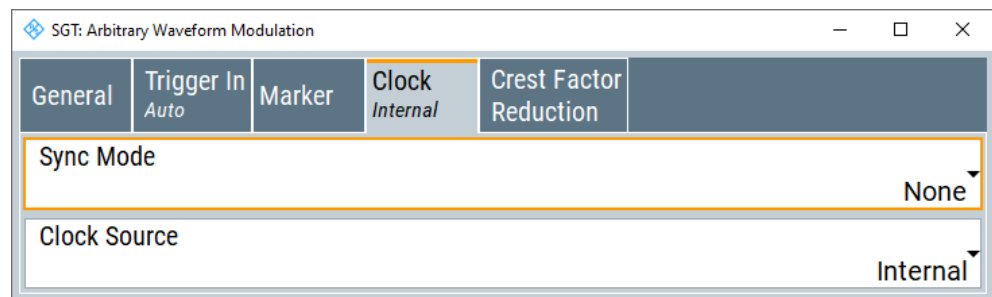
In the dialog, you can set the clock source and a delay.

Settings:

Sync Mode
Selects the synchronization mode.

"None"   The instrument is working in stand-alone mode.

"Sync Primary" The instrument provides all connected instrument with its synchronization (including the trigger signal) and reference clock signal.

"Sync Secondary"

                The instrument receives the synchronization and reference clock signal from another instrument working in a primary instrument mode.

"Sync Dig I/Q In"

> The instrument receives the synchronization and reference clock signal from the [DIGITAL I/Q] connector.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SYNChronization:MODE on page 404

Clock Source

Selects the clock source.

"Internal" The internal clock reference is used to generate the symbol clock.

"External" The external clock reference is fed in as the symbol clock or multiple thereof via the [USER 1/2] connector.

> The symbol rate must be correctly set to an accuracy of +/-2 % (see data sheet).
>
> The polarity of the clock input can be changed in the "Connector" dialog.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce on page 404

Clock Mode

Available only for "Clock Source > External"

Enters the type of externally supplied clock.

"Sample" A sample clock is supplied via the [USER 1/2] connector.

"Multiple Sample" A multiple of the sample clock is supplied via the [USER 1/2] connector; the sample clock is derived internally from it.

> The "Multiplier" window provided allows the multiplication factor to be entered.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CLOCk:MODE on page 403

Sample Clock Multiplier

Available only for "Clock Mode > Multiplier".

Enters the multiplication factor.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CLOCk:MULTiplier on page 403

Measured External Clock

Provided for permanent monitoring of the enabled and externally supplied clock signal.

Remote command:

:CLOCk:INPut:FREQuency? on page 357

Synchronisation State

Requires instruments working in secondary synchronization mode.

Displays the status of the external clock source. The status indicates, if the external clock source of the secondary instrument is synchronized or not synchronized yet.

Remote command:
:CLOCk:SYNC[:STATe]? on page 358

6.1.4 ARB offsets

► To access this dialog, select "SGMA-GUI > Instrument Name >Baseband > Frequency/Phase Offsets".
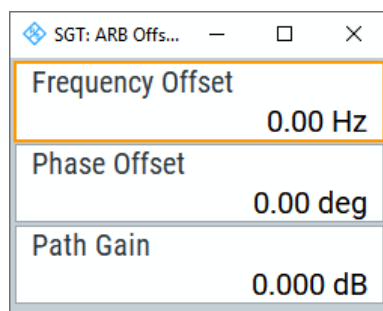
Settings:

Frequency Offset
Sets the frequency offset and shifts the ARB signal in the center frequency.

Remote command:
[:SOURce]:BB:FOFFset on page 400

Phase Offset
Sets the phase offset of the ARB signal.

Remote command:
[:SOURce]:BB:POFFset on page 400

6.1.5 Crest factor reduction

Required option: R&S SGT-K548

The R&S SGT-K548 is a software option that allows you to generate signals with reduced crest factor.

6.1.5.1 About the crest factor reduction

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.

About crest factors

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

A high crest factor arises, for example, for a multi carrier signal that has carriers with an identical start phase. 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 digital to analog (D/A) converter is relative to the maximum value, the average value is converted with a relatively low resolution. This low resolution leads to a high quantization noise.

Both effects increase the adjacent-channel power.

Clipping and filtering algorithm

A common and simple approach for achieving a lower PAR is the combination of clipping and filtering.

- 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.
  However, signal clipping not only changes the peak value but also the average value and the effect on the crest factor is unpredictable.
- Filtering is applied after clipping. The used filters are specially designed so that they filter out the distortion.

Peak cancellation algorithm

The peak cancellation algorithm uses Blackman windowed sinc pulses and subtracts them from the original baseband signal wherever the signal amplitude exceeds a defined threshold. This threshold equals maximum peak of the baseband signal minus a user-definable crest factor difference ("Desired Crest Factor Delta").

This algorithm often provides better EVM results of the output signal versus out of band noise introduced by the pulses, compared to the clipping and filtering method. The cancellation pulse bandwidth is configurable and the cancellation pulse transition bandwidth. The achieved resulting crest factor can be higher than expected, because of filters in the signal processing chain increasing the crest factor again after a previous crest factor reduction.

6.1.5.2   Crest factor reduction settings

Access:

► Select "Baseband" > "ARB" > "Crest Factor Reduction".
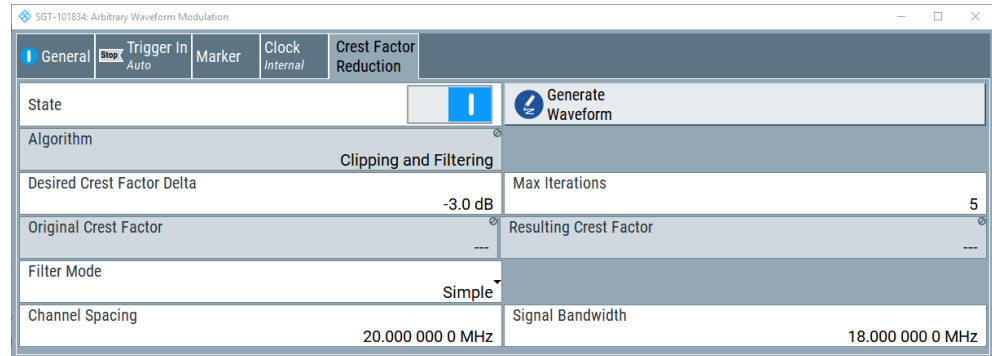
The dialog provides settings to configure and activate crest factor reduction.

Activating crest factor reduction

Crest factor reduction requires an active "ARB" state and a valid waveform file loaded to the ARB application.

1. Load a waveform file.

   a) Select "ARB" > "General" > "Load Waveform".
   b) In the file-select dialog, select the waveform file from the directory.

   See also chapter "How to load and play waveform files" in the R&S SGT user manual.

2. Select "General" > "State" > "On".

3. Select "Crest Factor Reduction" > "State" > "On".

The remote commands required to define these settings are described in Chapter 10.14.5, "SOURce:BB:ARBitrary:CFR subsystem", on page 449.

Settings:

State

Requires an active "ARB" state, see "Activating crest factor reduction" on page 137.

Activates crest factor reduction calculation.

Note: You cannot activate the crest factor reduction and the notch filter simultaneously. Enabling the notched filter automatically disables the crest factor reduction.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CFR[:STATe] on page 450

Generate Waveform

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

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

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CFR:WAVeform:CREate on page 454

Algorithm

Defines the algorithm for crest factor reduction.

"Clipping and Filtering"

This algorithm performs a hard clipping. It is followed by a low pass filtering of the result in an iterative manner until the target crest factor is reached. You can define the settings of the filter that is used for the calculation.

"Peak Cancelation"

This algorithm subtracts Blackman windowed sinc pulses from the signal wherever the amplitude is above a defined threshold.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CFR:ALGorithm on page 450

Desired Crest Factor Delta

Sets the value difference by which you want to change your crest factor.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CFR:DCFDelta on page 451

Max Iterations

Requires "Algorithm" > "Clipping and Filtering".

Sets the number of iterations that are used for calculating the resulting crest factor. The iteration process is stopped when the desired crest factor delta is achieved by 0.1 dB.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CFR:ITERations on page 452

Original Crest Factor

Displays the original crest factor of the waveform after the calculation of the resulting crest factor is completed. The original crest factor is calculated as an average over the whole waveform, including any idle periods that can be present in TDD waveforms.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CFR:OCFactor? on page 452

Resulting Crest Factor

Displays the resulting crest factor of the waveform after the calculations are completed. The resulting crest factor is calculated as an average over the whole waveform, including any idle periods that can be present in TDD waveforms.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:CFR:RCFactor? on page 453

Filter Mode

Requires "Algorithm" > "Clipping and Filtering".

Selects which filter mode is used for the filtering.

"Simple"   You can specify the RF bandwidth and channel spacing of the signal. The lowpass filter is designed to pass through frequency components inside the signal bandwidth and suppress components in the adjacent channel.
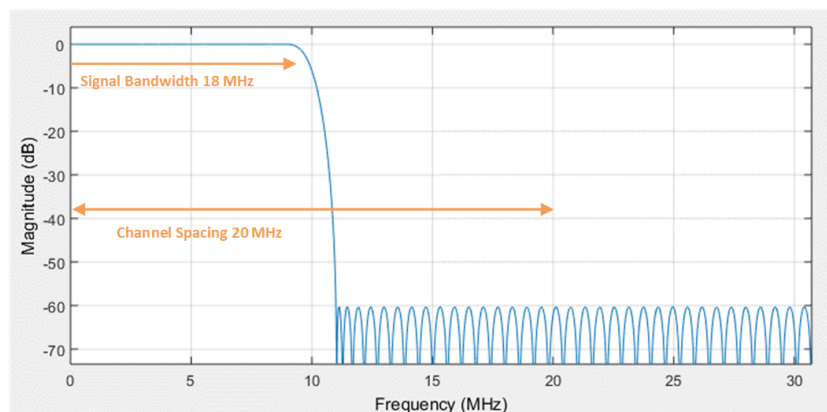
Figure 6-2: Simple filter mode

"Enhanced"   In the enhanced filter mode, you can specify the passband and stop-
band frequencies of the lowpass filter.
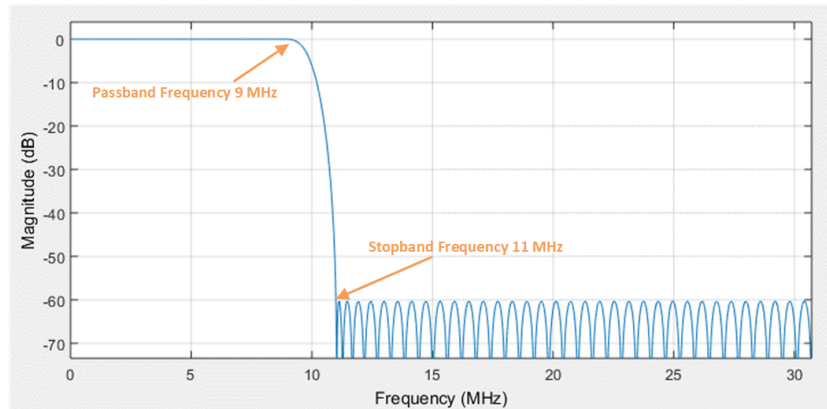
Figure 6-3: Enhanced filter mode

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer on page 451

Channel Spacing
Requires "Algorithm" > "Clipping and Filtering" and "Filter Mode" > "Simple".

Sets the channel spacing.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CFR:CSPacing on page 451

Signal Bandwidth
Requires "Algorithm" > "Clipping and Filtering" and "Filter Mode" > "Simple".

Sets the signal bandwidth. Set a value that is lower than the value of the "Channel
Spacing".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CFR:SBANdwidth on page 453

Stopband Frequency
Requires "Algorithm" > "Clipping and Filtering" and "Filter Mode" > "Enhanced".

Sets the stopband frequency of the filter. Frequency components higher than the stop-
band frequency are filtered out by the lowpass filter.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CFR:SFReq on page 454

Passband Frequency
Requires "Algorithm" > "Clipping and Filtering" and "Filter Mode" > "Enhanced".

Sets the passband frequency. Frequency components lower than the passband fre-
quency are passed through unfiltered.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CFR:PFReq on page 453

Maximum Filter Order

Requires "Algorithm" > "Clipping and Filtering" and "Filter Mode" > "Enhanced".

Sets the maximum filter order.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CFR:FORDer on page 452

Cancellation Pulse Bandwidth

Requires "Algorithm" > "Peak Cancellation".

Sets the bandwidth of the cancellation pulse.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CFR:CPBandwidth on page 451

Transition Bandwidth

Requires "Algorithm" > "Peak Cancellation".

Sets the transition bandwidth of the cancellation pulse.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CFR:TBANdwidth on page 454

6.2 Additive white Gaussian noise (AWGN) - noise generator

This section introduces the concept of the AWGN generator and describes the settings for generation of noise, sine wave interferer and adding noise to the generated signal.

The AWGN requires option R&S SGT-K62.

6.2.1 About the AWGN generator

The R&S SGT 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.

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.
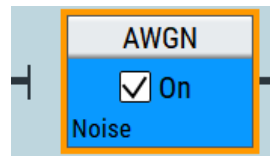
Figure 6-4: Representation of an "AWGN > Mode > Noise Only" in the block diagram

- **"CW Interferer mode":** a sinusoidal signal with an adjustable frequency offset and carrier-to-interferer (C/I) power ratio is added to the baseband signal by a counter instead of a shift register.

Signal and noise parameters

The Figure 6-5 illustrates the relation between the signal and noise parameters.
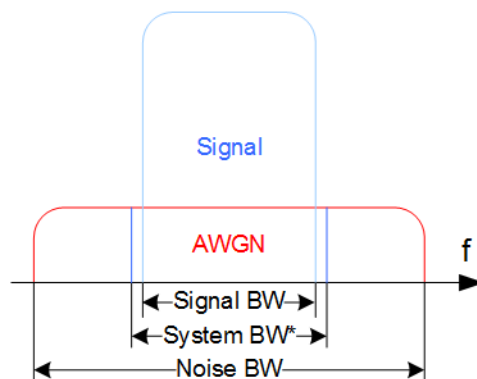
Figure 6-5: Graphical representation of the relation between system bandwidth and noise bandwidth (Minimum Noise/System BW = 2)

System BW* = Occupied BW

The **system bandwidth** is a measure for the transmitted RF bandwidth. The selected value is usually the occupied bandwidth and can therefore be a value greater than the pure signal bandwidth.

In the most test cases, the signal and the noise power are not defined directly but by the target's signal-to-noise ratio (SNR) or **carrier/noise ratio**.

The **carrier power** is a measure for the *signal without the noise distribution*.

To ensure flat noise within the selected system bandwidth, set a larger **noise bandwidth** 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"

Make sure that 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. The total measurable noise power usually exceeds the displayed value "Noise Power".
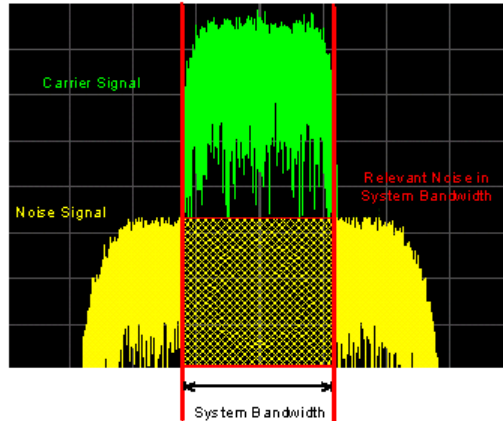
For a correct measurement of the noise power within the system bandwidth, measure the channel power with a signal analyzer.

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**.

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 = $(E_b/N_0)*(f_{bit}/B_{sys})$

B_{sys} is the system bandwidth and *Bit Rate f_{bit} = "Symbol Rate" * Modulation Value*.

Application fields

Typically, the noise generator is required for the following tests:

- In receiver sensitivity tests with predefined SNR of the receiver
- In bit-error or block-error measurements, depending on the set signal-to-noise ratio (SNR)
- Whenever a pure noise signal is required

6.2.2   AWGN settings

6.2.2.1   General settings

► To access the dialog box, select "SGMA-GUI > Instrument Name > AWGN > General"

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 399

Mode

Selects the mode for generating the interfering signal.

"Additive Noise"

The AWGN noise signal with selectable system bandwidth is added to the baseband signal.

"Noise Only"   The pure AWGN noise signal with selectable system bandwidth is modulated to the carrier. The connection to the baseband is interrupted.

"CW Interferer" A sine with a defined frequency offset is added to the baseband signal. The calculation of E_b/N_0 ratio is omitted.

Remote command:

`[:SOURce<hw>]:AWGN:MODE` on page 396

System Bandwidth

Available only for "Mode > Additive Noise" or "Mode > Noise Only".

Sets the RF bandwidth to which the set carrier/noise ratio relates.

Within this frequency range, the signal is superimposed with a noise signal which level corresponds exactly to the set C/N or S/N ratio.

Remote command:
[:SOURce<hw>]:AWGN:BWIDth on page 393

Minimum Noise/System Bandwidth Ratio
Available only for "Mode > Additive Noise" or "Mode > Noise Only".

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.

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 393

Target CW Frequency Offset
Available only for "Mode > CW Interferer".

Sets the desired frequency of the sine wave.

Remote command:
[:SOURce<hw>]:AWGN:FREQuency:TARGet on page 395

Resulting CW Frequency Offset
Available only for "Mode > CW Interferer".

Indicates the resulting frequency offset of the sine wave.

Remote command:
[:SOURce<hw>]:AWGN:FREQuency:RESult? on page 395

6.2.2.2 Noise power/output results settings

► To access the dialog box, select "SGMA-GUI > Instrument Name > AWGN > Noise Power/ Output Results"

Settings:

Noise Bandwidth

Available only for "Mode > Additive Noise" and "Mode >Noise Only" and when the
AWGN generator is activated.

Indicates the real noise bandwidth.

Remote command:
[:SOURce<hw>]:AWGN:BWIDth:NOISe? on page 393

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 394

Set Noise Power Via
Available only for "Mode > Additive Noise".

Selects the way that 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.

Remote command:
[:SOURce<hw>]:AWGN:POWer:MODE on page 397

Reference Mode
Selects whether the carrier or the noise power is kept constant if the C/N or Eb/N0 ratio is changed.

Remote command:
[:SOURce<hw>]:AWGN:POWer:RMODe on page 398

Bit Rate
Available only for "Mode > Additive Noise".

Indicates the bit rate used for converting C/N or S/N to E$_b$/N$_0$.

Remote command:
[:SOURce<hw>]:AWGN:BRATe on page 392

Carrier/Noise Ratio / Signal/Noise Ratio
Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

Sets the carrier/noise, signal/noise or respectively signal/interferer ratio.

Whether a configuration of C/N or S/N is enabled depends on the selected output Display Mode.
- For "Reference Mode > Carrier", this entry determines 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 remains constant.
- For "Reference Mode > Noise", this entry determines 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 / Signal 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 under Carrier + Noise Power / Signal + Noise Power (System Bandwidth) / Carrier + Interferer Power / Signal + Interferer Power.

Remote command:
[:SOURce<hw>]:AWGN:CNRatio on page 394

E_b/N_0
Available only for "Mode > Additive Noise".

Sets the ratio of bit energy to noise power density.

- For "Reference Mode > Carrier", this entry determines 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.
- For "Reference Mode > Noise", this entry determines 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 / Signal Power. This indication corresponds to the "Level" value in the "Status bar".
- The power of the output signal is displayed under Carrier + Noise Power / Signal + Noise Power (System Bandwidth) / Carrier + Interferer Power / Signal + Interferer Power.

Remote command:
[:SOURce<hw>]:AWGN:ENRatio on page 395

Carrier Power / Signal Power
Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

The name of this parameter depends on the selected output Display Mode.
- For "Reference Mode > Carrier", this parameter 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.
- For "Reference Mode > Noise", this parameter 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 under "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.

Remote command:
[:SOURce<hw>]:AWGN:POWer:CARRier on page 396

Noise Power (System Bandwidth) / Interferer Power
Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

Displays the power of the noise signal in the system respectively to the total bandwidth.

- "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
  - "Noise Reference Mode"
    Sets the power of the interfering signal. The power of the carrier is derived from the entered C/N or S/N value.
  - "Carrier Reference Mode"
    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 total measurable noise power (see below) usually exceeds the value displayed here. For correct measurement of the noise power within the system bandwidth, measure the channel power with a signal analyzer.
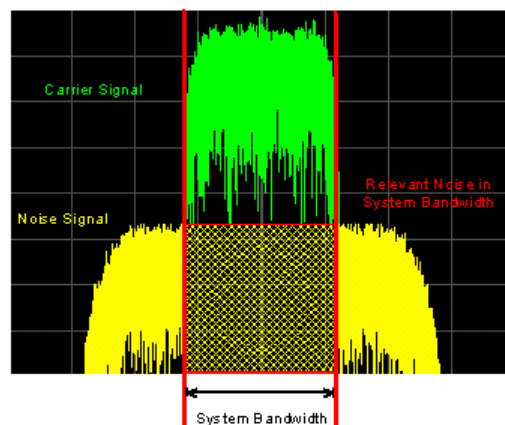
Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe on page 397

Noise Power (Total Bandwidth)
Displays the power of the noise signal in the total bandwidth in "Noise Only" and "Additive Noise" mode.

Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal? on page 397

Carrier + Noise Power / Signal + Noise Power (System Bandwidth) / Carrier + Interferer Power / Signal + Interferer Power

Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

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)

Remote command:

[:SOURce<hw>]:AWGN:POWer:SUM? on page 398

Carrier + Noise PEP / Signal + Noise PEP (Total Bandwidth) / Carrier + Interferer PEP / Signal + Interferer PEP

Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

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 399

6.3 I/Q modulation and impairment settings

6.3.1 I/Q modulation

The R&S SGT offers I/Q modulation with:
- External analog I/Q signals,
- External digital signals,
- Internal digital signals.

Either the external digital signal or the externally/internally generated baseband signal is fed into the I/Q modulator ("I/Q Mod" function block).
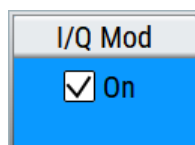
The external signal is input via the I and Q connector and transferred directly to the I/Q modulator ("I/Q Mod" function block). The external digital signal is configured in the "BB In" function block (see Chapter 6.9, "External baseband signal - baseband input", on page 262).

The internally generated baseband signal is configured in the baseband function block (see Chapter 6.1, "Baseband", on page 85). Before the signal is fed into the I/Q modulator, noise can be added and/or the signal can be impaired.

Impairments can also be set in the"I/Q Mod" menu to allow an externally applied analog I/Q signal to be impaired. An internal baseband signal can thus be impaired both digital (in the "Impairment" block in the "Impairment" menu) and analog in the I/Q modulator. If impairments are set in both menus, they superimpose each other in the signal.

6.3.2 Impairments

The R&S SGT allows the digital I/Q signal to be impaired before it is passed on to the I/Q modulator. These settings are available in the block diagram in the "Impairements" functional block.
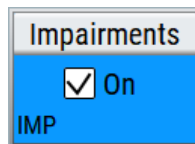
6.3.2.1 I and Q offset

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 usually 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 below.
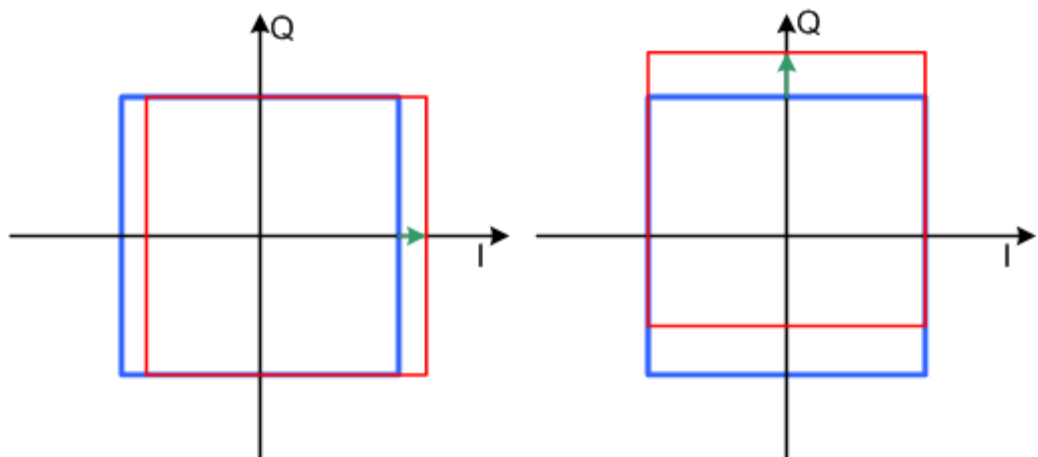
Figure 6-6: I offset (left) and Q offset (right) in the I/Q constellation diagram

6.3.2.2 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 below.
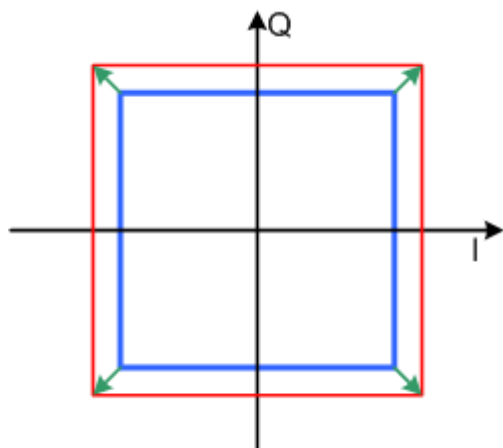
Figure 6-7: Effect of an increased amplitude in the I/Q constellation diagram

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. The imbalance occurs usually 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 below.
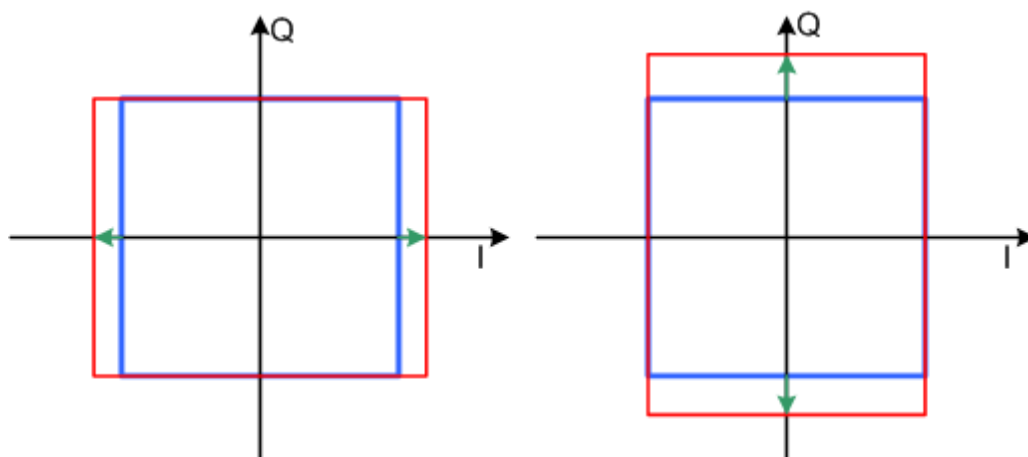
Figure 6-8: Negative gain imbalance (left) and positive (right) gain imbalance in the I/Q constellation diagram

6.3.2.3 Quadrature offset

Changes the phase angle between the I and 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 below.
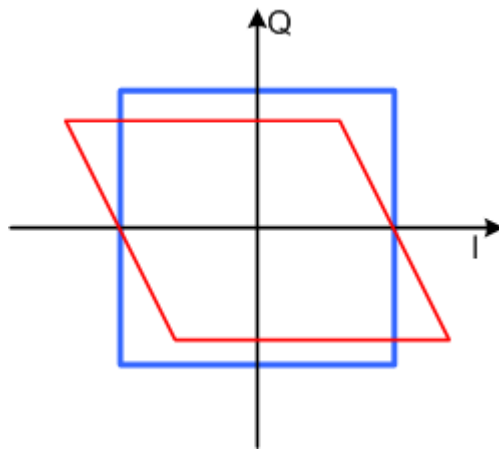
Figure 6-9: Positive quadrature offset in the I/Q constellation diagram

6.3.3 I/Q modulator settings

6.3.3.1 General settings

► To access this dialog, select:

    a) "SGMA-GUI > Instrument Name > IQ Mod > General"
    b) "SGMA-GUI > Instrument Name > Impairments > General"
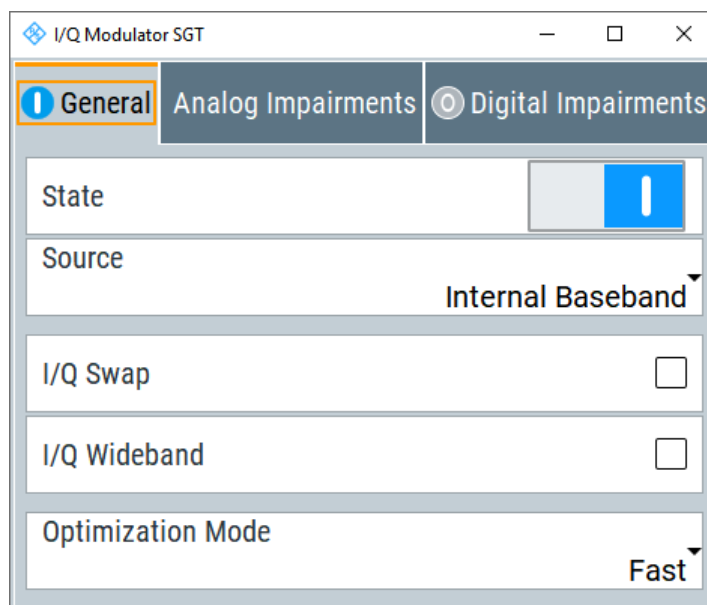
Settings:

State

Activates/deactivates I/Q modulation.

If "Analog Wideband I/Q In" is selected, the I/Q modulator is also deactivated and activated.

If "Internal Baseband I/Q In" is selected, the I/Q modulator is always activated automatically when signal generation is activated in the "Baseband" block. It can, however, be deactivated later.

The following functions have the same effect:
- The Mod On/Off icon in the SGMA-GUI.
- The "I/Q Mod > On/Off" in the I/Q Mod block in the block diagram.
- The "I/Q Modulator" > "State" on page 154 parameter.

Remote command:
[:SOURce]:IQ:STATe on page 480

IQ Source

Selects the input signal for the I/Q modulator.

"Analog Wideband I/Q In"
> Selects an external analog signal as the input signal. The signal must be applied at the inputs I and Q.

"Internal Baseband I/Q In"
> Selects the internal baseband signal as the input signal. This setting requires the additional equipment options for generating the various baseband signals.

Remote command:
[:SOURce]:IQ:SOURce on page 480

I/Q Swap

Available only for "Source > Internal Baseband".

Selects normal or swapped I/Q control. The modulation sidebands are inverted by swapping the I and Q signals.

This parameter enables I/Q modulation to be performed on signals according to IS2000 (cdma2000 standard) and most all other standards. As a result, an I/Q demodulator defined according to IS2000 can also be used for demodulating the generated signals.

The I/Q modulator defined in the IS2000 standard differs from the definition in the R&S SGT. The definition on which the R&S SGT is based is used by virtually all digital communication standards (except IS95 and IS2000).

In the final step, the filtered I/Q signal is modulated to the desired RF in a different way in the I/Q modulator:
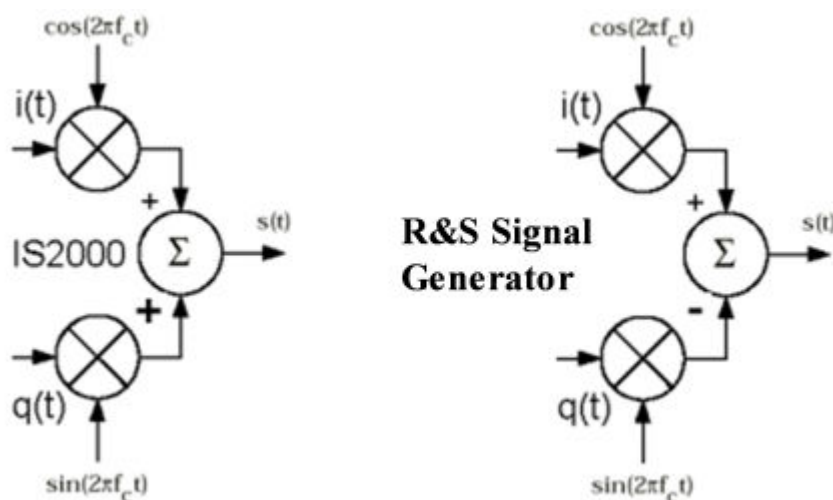
Figure 6-10: Definition of I/Q modulator in IS2000 and R&S SGT

According to IS2000, the RF signal s(t) is derived from the baseband I/Q signal as follows:

s(t)=i(t)cos(2pif$_c$t)**+**q(t)sin(2pif$_c$t)

The instrument family is based on the following definition:

s(t)=i(t)cos(2pif$_c$t)**-**q(t)sin(2pif$_c$t)

Set "I/Q Swap > On" so that an I/Q modulator defined according to IS2000 can cope with the RF signal generated by the R&S SGT.

"Off"   I/Q control is normal.

"On"   The I and Q signals are swapped.

Remote command:
[:SOURce<hw>]:IQ:SWAP[:STATe] on page 480
[:SOURce]:IQ:IMPairment:SWAP[:STATe] on page 479

I/Q Wideband
Optimized setting for wideband modulation signals (>5 MHz).

The modulation frequency response is decreased at the expense of poorer harmonic suppression. The decrease is achieved by shifting the switching frequencies of the low-pass filters in the output section.

Remote command:
[:SOURce]:IQ:WBSTate on page 480

Optimization Mode
Available only for "Source > Internal Baseband".

Selects the optimization mode.

"Fast"   Fast optimization by compensation for I/Q skew.
                 Use this mode in time sensitive environments.

"High Quality"   With "Source > Internal Baseband", enable an optimization by com-
                   pensation for I/Q skew and frequency response correction. The set-
                   ting times, however, increase.
                   Use this mode to generate an extremely flat signal. For information
                   on the I/Q modulation performance, see the data sheet.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE` on page 465

Crest Factor

Available only for "Source > Analog Wideband I/Q Input"

Sets the crest factor of the external analog signal.

The crest factor gives the difference in level between the peak envelope power (PEP)
and average power value (RMS) in dB.

This value is necessary to allow the correct output power to be generated at the RF
output. When the set output power is generated, the R&S SGT uses this value to com-
pensate the average power which is lower compared to the peak power.

The maximum input voltage at the I/Q input is equated to the peak power and is used
as the "reference" for setting the level of the output signal. Since the signal does not
usually supply the peak power at a constant level. Instead it supplies lower average
power. The crest factor specifies how many dB have to be added internally so that the
correct output power is achieved.

Remote command:
`[:SOURce]:IQ:CREStfactor` on page 478

6.3.3.2   Analog impairments

► To access this dialog, select:

   a) "SGMA-GUI > Instrument Name > IQ Mod > Analog Impairments"
   b) "SGMA-GUI > Instrument Name > Impairments >Analog Impairments"
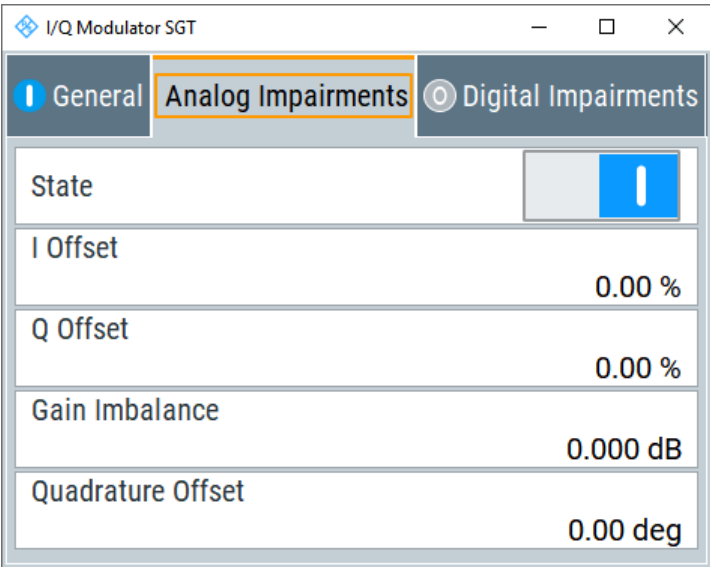
I/Q impairment for specific impairment of the I/Q modulation is set in the "Analog Impairments" dialog.

Settings:

State

Activates/deactivates I/Q impairment.

If activated, the settings for leakage, I/Q imbalance and quadrature offset become effective.

The state is indicated in the function block.

Remote command:

[:SOURce<hw>]:BB:IMPairment:STATe on page 465

I/Q Offset

Sets the 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 6.3.2.1, "I and Q offset", on page 151.

Remote command:

[:SOURce]:IQ:IMPairment:LEAKage:I on page 479
[:SOURce]:IQ:IMPairment:LEAKage:Q on page 479

Gain Imbalance

Sets the imbalance of the I and Q vector, see Chapter 6.3.2.2, "Gain and gain imbalance", on page 152.

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.

Remote command:
[:SOURce]:IQ:IMPairment:IQRatio[:MAGNitude] on page 478

Quadrature Offset
Sets the quadrature offset, see Chapter 6.3.2.3, "Quadrature offset", on page 152.

Remote command:
[:SOURce]:IQ:IMPairment:QUADrature[:ANGLe] on page 479

6.3.3.3 Digital impairments

Access:

1. Select "SGMA-GUI > Instrument Name > IQ Mod > Digital Impairments".

2. Select "SGMA-GUI > Instrument Name > Impairments > Digital Impairments".
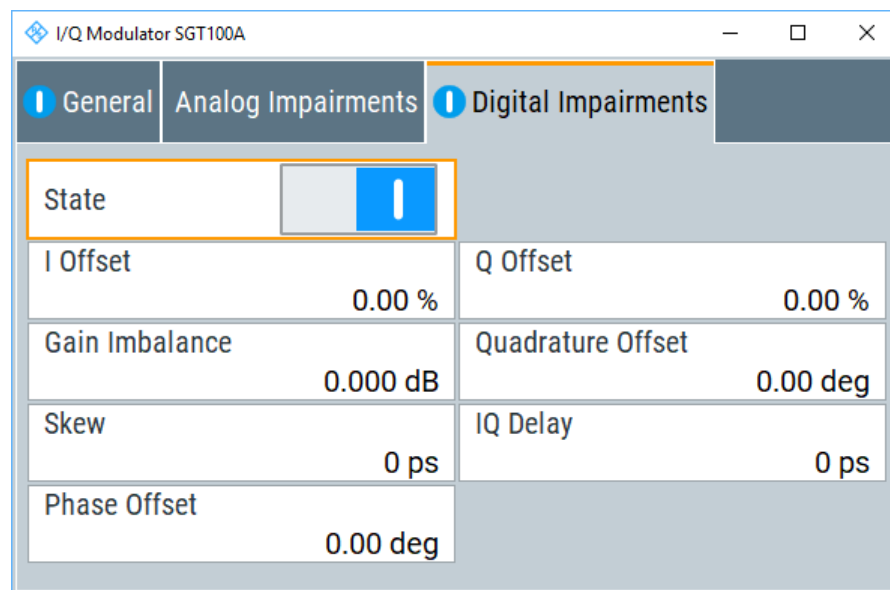
Settings:

State

Activates/deactivates digital I/Q impairment.

When activated, the settings for carrier leakage, I/Q imbalance and quadrature offset become effective.

Internal predistortion for compensating the I/Q modulator is not influenced by this setting.

Remote command:

[:SOURce<hw>]:BB:IMPairment:STATe on page 465

[:SOURce]:BB:IMPairment:IQOutput<ch>:STATe on page 465

I/Q Offset

Sets the carrier leakage (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 leakage completely (offset = 0 percent).

For more information, see Chapter 6.3.2.1, "I and Q offset", on page 151.

Remote command:

[:SOURce<hw>]:BB:IMPairment:LEAKage:I on page 463

[:SOURce<hw>]:BB:IMPairment:LEAKage:Q on page 464

[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:I on page 467

[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:Q on page 467

Gain Imbalance

Sets the imbalance of the I and Q vector (see Chapter 6.3.2.2, "Gain and gain imbalance", on page 152).

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.

Remote command:

[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude] on page 463

[:SOURce]:BB:IMPairment:IQOutput<ch>:IQRatio[:MAGNitude]
on page 466

Quadrature Offset

Sets the quadrature offset (see Chapter 6.3.2.3, "Quadrature offset", on page 152).

Remote command:

[:SOURce<hw>]:BB:IMPairment:QUADrature[:ANGLe] on page 464

[:SOURce]:BB:IMPairment:IQOutput<ch>:QUADrature[:ANGLe]
on page 467

Skew

Sets the time offset between the I and Q vectors.

In an I/Q modulator without I/Q skew, the I and Q vectors are aligned to the marker. With an I/Q skew, both vectors are shifted relative to the marker. The offset of each of the vectors to the marker is half of the I/Q skew value.

A positive I/Q skew means that the Q vector delays relative to the I vector and vice versa.

Remote command:

[:SOURce<hw>]:BB:IMPairment:SKEW on page 464

[:SOURce]:BB:IMPairment:IQOutput<ch>:SKEW on page 467

IQ Delay

Sets the time delay of both I and Q vectors relative to the selected trigger and marker or relative to the other instruments working in the primary/secondary instrument mode.

A positive value means that the I and Q vectors delay relative to the marker/trigger or to the other instrument and vice versa.

Remote command:

[:SOURce<hw>]:BB:IMPairment:DELay on page 462

[:SOURce]:BB:IMPairment:IQOutput<ch>:DELay on page 466

Phase Offset

Adds a phase offset to the digital impairments in the I/Q modulator. The phase of the digital impairments is shifted relatively to the I/Q samples.

Remote command:

[:SOURce]:BB:IMPairment:POFFset on page 465

[:SOURce]:BB:IMPairment:IQOutput<ch>:POFFset on page 466

6.4 I/Q analog output settings

The I/Q Analog Output requires option Differential Analog I/Q Outputs R&S SGT-K16.
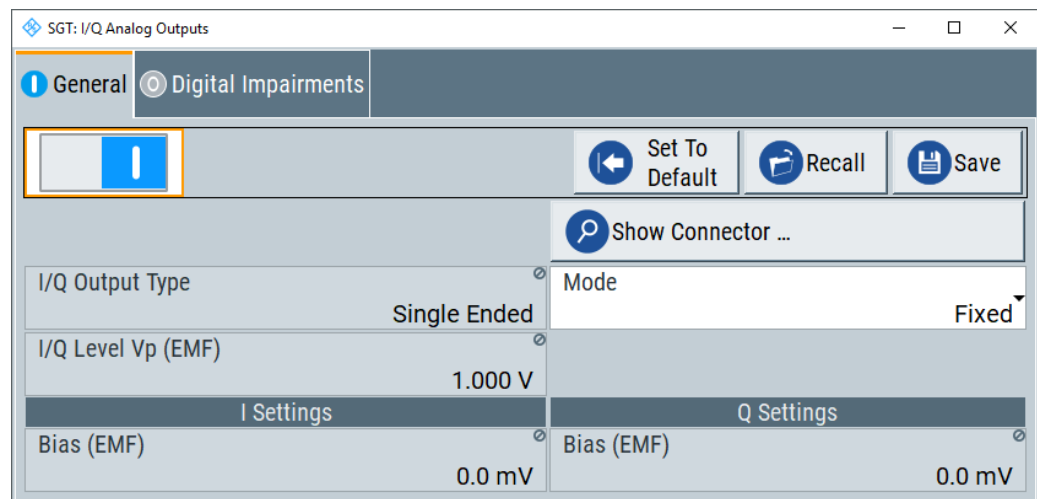
Maximum overall output voltage

The voltage of the analog output signals is defined as a combination of output voltage of the I and Q signal components and an optional bias voltage. If the differential output is used, an additional offset can be set, too. The values of these parameters are interdependent so that the magnitude of the sum of output voltage and bias voltage must not exceed 4V.

The following applies:

- Single ended signal:
  $V_p + V_{bias} \leq 4\ V$

- Differential signal:
  $0.5*V_p + |V_{bias}| + 0.5*V_{offset} \leq 4\ V$

Where:

- V_p is the output voltage as set with the parameter I/Q Level Vp EMF

- V_{bias} is the bias voltage as set with the parameter Bias (EMF)

- V_{offset} is the offset between inverting and non-inverting output as set with the parameter Offset (EMF)

For more information, see data sheet.

6.4.1　General analog I/Q output settings

Access:

► Select "I/Q Analog > I/Q Analog Outputs > General".

Settings:

State

Enables/disables the analog I/Q output.

Note: By default, these output connectors are deactivated.

Remote command:
[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe on page 481

Set to Default

Calls the default settings. The values of the main parameters are listed in the following table.

Parameter	Value
"State"	Not affected by the "Set to Default"
"RF Envelope"	Off
"I/Q Output Type"	Single Ended
"I/Q Level Vp (EMF)"	1 V
"Bias (EMF)"	0 mV

Remote command:

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet on page 481

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

Remote command:

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog? on page 482
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:STORe on page 482
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:LOAD on page 482
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:DELete on page 483

RF Envelope

In instruments equipped with option R&S SGT-K540, enables the output of a control signal that follows the RF envelope. This control signal is provided for power amplifiers envelope tracking testing. The signal is output at the I/I Bar connectors.

The envelope tracking (ET) is a method used by modern power amplifiers (PA) to improve their efficiency, especially when amplifying high crest factor RF signals. With envelope tracking, the PA estimates, i.e. "tracks", the RF signal and varies the supply voltage at the end-amplifying stage synchronous to the changes in the RF signal.

Remote command:

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:STATe

I/Q Output Type

Selects the type of output signal.

The provided parameters in the "I/Q Analog Outputs" dialog depend on the selected output mode.

"Single-Ended"   • If "RF Envelope > Off"
                   Single-ended output at the I/Q connectors.
                 • If "RF Envelope > On"
                   The envelope signal E is output at the I connectors.

                 You can define a bias between the output signal and ground.

"Differential"   • If "RF Envelope > Off"
                   The analog I/Q signal components are output at the I/Q and I/Q
                   Bar connectors.
                 • If "RF Envelope > On"
                   The inverted envelope signal Ē is output at the I Bar connectors.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE on page 483

Mode
Selects the mode for setting the outputs, independent or together.

"Fixed"   The I/Q signal components settings are predefined fix values:
                 • "Bias (EMF)" = "Offset (EMF)" = 0V
                 • "I/Q Level Vp (EMF)"
                   – Single-ended mode: "I/Q Level Vp (EMF)" = 1 V
                   – Differential mode: "I/Q Level Vp (EMF)" = 2 V

"Variable"   (R&S SGT-K16)
                 Enables modification of the I/Q signal components settings.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:MODE on page 484

I/Q Level Vp EMF
In "Mode > Variable", sets the output voltage for the I and Q signal components.

The value range is adjusted so that the maximum overall output voltage does not
exceed 4V, see "Maximum overall output voltage" on page 161.

Remote command:
[:SOURce<hw>]:IQ:OUTPut:LEVel on page 484

Couple I/Q Bias
In "Variable Mode", couples the bias setting of the I signal and the Q signal component.
With activated coupling, the settings of the I signal component automatically apply to
the Q signal component.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:COUPling[:STATe] on page 483

Bias (EMF)
If a bias is enabled, a DC voltage is superimposed upon the I or Q signal.

Effect of a positive bias	Effect of a negative bias
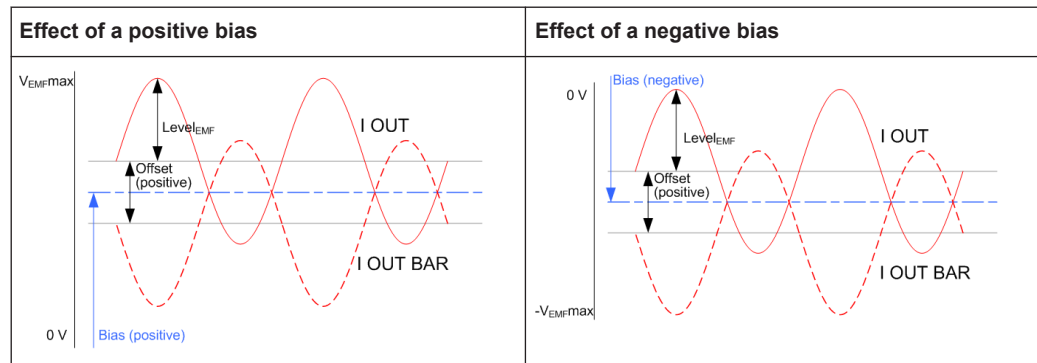
In "Single Ended" mode, this parameter defines the bias between the output signal and ground. It can be used to define the operating point of a DUT.

The value range is adjusted so that the maximum overall output voltage does not exceed 4V, see "Maximum overall output voltage" on page 161.

Remote command:

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:I on page 483

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:Q on page 483

Offset (EMF)

Sets an offset between the inverting and the non-inverting output.

The value range is adjusted so that the maximum overall output voltage does not exceed 4V, see "Maximum overall output voltage" on page 161.

The selected offset is set half in the positive and half in the negative direction.

Effect of a positive offset	Effect of a negative offset
A positive offset is set with half of the value in positive direction at the non-inverting outputs, in negative direction at the inverting outputs.	A negative offset is set with half of the value in negative direction at the non-inverting outputs, in positive direction at the inverting outputs.
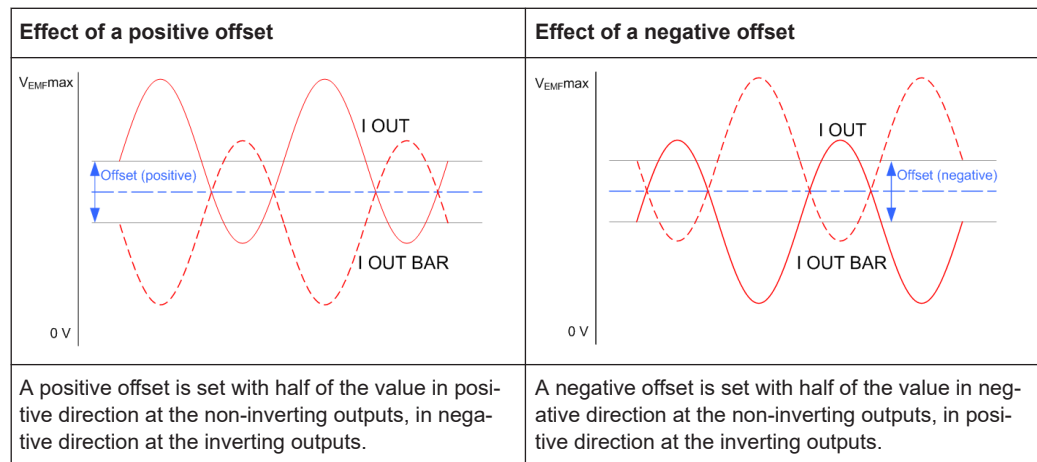
Example: Effect of a positive offset on the I signal component

"I Offset" = 100.0 mV

The offsets applied on the two output connectors as follows:
- +50.0 mV at the positive signal output
- -50.0 mV at the inverted signal output

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:I` on page 484

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:Q` on page 484

6.5   Generation of envelope tracking signals

Envelope tracking (ET) is a method used by modern power amplifiers (PA) to improve their efficiency, especially when amplifying RF signals with a high peak to average power (PAPR). An envelope tracking detector "tracks" the power variations in the input signal of the PA. The PA then varies synchronously to this variation the supply voltage v_{cc} at its end-amplifying stage.

This section introduces the concept of the envelope tracking functionality and the way that it is implemented in the R&S SGT.

6.5.1   Required options

The equipment layout for generation and output of envelope tracking signal includes:

● Option Differential Analog I/Q Outputs (R&S SGT-K16)

● Option Envelope Tracking (R&S SGT-K540)

● Optional option AM/AM AM/PM Predistortion (R&S SGT-K541)

For more information, see data sheet.

6.5.2   About the envelope tracking

The R&S SGT allows you to generate an envelope tracking signal, that follows the envelope variation of the RF signal.

Principle of the envelope tracking

The Figure 6-11 shows a simplified test setup for testing of a PA with an envelope tracking. This illustration is intended to explain the principle in general, not all connections and required equipment are considered.
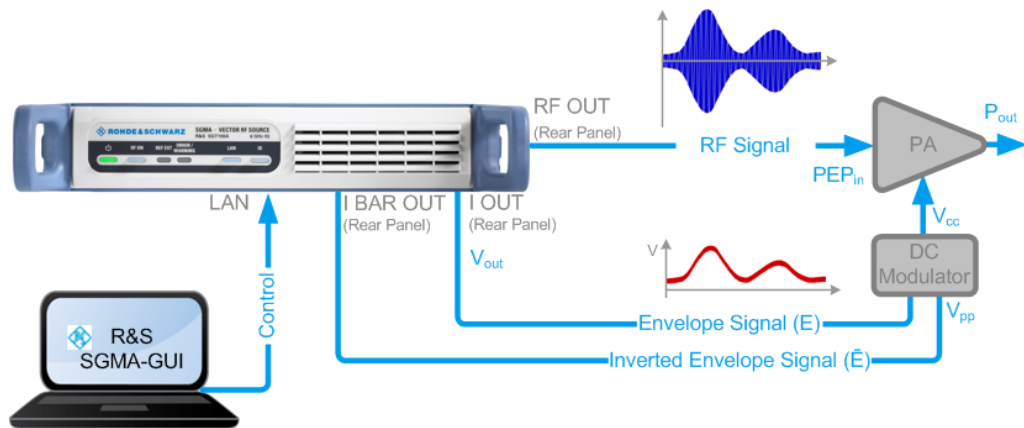
Figure 6-11: Simplified test setup for power amplifier envelope tracking tests

The R&S SGT in this setup is configured to generate both, an RF signal with complex modulation scheme and an envelope signal, that follows the envelope variation of this RF signal. A suitable test signal is, for example, an EUTRA/LTE DL signal.

The R&S SGT generates the envelope signal directly from the baseband signal. The envelope signal is a voltage signal, with voltage level V_{out} proportional to the power of the RF signal ($\sqrt{[I(t)^2+Q(t)^2]}$) of the corresponding path. If you do not apply a shaping function, the envelope signal linear dependent follows the variation of the RF signal's envelope.

The envelope signal is output at the I out and I Bar out rear panel connectors. This envelope signal is then further fed to an external DC modulator.

The PA receives the RF input signal and the dynamically adapted supply voltage v_{cc}. Ideally, the PA gain stays constant.

Suitable ARB signal to observe the effect of the envelope tracking settings

To simplify the explanation in the following sections, we use a simple ramp function as an ARB waveform modulated on the RF carrier.

6.5.2.1   Envelope voltage adaptation modes

In the R&S SGT, you define the voltage of the generated envelope signal using one of the following modes:

- **Auto Power/Normilized Envelope Voltage Adaptation:**
  In this mode, you define the desired input characteristics of the power amplifier.
  Based on these values and depending on the crest factor of the generated signal, the R&S SGT calculates:
  – The voltage on the I out/I Bar out connectors (V_{out}Min/Max) and a bias (Bias),
  – The RMS level of the RF signal

  The auto voltage adaptation mode is a suitable choice, if you have knowledge on the power amplifier components and characteristics. Common PA characteristics

are the supply voltage V_{cc}, the input power PEP_{in} required for working in the linear range and the gain characteristics of the external DC modulator.
You find the required values in the documentation of your power amplifier, for example in its data sheet.

- **Manual Envelope Voltage Adaptation:**
  In this mode, you can also define the operating range of the power amplifier based on a pre-gain and a post-gain range. Based on these values, the instrument calculates the supply voltage V_{cc}.

All modes support envelope shaping.

6.5.2.2 Signal parameters for testing according to the eTrak® specification

In the R&S SGT, you can select one of the predefined eTrak® interface types so that the generated signal is conformed with the MIPI®Alliance specification "Analog Reference Interface for Envelope Tracking Specification".

Table 6-3: Default parameters per eTrak® Interface Type

Parameter	1.2 Vpp	1.5 Vpp	2 Vpp
I/Q output Type	Differential	Differential	Differential
Bias	500 mV	600 mV	900 mV
Vpp Max	1.2 V	1.5 V	2 V
Vpp Max	1.2 V	1.5 V	2 V
Bipolar Input	On	On	On

6.5.2.3 Envelope shaping and shaping methods

Envelope shaping is a method that uses functions to describe the relationship between supply voltage and RF input power. An envelope-shaping function is a trade-off between effectivity and improved linearity of the PA.

In the R&S SGT, you can select the way you define the shaping function. You can choose between:

- 2 predefined simple linear functions
  (see "About the linear functions" on page 168)
- 3 detroughing functions with a configurable factor
  (see "About the detroughing function" on page 169)
- A polynomial function with up to 10 polynomial coefficients
  (see "About the polynomial function" on page 169)
- A shaping function defined as a shaping table
  (see "About the shaping table" on page 170)
- To set the correction values in raw format with a single remote control command
  (see "Shaping function in raw data format" on page 171)

The linear, the detroughing and the polynomial shaping functions are mathematical expressions that are described as function of the variable x, see Table 6-4.

Table 6-4: Definition of the variable x depending on the envelope voltage adaptation mode

"Envelope Voltage Adaptation"	x
Auto Power	$x = V_{in} - V_{in,\,min}$ $x \geq 0$
Auto Normalized	$x = V_{in}/V_{in,max}$
Manual	$x = V_{Env}/V_{Env,max}$

The mathematical expressions and further information on the shaping functions are provided in the corresponding sections.

See also "Converting shaping functions and understanding the displayed values" on page 171.

About the linear functions

The linear shaping can be used for less demanding applications, simple analysis, and the first interactions by designing the optimum envelope shape. Because the shaping gain of the linear function is 0 dB, in "Envelope Voltage Adaptation > Manual" mode this function is suitable for determining the "Pre-/Post-Gain" values (see Example"Calculating the current V_{CC} in "Manual" mode" on page 175).

Provided are two linear functions, where each of them depends on the "Envelope Voltage Adaptation" mode:

- Linear (Voltage)
    - $f(x) = x$ in "Auto Normalized/Manual"
    - $f(x) = b*x + V_{cc,min}$ in "Auto Power"
- Linear (Power)
    - $f(x) = x^2$ in "Auto Normalized/Manual"
    - $f(x) = b*x^2 + V_{cc,min}$ in "Auto Power"

Where:

- The variable *x* depends on the "Envelope Voltage Adaptation" mode, see Table 6-4.
- The constant *b* is calculated as:
  $b = (V_{cc,max} - V_{cc,min})/(V_{in,max} - V_{in,min})$

See also "Converting shaping functions and understanding the displayed values" on page 171.

About the detroughing function

Detroughing functions are well defined mathematical functions that prevent that the supply voltage V_{cc} drops down to zero or falls under specified limits. That is, they prevent that the signal is clipped.

Provided are the following functions:

- $f(x) = x + d*e^{-x/d}$
- $f(x) = 1 - (1 - d)*\cos(x*pi/2)$
- $f(x) = d + (1 - d)*x^a$

Where:

- x is a variable, that depends on the "Envelope Voltage Adaptation" mode, see Table 6-4
- a is the Exponent (a).
- d is the Detroughing Factor (d), that limits the supply voltage V_{cc} in the low-power region and controls the shaping.
  The detroughing factor (d) can be set manually or derived from the selected V_{cc} value. In the latter case, it is calculated as follows:
  $d = V_{cc,min}/V_{cc,max}$
  See Couple Detroughing Factor with Vcc.
  A "Detroughing Factor = 0" defines a linear function.

See also "Converting shaping functions and understanding the displayed values" on page 171.

About the polynomial function

The polynomial function is an analytical method to describe a shaping function. The polynomial function is defined as follows:

$f(x) = a_0 + \sum(a_n*x^n)$, where n ≤10 and:

- Depending on the "Envelope Voltage Adaptation" mode, *f(x)* is:
  - $f(x) = V_{cc}(x)$ in "Auto Power"
  - $f(x) = V_{cc}/V_{cc,max}(x)$ in "Auto Normalized/Manual"
- The polynomial order *n*, the polynomial constant *a₀*, and polynomial coefficients *a₀* to *aₙ* are user-definable, see Chapter 6.5.7, "Polynomial coefficients settings", on page 196
- x depends on the "Envelope Voltage Adaptation" mode, see Table 6-4

The default polynomial function with n = 1, $a_0 = 0$ and $a_0 = 1$ describes a linear function.

See also:

- Figure 6-22
- "Converting shaping functions and understanding the displayed values" on page 171.

File format of the polynomial function file

You can store a polynomial function in a file or even define the polynomial coefficients, store them as a file and load this file into the instrument. The polynomial files are files with extension `*.iq_poly`.

The file contains an optional header `# Rohde & Schwarz - IQ Output Envelope Polynomial Coefficients # a0,a1,a2,...` and a list of comma-separated coefficient values.

Example: Polynomial function file content

```
# Rohde & Schwarz - IQ Output Envelope Shaping Table
# a0,a1,a2,...
0.135,0.91,0.34,-0.59,-0.11
```

About the shaping table

The envelope-shaping table is a widely used method to define the shaping function. This kind of definition is suitable if you have knowledge on or aim to achieve an exact relation between supply voltage and RF input power. For example, with suitable settings, the shaping table can precisely describe the transition region of the PA.

You can receive information on suitable envelope-shaping values form the power amplifier manufacturer.

In the R&S SGT, there are two ways to define a shaping table function:

- **Externally**
  Create a shaping table file as a CSV file with Microsoft Excel, with a Notepad or a similar tool. Save it with the predefined extension, transfer it to and load it into the instrument.
  See also "File format of the shaping table file" on page 170.
- **Internally**
  Use the built-in editor table editor, see Chapter 6.5.6, "Edit I/Q envelope shape settings", on page 194.

File format of the shaping table file

The shaping table files are files with predefined extension and simple file format, see Table 6-5.

Table 6-5: Shaping table files: format and extensions

"Envelope Voltage Adaptation"	File extension	Header (optional)
Auto Power	`*.iq_lutpv`	`# Rohde & Schwarz - IQ Output Envelope Shaping Table` `# Power[dBm],Vcc[V]`
Auto Normalized/Manual	`*.iq_lut`	`# Rohde & Schwarz - IQ Output Envelope Shaping Table` `# Vin/Vmax,Vcc/Vmax`

The header is optional. The file content is list of up to 4000 comma-separated value pairs; a new line indicator separates the pairs.

Example: Shaping table file content (*.iq_lut file)

```
# Rohde & Schwarz - IQ Output Envelope Shaping Table
# Vin/Vmax,Vcc/Vmax
0.3,0.4
0.35,0.45
0.56,0.55
0.4,0.5
0.6,0.65
0,0.135
```

Shaping function in raw data format

The shaping values are defined directly, with a single remote control command. You define up to 4000 comma-separated value pairs, describing the `Vin/Vmax,Vcc/Vmax` or `Power[dBm],Vcc[V]`.

Example:

```
SOURce1:OUTPut:ANALog:ENVelope:SHAPing:PV:FILE:DATA 0,0, 0.1,0.2, 1,1
```

See:

- `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:DATA` on page 497
- `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:DATA` on page 497
- `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:NEW` on page 497
- `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:NEW` on page 497

Converting shaping functions and understanding the displayed values

If an envelope function is defined, the "Shaping" dialog displays the diagram of the resulting envelope shape.

See for example Figure 6-17.

Several parameters influence the displayed information:

- The selected "Envelope Voltage Adaptation" determines whether the x-axis uses normalized or linear values
- The selected "Graphic Configuration > Scale" sets the x-axis units
- The selected V_{cc}Min/Max and PEP_{in}Min/Max values set the borders of the clipping areas
- The selected "Shaping" function and the parameters influence the envelope shape.

The illustration on Figure 6-12 shows how these parameters influence a linear shaping function.
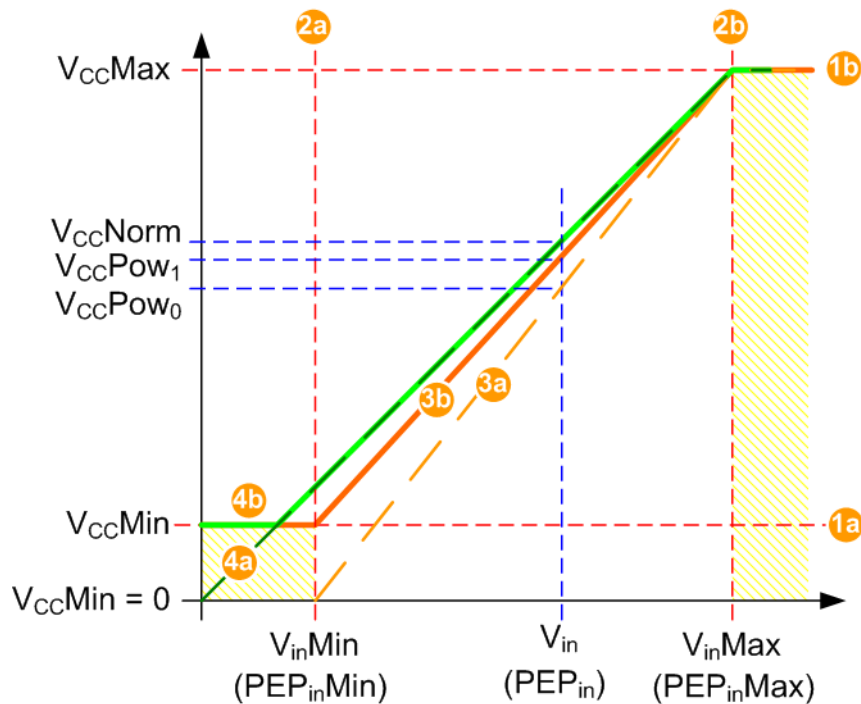
Figure 6-12: Understanding the displayed values ("Shaping > Linear (Voltage)")

Shaded area = Area where the signal is clipped and the envelope signal is held constant.
1a, 1b, 2a, 2b = $V_{cc,min}$/$V_{cc,max}$ and PEP$_{in}$Min/Max values that set the borders of the clipping areas
Shaping = Linear (Voltage)
3a = Linear function (dashed line) in "Auto Power" mode, if $V_{cc,min}$ = 0 V
3b = Linear function in "Auto Power" mode, if $V_{cc,min}$ > 0 V
4a = Linear function (dashed line) in "Auto Normalized" mode, if $V_{cc,min}$ = 0 V
4b = Linear function in "Auto Normalized" mode, if $V_{cc,min}$ > 0 V
V_{in} = Operating point
V_{cc}Norm = V_{cc} in "Auto Normalized" mode
V_{cc}Pow$_0$ = V_{cc} in "Auto Power" mode and $V_{cc,min}$ = 0 V
V_{cc}Pow$_1$ = V_{cc} in "Auto Power" mode and $V_{cc,min}$ > 0 V

For information on the provided shaping functions and their formulas, see:

- "About the linear functions" on page 168
- "About the detroughing function" on page 169
- "About the polynomial function" on page 169

The group of examples in this section uses the same linear shaping function to explain the representation in the different voltage adaptation modes. The example explains the displayed values and how they are calculated and converted. The same principle applies for the other shaping methods.

Common settings

- "Envelope Voltage Adaptation > Auto Power"
- V_{cc} Max = 1 V
- PEP$_{in}$Min = -30 dBm corresponds to $V_{in,min}$ = 0.0071 V

- PEP$_{in}$Max = 0 dBm corresponds to V$_{in,max}$ = 0.2236 V

- P$_{in}$ = -15 dBm corresponds V$_{in}$ = 0.04 V

- PEP = -3.4 dB

- "Shaping > Linear (Voltage)"

"Graphic Scale > Power"	"Graphic Scale > Voltage"
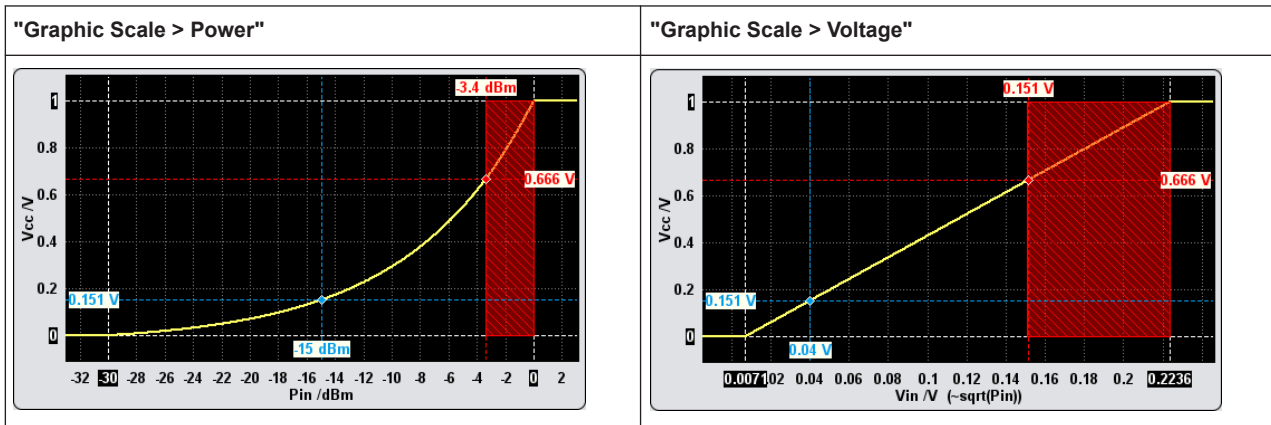
Example: Calculating the current V$_{cc}$Pow$_0$ ("Auto Power" mode, V$_{cc}$ Min = 0 V)

Configuration as described in Common settings and:

- **V$_{cc,min}$ = 0 V**

- f(x) = b*x + V$_{cc,min}$
  (see "About the linear functions" on page 168)

V$_{cc}$Pow$_0$ = [(V$_{cc,max}$ - V$_{cc,min}$)/(V$_{in,max}$ - V$_{in,min}$)] * (V$_{in}$ - V$_{in,min}$) + V$_{cc,min}$

V$_{cc}$Pow$_0$ = [(1 - 0)/(0.2236 - 0.0071)]*(0.04 - 0.0071) + 0

V$_{cc}$Pow$_0$ = 0.151 V

Example: Calculating the current $V_{cc}Pow_1$ ("Auto Power" mode, V_{cc} Min > 0 V)

Configuration as described in Common settings and:

- $V_{cc,min}$ = 200 mV

$V_{cc}Pow_1 = [(V_{cc,max} - V_{cc,min})/(V_{in,max} - V_{in,min})] * (V_{in} - V_{in,min}) + V_{cc,min}$

$V_{cc}Pow_1 = [(1 - 0.2)/(0.2236 - 0.0071)]*(0.04 - 0.0071) + 0.2$

$V_{cc}Pow_1$ = 0.321 V
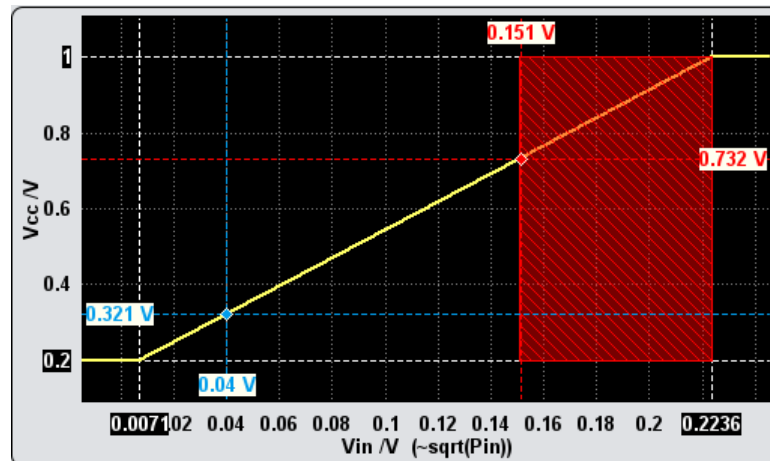
Example: Calculating the current $V_{cc}Norm$ ("Auto Normalized" mode)

Configuration as described in Common settings and:

- "Envelope Voltage Adaptation > Auto Normalized"

- The x-axis shows the normalized values $V_{in}/V_{in,max}$;
  The operating point with V_{in} = 0.04 V corresponds to
  $V_{in}/V_{in.max}$ = 0.04 / 0.2236 = 0.178

- f(x) = x, i.e.
  $V_{cc}Norm = V_{in}/V_{in,max}$
  $V_{cc}Norm$ = 0.178 V
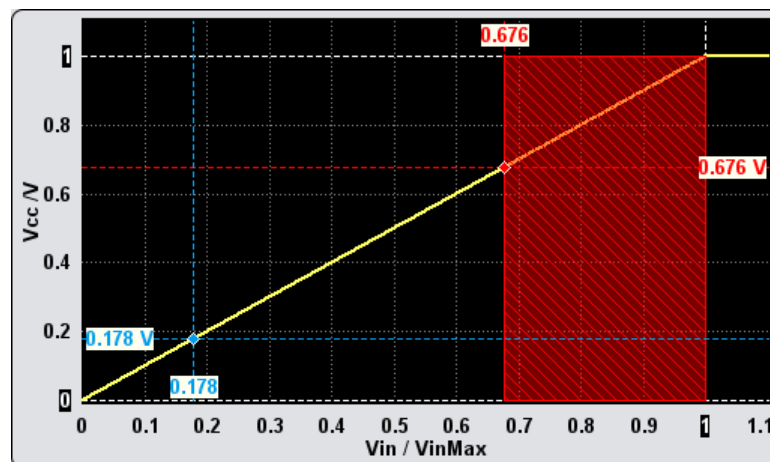
If the $V_{cc,min}$ value is changed ($V_{cc,min} > 0$ V), then the following applies:

- If $0 < V_{in}/V_{in,max} \leq V_{cc,min}$, the signal is clipped and $V_{cc}Norm = V_{cc,min}$
- If $V_{in}/V_{in,max} > V_{cc,min}$, then $V_{cc}Norm = V_{in}/V_{in,max}$

For the previous example, if $V_{cc,min} = 200$ mV, that $V_{cc}Norm = V_{cc,min} = 0.2$ V.
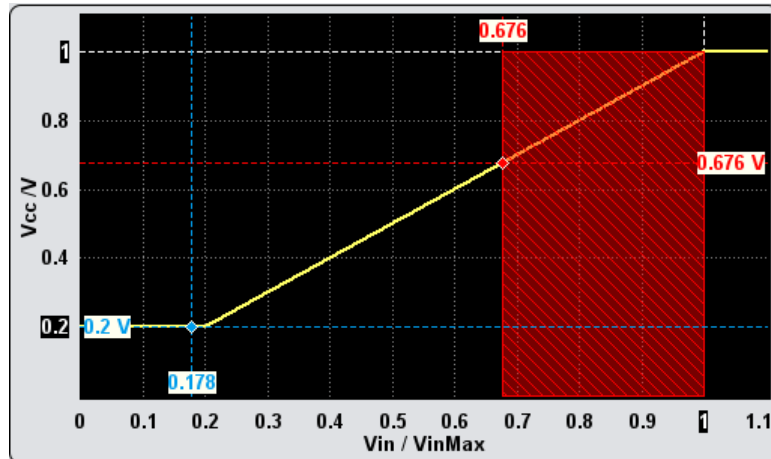
Example: Calculating the current V_{CC} in "Manual" mode

In "Envelope Voltage Adaptation > Manual" mode, set the parameter "Pre-Gain = PEP = - 3.4 dB".

The displayed shaping function resembles the shaping function in "Auto Normalized" mode; the same formulas apply, too.
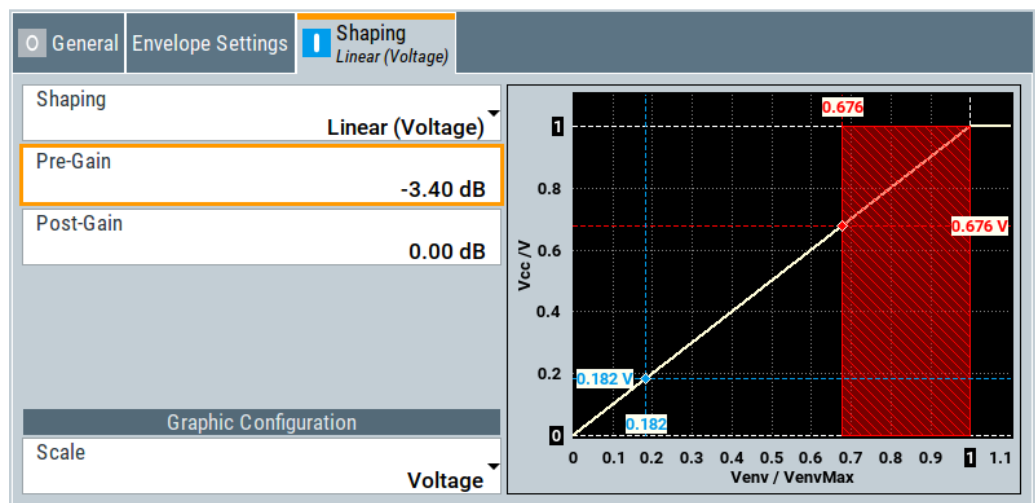
You can also query the V_{CC} values for any specified x in the supported voltage adaptation mode and units.

See `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue?` on page 494.

Additional information

The described principle applies for any shaping function.

Only if linear shaping is used, the V_{CC}Norm can also be directly converted to V_{CC}Pow according to the following formula:

$f_{Pow}(x) = [f_{Norm}(x) - V_{in,min}/V_{in,max}]*[(V_{cc,max} - V_{cc,min})/(1 - V_{in,min}/V_{in,max})]$

For example, if $f_{Norm}(x) = V_{CC}$Norm = 0.178 V, $f_{Pow}(x) = V_{cc}$Pow$_0$ is:

V_{cc}Pow$_0$ = [0.178 - 0.0071/0.2236]*[(1 - 0)/(1 - 0.0071/0.2236)]

V_{cc}Pow$_0$ = 0.151 V

6.5.3 General RF envelope settings

Access:

1. In the block diagram, select the "I/Q OUT" connector to unfold the "I/Q Analog" block.

2. Select "I/Q Analog > I/Q Analog Settings > General".

3. Select "RF Envelope > On".
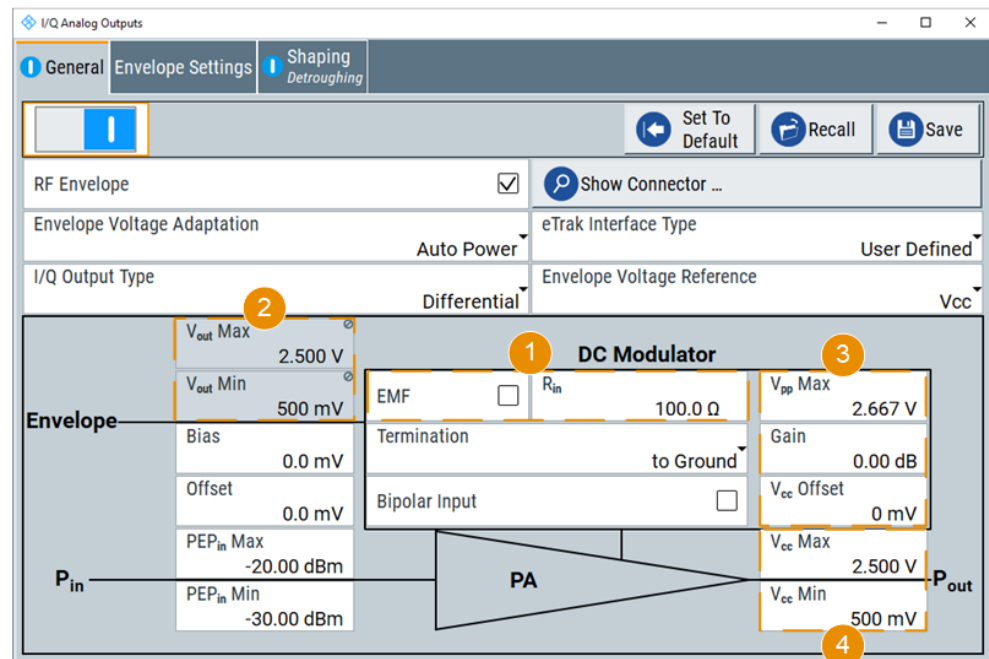
Figure 6-13: RF Envelope Settings (Example)

1 = Termination and input impedance of the circuit board
2 = Voltage level measured at the circuit board
3 = Signal characteristics of the DC Modulator
4 = Signal characteristics at the inputs of the PA (see the documentation of the PA, for example its data sheet)

The remote commands required to define these settings are described in Chapter 10.14.13, "SOURce:IQ:OUTPut:ENVelope commands", on page 485.

Settings:

State

Enables/disables the analog I/Q output.

Note: By default, these output connectors are deactivated.

Remote command:

[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe on page 481

Set to Default

Calls the default settings. The values of the main parameters are listed in the following table.

Parameter	Value
"State"	Not affected by the "Set to Default"
"RF Envelope"	Off
"I/Q Output Type"	Single Ended
"I/Q Level Vp (EMF)"	1 V
"Bias (EMF)"	0 mV

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet` on page 481

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

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog?` on page 482
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:STORe` on page 482
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:LOAD` on page 482
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:DELete` on page 483

RF Envelope

Enables the output of a control signal that follows the RF envelope. This control signal is provided for power amplifiers envelope tracking testing. The signal is output at the I out and I Bar out connectors.

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:STATe` on page 488

Envelope Voltage Adaptation

Defines the way you configure the voltage of the envelope tracking generator (see Chapter 6.5.2.1, "Envelope voltage adaptation modes", on page 166).

"Auto Normalized"

Generation based on the physical characteristics of the power amplifier; the power values are normalized based on the selected PEPin Max value.
This mode enables you to use the complete range of a selected detroughing function.
See also Shaping settings and compare the values on the X axis on the graphical display.

"Auto Power" Generation based on the physical characteristics of the power amplifier, where the input power of the PA "PEP$_{in}$" is defined with its min and max values.

"Manual" Generation, in that the operating range of the amplifier is defined based on a pre-gain and a post-gain range.

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:ADAPtion` on page 488

eTrak® Interface Type

Selects one of the predefined interface types or allows user-defined settings.

See Chapter 6.5.2.2, "Signal parameters for testing according to the eTrak® specification", on page 167.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:ETRak` on page 489

I/Q Output Type
Selects the type of output signal.

The provided parameters in the "I/Q Analog Outputs" dialog depend on the selected output mode.

"Single-Ended"
- If "RF Envelope > Off"
  Single-ended output at the I/Q connectors.
- If "RF Envelope > On"
  The envelope signal E is output at the I connectors.

You can define a bias between the output signal and ground.

"Differential"
- If "RF Envelope > Off"
  The analog I/Q signal components are output at the I/Q and I/Q Bar connectors.
- If "RF Envelope > On"
  The inverted envelope signal Ē is output at the I Bar connectors.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE` on page 483

Envelope Voltage Reference
Defines whether the envelope voltage V_{out} is set directly or it is estimated from the selected supply voltage V_{cc}.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VREF` on page 489

V_{out}Min/Max
Displays the minimum and maximum values of the peak-to-peak voltage V_{out} voltage on the interface between the circuit board and the DC modulator.

For "Envelope Voltage Reference" , sets the value of this parameter.

To measure the V_{out} voltage:
- Use a suitable probe, i.e. use a differential probe if a "Wire to Wire" termination is used and a single ended probe otherwise
- Measure at the circuit board after the termination impedance R_{in}.

Estimated "V_{out}Min/Max" values are calculated based on the selected supply voltage V_{cc}Min/Max, enabled Gain and V_{cc}Offset in the DC modulator.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VOUT:MIN` on page 490
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VOUT:MAX` on page 490

Bias
Sets a DC voltage, superimposed upon the envelope signal E and the inverted envelope signal E Bar.

Use this parameter to define the operating point of a DUT.

"I/Q Output Type"	Termination	"Bias" defines
"Single Ended"	-	The bias between the envelope signal E and ground
"Differential"	"To Ground"	Superimposed DC voltage, where "Bias" is related to the selected R_{in}. See also Table 6-6
	"Wire To Wire"	Superimposed DC voltage, where "Bias" is related to high impedance (1 MΩ).

Table 6-6: Effect of enabled bias

Effect of a positive bias	Effect of a negative bias
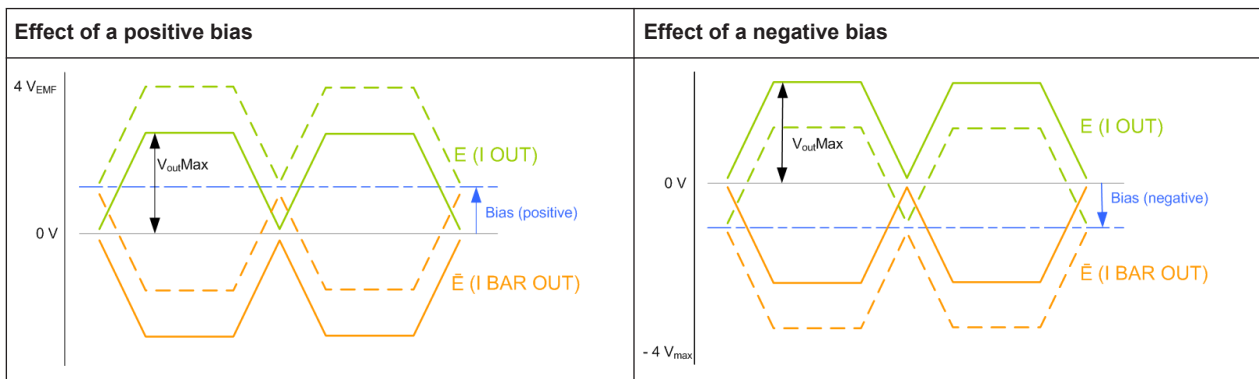
Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:BIAS on page 490

DC Modulator characteristics
Refer to the product documentation of the external DC modulator for information on its characteristics.

The following settings are required:

EMF ← DC Modulator characteristics
Activates EMF, which defines whether the EMF or the voltage value is displayed.

An EMF-based calculation assumes an open-end circuit. Disable this parameter for testing in more realistic conditions, where you define the input impedance of the used external DC modulator R_{in}. The R&S SGT then calculates the envelope output voltage V_{out}Min/Max based on it.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:EMF[:STATe] on page 491

R_{in} ← DC Modulator characteristics
If "EMF > Off", sets the input impedance R_{in} of the external DC modulator.
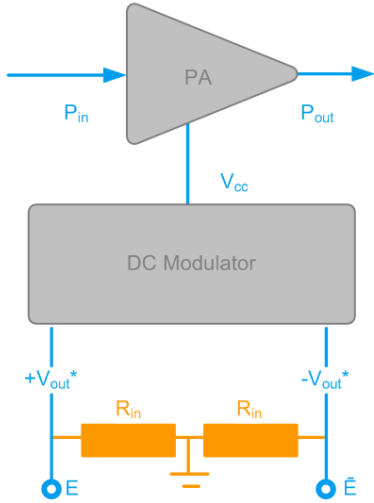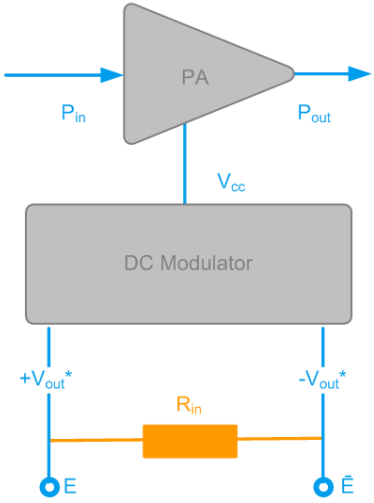
Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:RIN on page 491

Termination ← DC Modulator characteristics
If "I/Q Output Type > Differential" and "EMF > Off", defines the way the inputs of the DC modulator are terminated.

The termination influences the way an enabled Bias is applied.

"To Ground"	"Wire to Wire"
*⁾ Bias = 0 and V_{cc}Offset = 0	*⁾ Bias = 0 and V_{cc}Offset = 0
Both inputs of the DC modulator are terminated to ground.	This termination is also referred as a common mode voltage.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:TERMination on page 492

Bipolar Input ← DC Modulator characteristics
If "I/Q Output Type> Differential", enables the instrument to generate a bipolar signal.

The envelope signal E swings above and below the inverted envelope signal E Bar; the R&S SGT calculates and applies a suitable envelope V_{cc}Offset automatically.
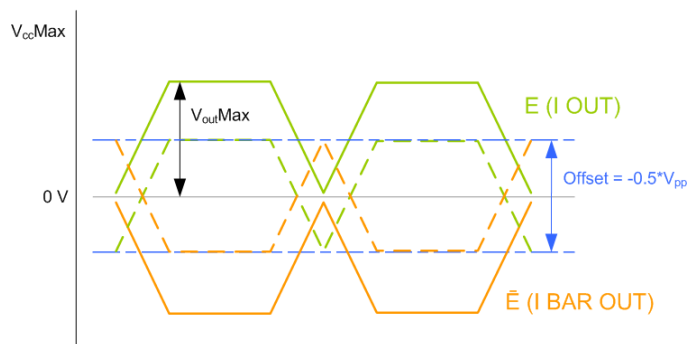
Figure 6-14: Effect of a "Bipolar Input > On"

This parameter influences the lower limit of the supply voltage V_{cc}.

The generated signal is conformed with the MIPI®Alliance specification "Specification for Analog Reference Interface for Envelope Tracking".

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:BINPut` on page 492

V_{pp}Max ← DC Modulator characteristics

Sets the maximum value of the peak-to-peak driving voltage V_{pp} of the external DC modulator.

The V_{pp} limits:

- The value range of the supply voltage V_{cc}Min/Max
  $V_{pp} ≥ V_{CC}$Max
- In "I/Q Output Type > Differential", the voltage of the generated envelope signal V_{out}Min/Max as follows:
  $V_{pp} ≥ V_{out}$Max[E] - V_{out}Max[E Bar], where [E] and [E Bar] refer to the envelope signal and the inverted envelope signal.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VPP[:MAX]` on page 491

Gain ← DC Modulator characteristics

Sets the gain of the external DC modulator.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:GAIN` on page 492

V_{cc}Offset ← DC Modulator characteristics

Applies a voltage offset on the supply voltage V_{cc}Min/Max, i.e. compensates a possible offset from the external DC modulator. Reduces the envelope output voltage V_{out}Min/Max by this value to maintain the supply voltage V_{cc} in the defined value range.
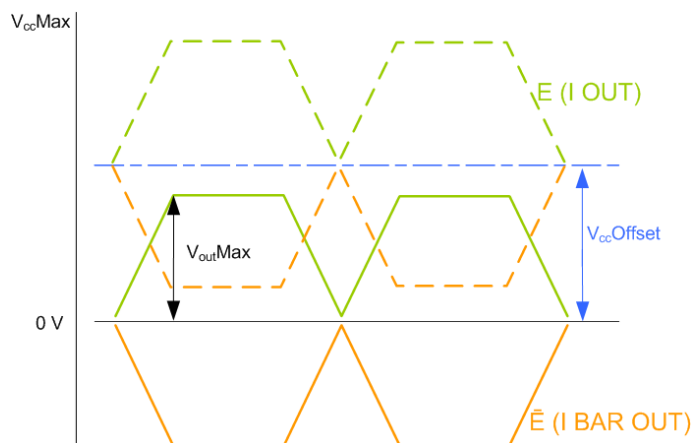
Figure 6-15: Effect of a Vcc offset

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:OFFSet` on page 492

PA characteristics

Refer to the product documentation of the power amplifier (PA) for information on its characteristics.

The following settings are required:

V_{cc}Min/Max ← PA characteristics
Displays the minimum and maximum values of the supply voltage V_{cc}, as required by the power amplifier (PA).

For "Envelope Voltage Reference > Vcc", sets the minimum and maximum values of the supply voltage V_{cc}.

The value range of the supply voltage V_{cc} is determined by the allowed peak-to-peak driving voltage V_{pp} of the external DC modulator and the enabled V_{cc}Offset.

V_{cc}Max ≤ V_{pp}Max

The V_{cc} is calculated as follows:

V_{cc} = Vout * Gain + Vcc Offset

Example:
Envelope Voltage Reference = V_{cc}

V_{cc}Offset = 0 mV

V_{cc}Max = 1 V = 0 dBV

Gain = 3 dB

V_{cc}Max [dBV] - Gain [dB] = V_{out}Max or

V_{out}Max = 0 dBV - 3 dB = -3 dBV = 0.708 V

"Bipolar Input"	**Value range "V_{cc}Min"**
"State > On"	V_{cc}Min = - 0.5*V_{pp}Max **Note:** Implemented as a V_{cc}Offset, see Effect of a "Bipolar Input > On".
"State > Off"	V_{cc}Min = 0 to V_{cc}Max

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:MIN on page 493
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:MAX on page 493

Power Offset ← PA characteristics
Indicates an enabled power offset, for example to compensate power attenuation because of cable lengths.

The displayed value is applied as level offset to the generated RF signal and considers the following settings:
- "RF > RF Level > Level > Offset"
- "RF > RF Level > UCOR"

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:POWer:OFFSet?
on page 495

PEP$_{in}$Min/Max ← PA characteristics

Sets the minimum and maximum values of the input power PEP$_{in}$, as required by the power amplifier (PA).

The "PEP$_{in}$Min/Max" parameters define the linear range of the PA. Refer to the product documentation of the PA for information on the characteristics of the required input signal.

The value range corresponds to the value range of output level.

Remote command:

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:PIN:MIN on page 494
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:PIN:MAX on page 495

6.5.4 Envelope settings

Access:

1. Enable the generation of envelope tracking signal.
   See Chapter 6.5.3, "General RF envelope settings", on page 176.

2. Select "I/Q Analog Settings > Envelope Settings".
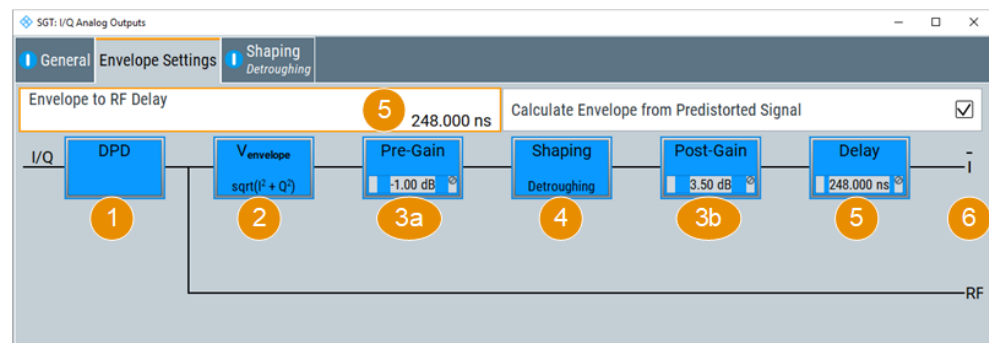
1	= Enabled Digital Predistortion
2	= Envelope detector, $\sqrt{[I(t)^2+Q(t)^2]}$; indication changes, depending on the Envelope Voltage Adaptation
3a, 3b	= (for "Envelope Voltage Adaptation > Manual") Pre-Gain/Post-Gain
4	= Shaping state and shaping function; gray background color = deactivated shaping
5	= Enabled Envelope to RF Delay
6	= Indicates the output connectors, depending on the I/Q Output Type

The dialog displays an *interactive* overview diagram of the ET processing chain. The diagram displays information on shaping state, incl. current shaping method and setting, like gains or delay.

Tip: Hotspots for quick access. The displayed blocks are hotspots. Select one of them to access the related function.

The remote commands required to define these settings are described in Chapter 10.14.13, "SOURce:IQ:OUTPut:ENVelope commands", on page 485.

Settings:

Envelope to RF Delay

Sets the time delay of the generated envelope signal relative to the corresponding RF signal. A positive value means that the envelope signal delays relative to the RF signal and vice versa.
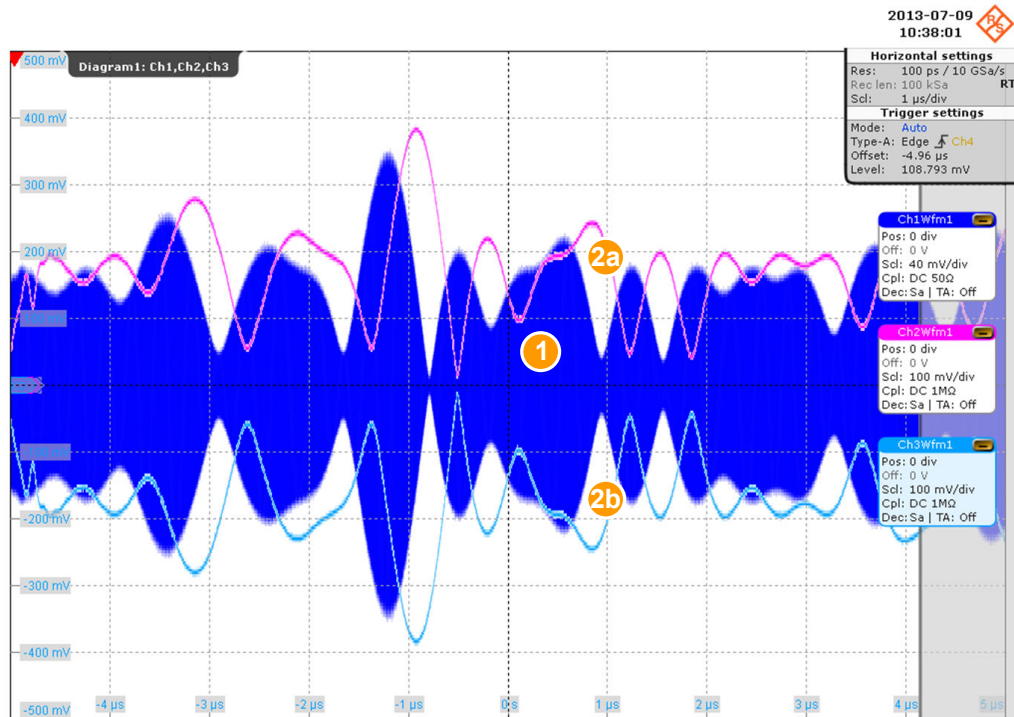
Figure 6-16: Effect of enabled positive RF delay

1   = RF signal
2a, 2b = Envelope signal E and inverted envelope signal E BAR

Use this parameter to compensate possible timing delays caused by connected cables and align the input signals at the PA to prevent unwanted effects, like memory effects or decreased linearity.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:DELay on page 489

Calculate Envelope from Predistorted Signal
Option: R&S SGT-K541

Enables the calculation of the envelope signal from the original baseband signal or from the AM/AM and/or AM/FM predistorted signal.

See also Chapter 6.6, "Applying digital predistortion", on page 198.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:FDPD on page 490

6.5.5 Shaping settings

Access:

1. Enable the generation of envelope tracking signal.
   See Chapter 6.5.3, "General RF envelope settings", on page 176.

2. Enable "Envelope Voltage Adaptation > Auto Power/Normalized".

3. Select "I/Q Analog Outputs > Shaping".
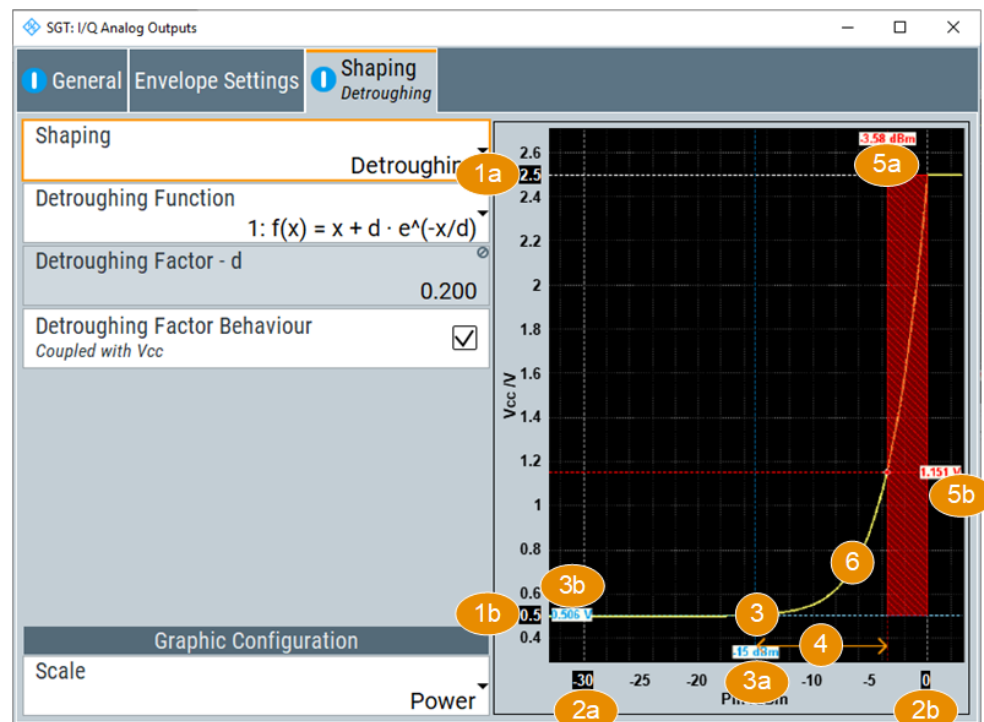
Figure 6-17: Understanding the displayed information ("Envelope Voltage Adaptation > Auto Power", "Shaping > Detroughing")

1a, 1b = Indicates the values of V_{cc}Min/Max
2a = Values smaller than PEP_{in}Min are clipped.
2b = Values greater than PEP_{in}Max are clipped.
3 = Operating point; corresponds to the RF RMS power level.
3a = Current RF RMS power level; an enabled "RF Level > Level Offset" is considered.
3b = Current V_{CC}
4 = Crest factor of the generated signal
5a, 5b = The values correspond to the PEP of the generated RF signal and the V_{CC}; shaded area indicates the calculated Pre-Gain.
6 = Current envelope shape, defined by the detroughing function and detroughing factor

The settings allow the configuration of the shape of the RF envelope signal. The instrument applies the settings and calculates the shaping function. A diagram visualizes the resulting envelope shape, as function of the selected supply voltage V_{cc} and PEP_{in} value limits, the calculated pre-gain and the estimated operating point of the PA.

See also:
● "Converting shaping functions and understanding the displayed values"
on page 171.

The remote commands required to define these settings are described in Chapter 10.14.13, "SOURce:IQ:OUTPut:ENVelope commands", on page 485.

Settings:

Shaping

Enables envelope shaping and selects the method to define the shaping function.

For detailed information on the shaping functions, see:
● Chapter 6.5.2.3, "Envelope shaping and shaping methods", on page 167
● "Converting shaping functions and understanding the displayed values"
on page 171.

"Off"   Envelope shaping is not adopted.
                         Previously configured values of the parameters Pre-Gain and Post-
                         Gain are ignored.
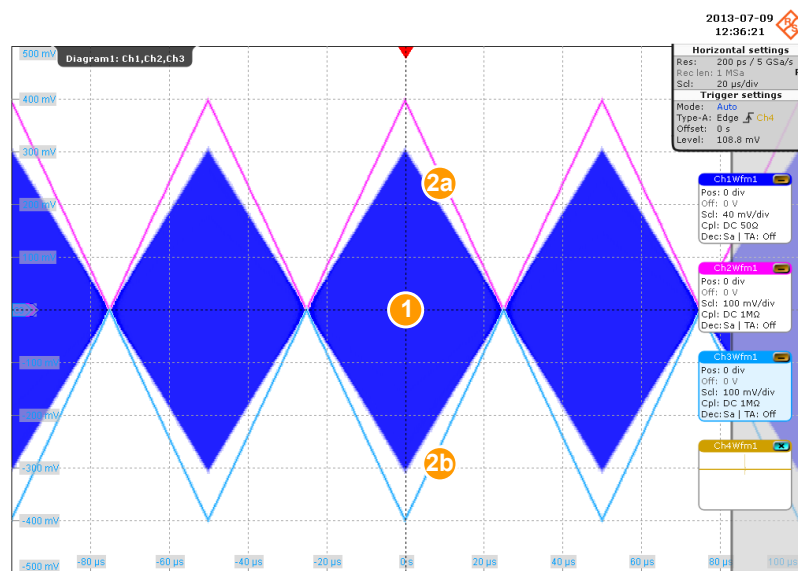
Figure 6-18: Generated RF, envelope and inverted envelope signal

1   = RF signal (simple ramp function)
2a, 2b = Envelope signal E and inverted envelope signal E Bar

"Linear (Voltage)/Linear (Power)"
                         The shaping function is a simple linear function.
                         The linear shaping is not used in practice but can be used for less
                         demanding applications, simple analysis, and the first interactions by
                         designing the optimum envelope shape. For "Envelope Voltage Adap-
                         tion > Manual", this function is suitable to determine the "Pre-/Post-
                         Gain" values, because the shaping gain of the linear function is 0 dB.

"Polynomial"   The shaping function is defined by a polynomial with configurable order and coefficients.
Select Polynomial coefficients settings to access the settings.
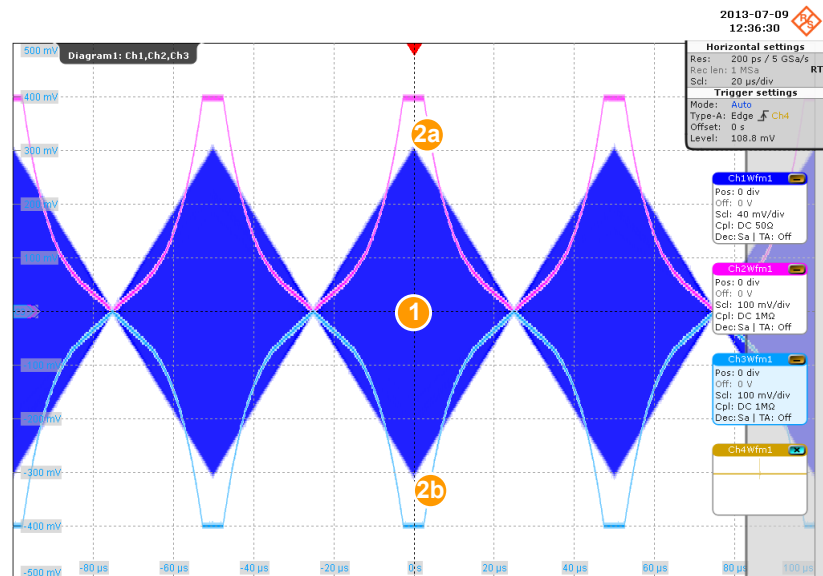
Figure 6-19: Effect of a polynomial shaping on the envelope and inverted envelope signal

1   = RF signal (simple ramp function)
2a, 2b = Envelope signal E and inverted envelope signal E Bar

"From Table"   The shaping function is defined by user-defined value pairs in form of a shaping table.

This shaping function is suitable if you have knowledge on or aim to achieve an exact relation between the supply voltage and RF output power. For example, by describing the transition region of a PA.

Select "Shaping Table" to access the settings.
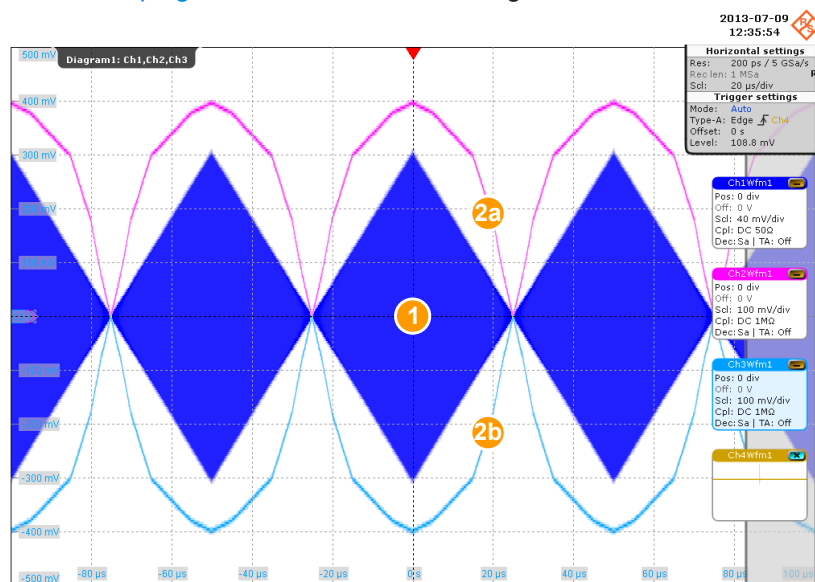
Figure 6-20: Effect of a table shaping on the envelope and inverted envelope signal

1   = RF signal (simple ramp function)
2a, 2b = Envelope signal E and inverted envelope signal E Bar

"Detroughing"   The shaping function applies a detroughing to prevent that the supply voltage V_{cc} drops down to zero.
Use the "Detroughing Factor" to limit the supply voltage V_{cc} in the low-power region.
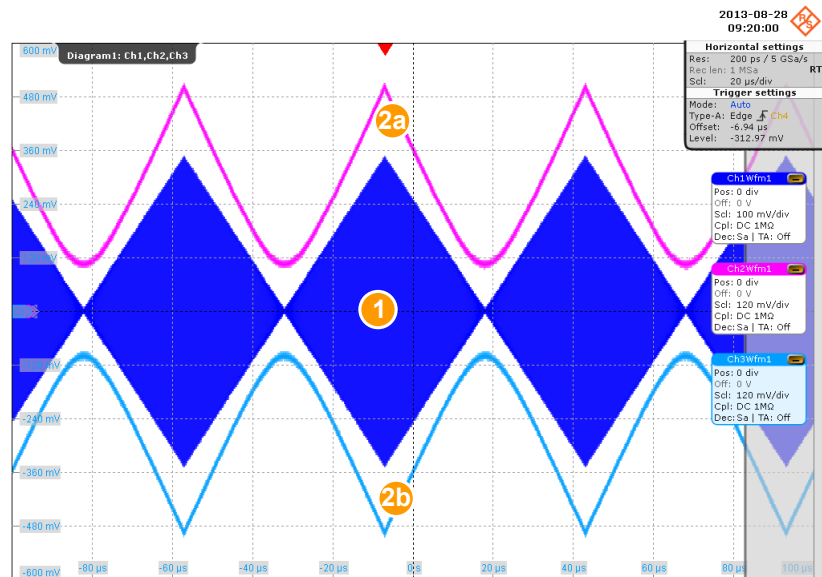
Figure 6-21: Effect of a detroughing function on the envelope and inverted envelope signal

1   = RF signal (simple ramp function)
2a, 2b = Envelope signal E and inverted envelope signal E Bar

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:MODE on page 495

Detroughing Function
Selects the mathematical function describing the detroughing.

The following functions are available:
- $f(x) = x + d*e^{-x/d}$
- $f(x) = 1 - (1 - d)*\cos(x*pi/2)$
- $f(x) = d + (1 - d)*x^a$

Where:
- x depends on the "Envelope Voltage Adaptation" mode, see Table 6-4
- d = Detroughing Factor (d)
- a = Exponent (a)

For more information, see "Converting shaping functions and understanding the displayed values" on page 171.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:
FUNCtion on page 499

Detroughing Factor (d)

For inactive coupling of the detroughing factor with V_{cc}, sets a start offset to limit the supply voltage V_{cc} in the low-power region.

The detroughing factor also controls the shaping. "Detroughing Factor = 0" defines a linear function.

See also "Couple Detroughing Factor with Vcc" on page 192.

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:FACTor` on page 500

Couple Detroughing Factor with Vcc

Enable this parameter to derive the detroughing factor (d) from the selected V_{cc} value. This ensures that the minimum supply voltage V_{cc} does not drop under the specified limits and the signal is not clipped.

The detroughing factor is calculated as follows:

$d = V_{cc}Min/V_{cc}Max$

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:COUPling` on page 499

Exponent (a)

For the third detroughing function, sets the exponent (a), see Detroughing Function.

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:PEXPonent` on page 500

Pre-Gain

For "Envelope Voltage Adaptation > Manual", sets a pre-gain (i.e. an attenuation) to define the operating range of the power amplifier. The pre-gain can be used to define and test only a specific (required) part of the operating range.

For "Envelope Voltage Adaptation > Auto", calculates the value automatically as following:

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:GAIN:PRE` on page 496

Post-Gain

For "Envelope Voltage Adaption > Manual", sets a post-gain to compensate the attenuation introduced by the pre-gain and the gain of the shaping function.

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:GAIN:POST` on page 496

Polynomial Coefficients

For "Shaping > Polynomial", accesses a dialog to describe the envelope shape as a polynomials function, see Chapter 6.5.7, "Polynomial coefficients settings", on page 196.

Shaping Table

For "Shaping > From Table", accesses the standard "Envelope Select" dialog with functions to define a new shaping table file, select or edit an existing one.

The shaping table files are files with predefined extension and file format, see "File format of the shaping table file" on page 170.

You can create a shaping table externally or internally.

"Select"	Selects and loads an existing file.
"New"	Creates a file
"Edit"	Access a standard built-in table editor, see Chapter 6.5.6, "Edit I/Q envelope shape settings", on page 194.

Remote command:
For "Envelope Voltage Adaption > Manual":
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:CATalog?`
on page 496
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE[:SELect]`
on page 496
For "Envelope Voltage Adaption > Auto":
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:CATalog?` on page 496
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE[:SELect]` on page 496

Interpolation

For "Shaping > From Table", enables a linear interpolation between limited number of defined value pairs in the table, to prevent abrupt changes.

Table 6-7: Effect of parameter "Interpolation"

"Interpolation > Off"	"Interpolation > Linear Voltage"
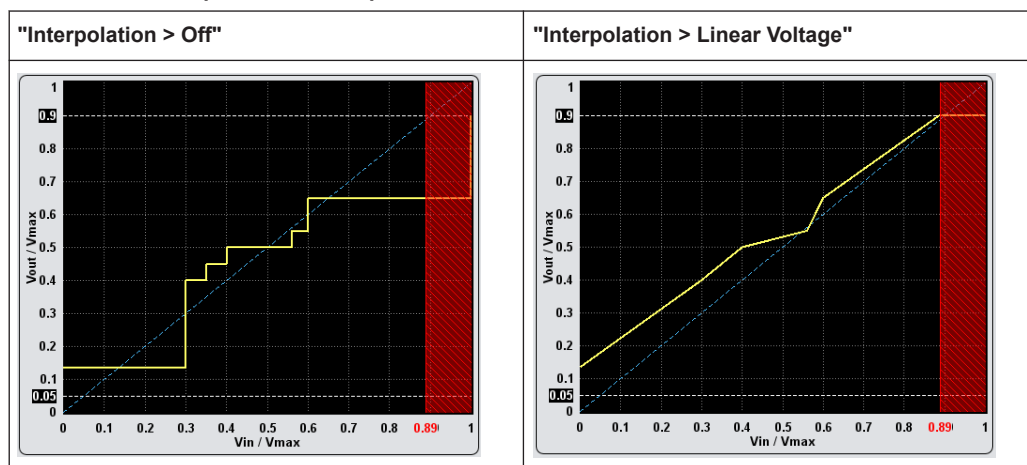
Remote command:

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:INTerp
on page 497

Graphic Configuration
Comprises settings to configure the graphical display.

Scale ← Graphic Configuration
Determines the units, "Voltage" or "Power", used on the x and y axis.

Table 6-8: Units on the x axis

"Envelope Voltage Adaption"	"Scale > Power"	"Scale > Voltage"
Auto Power	P_{in} [dBm]	V_{in} [V] = $\sqrt{P_{in}}$
Auto Normalized	P_{in}/P_{max}	V_{in}/V_{max}

Remote command:

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:SCALe
on page 496

Diagram ← Graphic Configuration
Visualizes the resulting envelope shape, as function of the selected supply voltage V_{cc} and PEP_{in} value limits, the calculated pre-gain and the estimated operating point of the PA.

See Figure 6-17.

Remote command:

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue:LEVel?
on page 493
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue:PEP?
on page 493
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue? on page 494

6.5.6 Edit I/Q envelope shape settings

The envelope shaping table is a method to define the shaping function.

Access:

1. Enable the generation of envelope tracking signal.
   See Chapter 6.5.3, "General RF envelope settings", on page 176.

2. Select "Envelope Voltage Adaptation > Manual".

3. Select "Shaping Settings > Shaping > From Table".

4. Select "Shaping Table > New"

5. Enter the "File Name", e.g. *MyLUT*

   The "Envelope Shaping File" dialog closes.

The "Shaping > Shaping Table" confirms that the newly created file is assigned.

6. Select "Shaping Table > MyLUT > Edit"

7. Define the value pairs "Vin/Vmax" and "Vcc/Vmax". The order is uncritical.

8. Select "Save".

    The instrument loads the configured values automatically and displays the shaping function.

9. Select "Shaping Settings > Interpolation > Linear (Voltage)".

    The display confirms the used interpolation.

The remote commands required to define these settings are described in Chapter 10.14.13, "SOURce:IQ:OUTPut:ENVelope commands", on page 485.

Settings:

Vin/Vmax, Vcc/Vmax/Power (dBm), Vcc (V)
Sets the normalized values of the value pairs.

"Vin/Vmax, Vcc/Vmax"
                Value pairs in "Envelope Voltage Adaptation > Manual/Auto Normalized" mode.

"Power(dBm), Vcc(V)"
                Value pairs in "Envelope Voltage Adaptation > Auto Power" mode.

Remote command:
n.a.

Fill Table Automatically
Standard function for filling a table automatically with user-defined values.

"From / Range"
                Defines the start line and number of the rows to be filled.

"Select Column to Fill"
                Selects the respective value, including the unit.

"Start / End Value"
                Default values corresponding to the selected column.

"Increment"   Determines the step size.

"Fill"   Fills the table.
                Fill both columns and then save the list. Otherwise the entries are lost.

Goto, Edit, Save As, Save
Standard functions for editing of data lists.

Changed and unsaved values are displayed on a yellow background.

Remote command:
n.a.

6.5.7 Polynomial coefficients settings

Access:

1. Enable the generation of envelope tracking signal.
   See Chapter 6.5.3, "General RF envelope settings", on page 176.

2. Select "Envelope Voltage Adaptation > Auto Normalized".

3. Select "Shaping Settings > Shaping > Polynomial".

4. Select "Polynomial Coefficients".
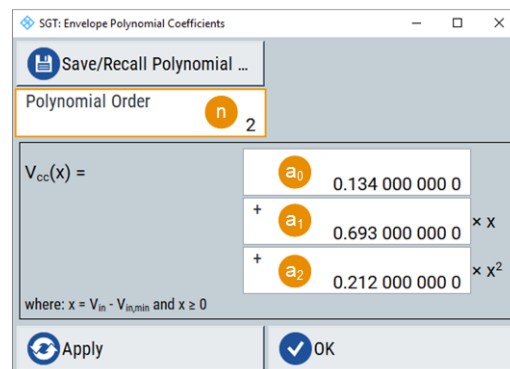
Figure 6-22: Polynomial Coefficients: Understanding the displayed information

The polynomial function is an analytical method to describe a shaping function. With the provided settings, you can define a polynomial function with up to 10th order to describe the envelope shape.

5. Select "Polynomial Order = 2" (n = 2).

6. Set the constant a_0 and the polynomial coefficients a_1 and a_2.

7. Select "Apply".

   The instrument loads the configured values and displays the shaping function.

8. To store the defined shaping function:

   a) Select "Save/Recall Polynomial"
   b) Navigate throughout the file system.
   c) Enter a "File Name", e.g. *MyPolynomial_2thOrder*
   d) Select "OK".

9. Select "Polynomial Coefficients > OK" to close the dialog.

The remote commands required to define these settings are described in Chapter 10.14.13, "SOURce:IQ:OUTPut:ENVelope commands", on page 485.

Settings:

Save/Recall Polynomial

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

The polynomial files are files with extension `*.iq_poly`, see "File format of the polynomial function file" on page 170.

Remote command:

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:CATalog?` on page 498

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:STORe` on page 498

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:LOAD` on page 498

Polynomial Order

Defines the polynomial order n, that is the number of polynomial coefficients (see "About the polynomial function" on page 169).

To confirm the settings, select "Apply".

Remote command:
See `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients` on page 497.

Polynomial constant and coefficients

Sets the polynomial constant a_0 and the polynomial coefficients a_1 to a_n.

The polynomial constant and coefficients influence the envelope shape.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients` on page 497

Apply, OK

Triggers the instrument to adopt the selected function.

Use "OK" to apply the setting and exits the dialog.

Remote command:
See `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients` on page 497

6.6 Applying digital predistortion

Digital predistortion (DPD) is a method to improve the efficiency of RF power amplifiers. In the R&S SGT, the generated digital signal can be deliberately AM/AM and AM/PM predistorted.

6.6.1 Required options

The equipment layout for digital predistortion includes:

- Option AM/AM AM/PM predistortion (R&S SGT-K541)
- Optional option envelope tracking (R&S SGT-K540)

6.6.2 About digital predistortion

Power amplifiers are an essential part of any telecommunication systems. While amplifying the transmitted signal, power amplifiers sometimes also distort this signal and change its amplitude and/or phase characteristics. Such distortions result in undesired effects like spectrum regrowth, harmonic generation, intermodulation (IM) products, or increased bit error rate.

The principle of the digital predistortion

To compensate for the distortions caused by the transmission system, the signal is deliberately digitally predistorted. Digital predistortion (DPD) is a method to apply wanted and well-defined predistortion on the transmitted signal. When this signal is amplified, the resulting signal features the identical characteristics, as the initial signal before the predistortion.
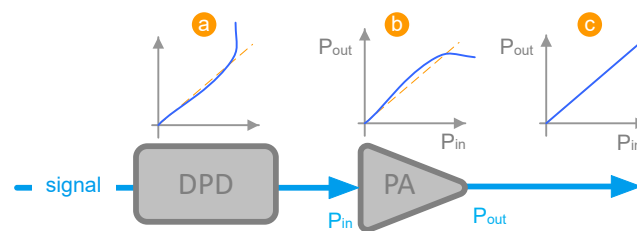
Figure 6-23: Illustration of predistortion principle

DPD = Digital predistortion
PA   = Power amplifier
a   = Predistortion function
b   = Characteristic of the power amplifier, for example the non-linear input power vs. output power (AM/AM) function
c   = Ideal linearized characteristic of the amplified signal

Digital predistortion models

When testing power amplifiers, it is important to measure and analyze signal distortions.

Of several known models, this implementation focuses on the following two types of distortion:

- The AM/AM (amplitude-to-amplitude) distortion and
- The AM/PM (amplitude-to-phase) distortion.

An AM/AM representation is a standard method that shows the signal power level at the input of the DUT against the power level at the output of the DUT. The default unit for both axes is dBm but the AM/AM representation can also be normalized.

An AM/PM curve shows the phase difference in degrees (y-axis) for every input power level (x-axis).

With option R&S SGT-K541, you can define both, an AM/AM and an AM/PM predistortion and apply them separately or superimposed on each other on the generated digital baseband signal.

If your instrument is equipped with the option R&S SGT-K540, you can also apply pre-distortions on the generated envelope signal.

Refer to Chapter 6.5, "Generation of envelope tracking signals", on page 165 for more information.

6.6.2.1 Defining the power level of the generated signal

You can define the level of the generated signal in one of the following ways:

- **"Level Reference > Before DPD"**
  In this mode, the "Level" parameter in the status bar of the instrument defines the signal level before the DPD is applied.
  Signal with selected level is pre-distorted and depending on the selected AM/AM and AM/PM functions, attenuated or boosted.

- **"Level Reference > After DPD"**
  In this mode, you define the resulting signal level. Based on this value and depending on current predistortion function, the R&S SGT calculates the level of the signal to be pre-distorted.
  The level calculation requires several interaction cycles; the number of iterations is a trade-off between level accuracy and speed.

6.6.2.2 Defining the correction values

In the R&S SGT, you can select the way you define the predistortion function and choose between:

- A polynomial function with up to 10 polynomial coefficients
  (see "Polynomial function" on page 200)
- A predistortion function defined as a look-up table
  (see "Shaping table" on page 200)
- A normalized data
  (see "Normalized data" on page 201)
- To set the correction values in raw format with a single remote control command
  (see "Predistortion function in raw data format" on page 202).

Polynomial function

The polynomial function is an analytical method to describe a predistortion function. When using the polynomial function, you do not define the correction values (ΔPower and ΔPhase) directly as it is in the look-up table. You describe the predistortion function and the R&S SGT derives the correction values out of it.

See Chapter 6.6.3.4, "Polynomial coefficients settings", on page 211.

This implementation uses a polynomial with complex coefficients defined as follows:

$P_{DPD}(x) = \sum[(a_n+j*b_n)*x^n]$,

Where:

- n = "Polynomial Order" ≤ 10
- $x = P_{in}/P_{in}Max$
- a_n and b_n are user-defined coefficients, defined as Cartesian (polar) or cylindrical coordinates.
  In Cartesian coordinates system, the coefficients b_n are expressed in degrees.

The R&S SGT calculates the AM/AM and AM/PM predistortion functions as follows:

- $AM/AM(x) = abs[P_{DPD}(x)]$
- $AM/PM(x) = tan^{-1}\{Im[P_{DPD}(x)]/Re[P_{DPD}(x)]\}$

The R&S SGT calculates the correction values (ΔAM/AM and ΔAM/PM functions) as follows:

- $\Delta AM/AM(x) = AM/AM(x) - x = abs[P_{DPD}(x)] -x$
- $\Delta AM/PM(x) = AM/PM(x) = tan^{-1}\{Im[P_{DPD}(x)]/Re[P_{DPD}(x)]\}$

File format of the polynomial file

You can store a polynomial function in a file or even define the polynomial coefficients, store them as a file and load this file into the instrument. The polynomial files are files with the extension `*.dpd_poly`.

The file contains an optional header `# Rohde & Schwarz - Digital Predistortion Polynomial Coefficients # a0,b0, a1,b1, a2,b2, ...` and a list of comma-separated coefficient value pairs, stored in Cartesian coordinates.

For values above the selected Input Range (PEP$_{in}$) From/To, the predistortion function assumes a linear ratio of the input to output power.

Example: Polynomial function file content

```
# Rohde & Schwarz - Digital Predistortion Polynomial Coefficients
# a0,b0, a1,b1, a2,b2, ...
0,0,-0.25,0.2,0.6,-0.3,0.3,0.3,0.5,-0.4
```

Shaping table

In the R&S SGT, there are two ways to define the predistortion function in form of a shaping table:

- **Externally**

Create a correction table file as a CSV file with Microsoft Excel, with a Notepad or a similar tool. Save the file with the predefined extension, transfer and load it into the instrument.
See also "File format of the correction table file" on page 201.

- **Internally**
  Use the built-in editor table editor, see Chapter 6.6.3.3, "Edit predistortion table settings", on page 210.

File format of the correction table file

The correction table files are files with predefined extension and simple file format, see Table 6-9.

Table 6-9: Shaping table files: format and extensions

Predistortion model	File extension	Header (optional)
AM/AM	`*.dpd_magn`	`# Rohde & Schwarz - Digital AM/AM Predistortion` `Table Pin[dBm],deltaPower[dB]`
AM/PM	`*.dpd_phase`	`# Rohde & Schwarz - Digital AM/PM Predistortion` `Table Pin[dBm],deltaPhase[deg]x`

The header is optional. The file content is a list of up to 4000 comma-separated value pairs, describing the delta values for amplitude or phase related to the absolute input power P_{in}. A new line indicator separates the pairs.

For values above the selected Input Range (PEP$_{in}$) From/To, the predistortion function assumes a linear ratio of the input to output power.

Example: Shaping table file content (*.dpd_magn file)

```
# Rohde & Schwarz - Digital AM/AM Predistortion Table
Pin[dBm],deltaPower[dBm]
-30,0.5
3,-0.01
```

Normalized data

In the R&S SGT, there are two ways to define the predistortion function as normalized data:

- **Externally**
  We recommend that you calculate the normalized correction data by a connected R&S®FSW equipped with R&S®FSW-K18 power amplifier and envelope tracking measurements option.
  You can also create the correction table file as a CSV file with Microsoft Excel, with a Notepad or a similar tool. Save the file with the predefined extension, transfer and load it into the instrument.
  See also "File format of the correction table file" on page 201.

- **Internally**
  Use the built-in editor table editor, see Chapter 6.6.3.3, "Edit predistortion table settings", on page 210.

File format of the normalized data

The normalized data files are files with predefined extension `*.dpd_norm` and simple file format, see "File format of the normalized data" on page 202.

The file contains an optional header `# Rohde & Schwarz - Digital Predistortion Normalized Table Data # PinMax [dBm] # number of points # Vin/Vmax, deltaV/V, deltaPhase [deg]`, the values of the Pin_{Max}, the number of the subsequent points and a list of comma-separated groups of three values.

Example: Normalized data file content

```
# Rohde & Schwarz - Digital Predistortion Normalized Table Data
# PinMax [dBm]
# number of points
# Vin/Vmax, deltaV/V, deltaPhase [deg]
10
4096
0,0,0
0.0002442,-0.00018246,0.28052
0.0004884,-0.00036487,0.28041
0.0007326,-0.00054723,0.2803
0.0009768,-0.00072954,0.28019
0.001221,-0.00091181,0.28008
0.0014652,-0.001094,0.27996
...
```

Predistortion function in raw data format

The predistortion values are defined directly, with a single remote control command:

- Define up to 4000 comma-separated value pairs, describing the absolute input power P_{in} and the delta values for amplitude or phase (ΔPower and ΔPhase).
  Example:
  ```
  SOURce1:IQ:DPD:SHAPing:TABLe:AMAM:FILE:DATA -30.4,-5.2,
  -25.1,-4.5, -18.5,-2.5, -10.5,-1
  ```
  See:
  - `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:DATA` on page 511
  - `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:DATA` on page 511
  - `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:NEW` on page 510
  - `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:NEW` on page 510
- Define the absolute maximum input power Pin_{max}, the number of subsequent points, and the normalized values Vin/Vmax, ΔV/V, ΔPhase [deg] as binary data. See `[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA` on page 513.

6.6.2.3 Finding out the correction values

If you know the properties of the used power amplifier, you can calculate suitable correction values.

We assume that the characteristics of a power amplifier have been measured and that the left graphic in the following table shows the AM/AM curve of this amplifier.

Defining correction coefficients for an AM/AM predistortion (example)
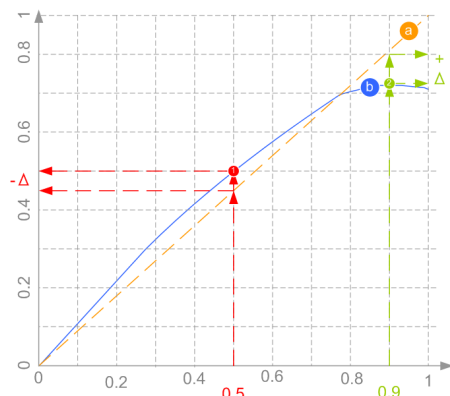
a = ideal characteristic; if the amplifier did not distort the signal, the normalized magnitude would be a line

b = measured AM/AM curve; the normalized magnitude varies as a function of input power

Resulting AM/AM predistortion function (example)
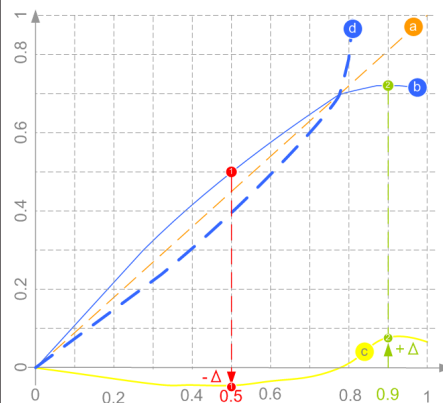
a = ideal characteristic

b = measured AM/AM curve

c = resulting AM/AM predistortion function, i.e. correction values curve

d = ideal predistorted signal

The required correction coefficient ΔPower is the difference between the ideal and the real normalized amplitude for one particular input power. To compensate for the nonlinearity and the deviation from the ideal line: select a negative correction value (-Δ) for any input power where the real normalized amplitude is greater than the ideal one (1). Logically, a positive correction value (+Δ) compensates for (i.e. boost) an amplitude that is smaller than the ideal one (2).

Ideally, a signal predistorted with a suitable function (c) and then amplified by the particular PA would have a linear characteristic (a).

6.6.3 Digital predistortions AM/AM and AM/PM settings

You can add digital predistortion to the generated baseband signal and thus compensate an amplitude and a phase distortion of the DUT, for example of the tested power amplifier.

Access:

► Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM".
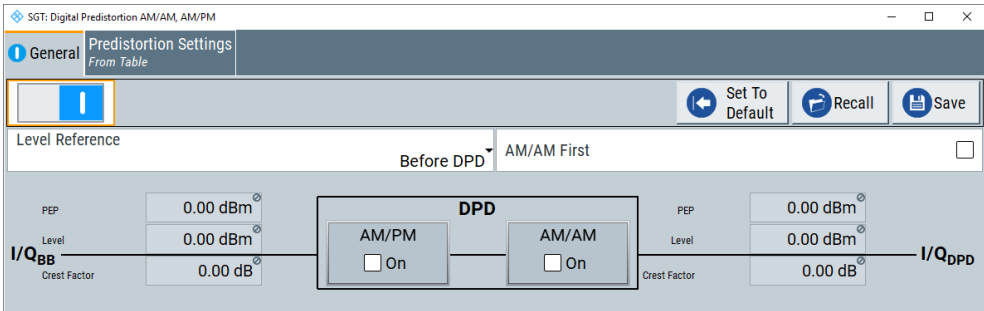
The dialog covers the settings for digital predistortion, like select and enabling an AM/AM and/or AM/PM predistortion, select the way the predistortion function is defined and specify the correction values.

The remote commands required to define these settings are described in Chapter 10.14.14, "SOURce:IQ:DPD subsystem", on page 500.

Settings:

6.6.3.1 General settings

State

Enables/disables the generation of digital predistorted signals.

Remote command:

`[:SOURce<hw>]:IQ:DPD:STATe` on page 503

Set to Default

Calls the default settings. The values of the main parameters are listed in the following table.

Parameter	Value
"State"	Not affected by the "Set to Default"
"Level Reference"	Before DPD

Parameter	Value
"AM/AM First"	Off
"AM/PM, AM/AM"	Off

Remote command:

[:SOURce<hw>]:IQ:DPD:PRESet on page 503

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

Remote command:

[:SOURce<hw>]:IQ:DPD:SETTing:CATalog? on page 503

[:SOURce<hw>]:IQ:DPD:SETTing:STORe on page 504

[:SOURce<hw>]:IQ:DPD:SETTing:LOAD on page 504

[:SOURce]:IQ:DPD:SETTing:DELete on page 504

AM/AM First

Toggles the order the AM/AM and AM/PM predistortions are applied.

Remote command:

[:SOURce<hw>]:IQ:DPD:AMFirst on page 507

Level Reference

Switches between dynamic and static adaptation of the range the selected DPD is applied on.

"Before DPD/After DPD"

Selects dynamic range calculation and defines whether the selected "Level" value corresponds to the signal level before or after the pre-distortion, see Chapter 6.6.2.1, "Defining the power level of the generated signal", on page 199.

"Static DPD"   Selects static (constant) range limits. To adjust the range, use the parameter Pre-Gain.

Remote command:

[:SOURce<hw>]:IQ:DPD:LREFerence on page 507

Maximum Output Level Error

For "Level Reference > After DPD", sets the allowed maximum error, see Chapter 6.6.2.1, "Defining the power level of the generated signal", on page 199.

Remote command:

[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor:MAX on page 508

Maximum Number of Iterations

For "Level Reference > After DPD", sets the maximum number of performed iterations to achieving the required Maximum Output Level Error.

See also Chapter 6.6.2.1, "Defining the power level of the generated signal", on page 199.

Remote command:

[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor:MAX on page 508

Achieved Output Level Error

Displays the resulting level error, see Chapter 6.6.2.1, "Defining the power level of the generated signal", on page 199.

Remote command:

[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor? on page 507

Input/Output PEP, Level and Crest Factor

Displays the calculated values the before and after the DPD.

A value of -1000 indicates that the calculation is impossible or there are no measurements results available.

Remote command:

[:SOURce<hw>]:IQ:DPD:INPut:PEP? on page 509

[:SOURce<hw>]:IQ:DPD:INPut:LEVel? on page 509

[:SOURce<hw>]:IQ:DPD:INPut:CFACtor? on page 509

[:SOURce<hw>]:IQ:DPD:OUTPut:PEP? on page 509

[:SOURce<hw>]:IQ:DPD:OUTPut:LEVel? on page 509

[:SOURce<hw>]:IQ:DPD:OUTPut:CFACtor? on page 509

AM/AM and AM/PM State

Enables/disables the AM/AM and AM/PM digital predistortion.

If both predistortions are enabled simultaneously, the instrument applies the AM/AM predistortion first and compensates the phase error of the PA afterwards.

Compare the displayed signal processing chain.

Remote command:

[:SOURce<hw>]:IQ:DPD:AMAM:STATe on page 504

[:SOURce<hw>]:IQ:DPD:AMPM:STATe on page 504

6.6.3.2   Predistortion settings

Access:

1.   Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM > Predistortion Settings".

2. Select a shaping function, for example the shaping file form Example"Shaping table file content (*.dpd_magn file)" on page 201.
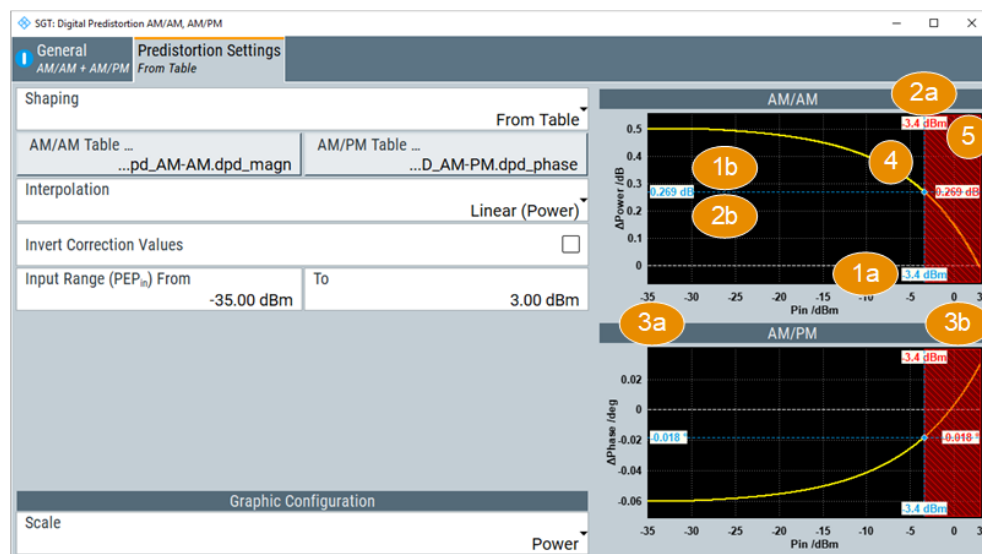
Figure 6-24: Predistortion Settings > From Table: Understanding the displayed information

1a	= Normalized value of the current RF RMS power level
2a	= Normalized value of the current PEP of the generated RF signal
1b, 2b	= Correction values
White dashed line	= Ideal zero correction function; no correction is necessary.
Yellow curve	= Predistortion function
3a, 3b	= Input Range (PEP$_{in}$) From/To
4	= Positive correction coefficients to compensate values below the ideal ones
5	= Values greater than the PEPin Max are ignored.

The dialog covers the settings for digital predistortion, like select and enabling an AM/AM and/or AM/PM predistortion, select the way the predistortion function is defined and specify the correction values.

Settings:

Shaping

Selects the method to define the correction coefficients.

"From Table"   As value pairs in form of a shaping table.
Select "AM/AM or AM/PM Shaping Table" to access the settings, see Chapter 6.6.3.3, "Edit predistortion table settings", on page 210.

"Polynomial"	By a polynomial with configurable order and coefficients. Select "Polynomial Coefficients" to access the settings, see Chapter 6.6.3.4, "Polynomial coefficients settings", on page 211.
"Normalized"	As a normalized data. Select "Normalized Data" to access the settings, see Chapter 6.6.3.5, "Normalized data settings", on page 214.

Remote command:

[:SOURce<hw>]:IQ:DPD:SHAPing:MODE on page 510

Interpolation

For "Shaping > From Table/Normalized", enables a linear interpolation between limited number of defined value pairs in the table, to prevent abrupt changes.

Table 6-10: Effect of parameter Interpolation

"Interpolation > Off"	"Interpolation > Linear (Power)"
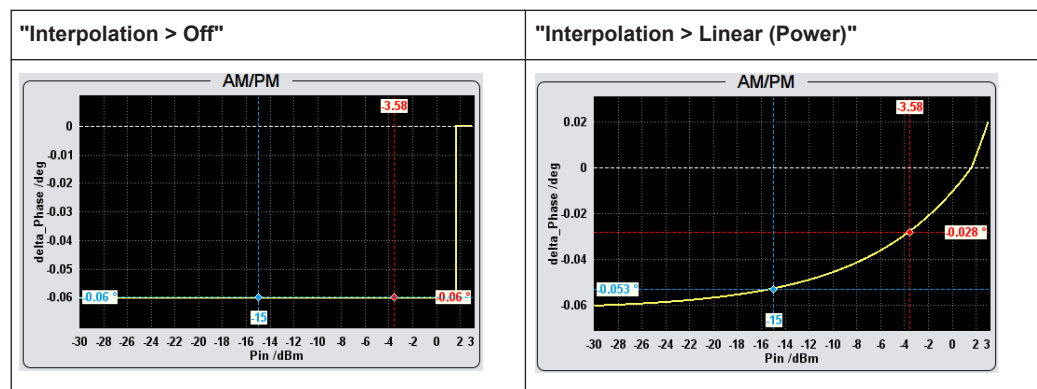
Remote command:

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:INTerp on page 511

Invert Correction Values

Inverts the defined correction values.

Applies the exact invert predistortion coefficients without changing the defined predistortion table.

This function is also useful to toggle between predistortions with corrections related to the input power and to the output power.

Table 6-11: Effect of parameter Invert correction values

"Invert correction values > Off"	"Invert correction values > On"
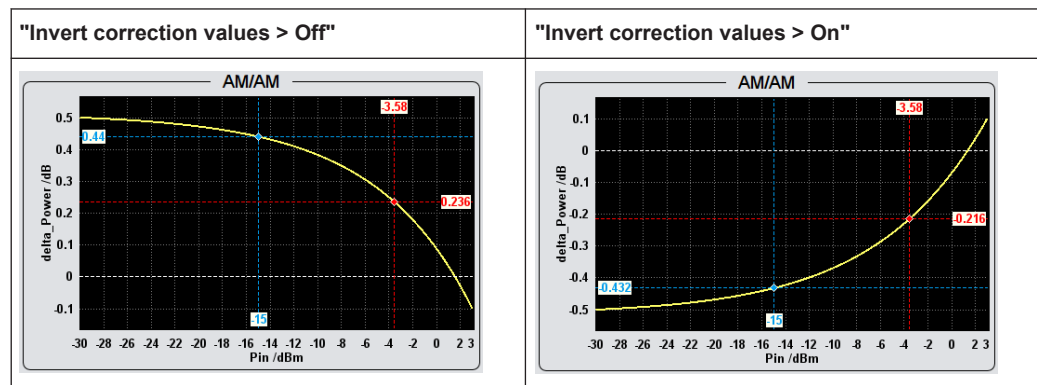
Remote command:

[:SOURce<hw>]:IQ:DPD:SHAPing[:TABLe]:INVert on page 511

Input Range (PEP$_{in}$) From/To

Defines the minimum and maximum input power PEP$_{in}$.

If you apply digital predistortion on signals used for power amplifier tests with envelope tracking, set the PEP$_{in}$Max value to the maximum value of the input power PEPin Max, as required by the power amplifier (PA).

Remote command:

[:SOURce<hw>]:IQ:DPD:PIN:MIN on page 509

[:SOURce<hw>]:IQ:DPD:PIN:MAX on page 509

Pre-Gain

For "General > Level Reference > Static DPD", sets a pre-gain (i.e. an attenuation) to define the range the DPD is applied in. The pre-gain can be used to define and test only a specific (required) part of the operating range.

For "General > Level Reference > Before/After DPD", the range is limited by the current PEP of the signal.

See Figure 6-24.
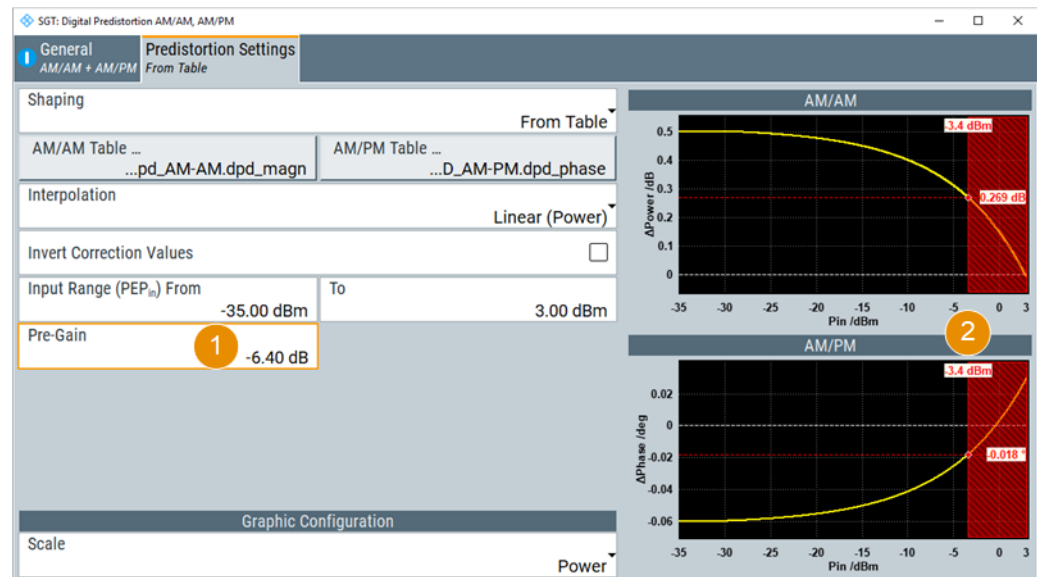
1 = Pre-gain limits the effective range of the shaping function
2 = Values above this limit are ignored

Remote command:

[:SOURce<hw>]:IQ:DPD:GAIN:PRE on page 509

Shaping Table

Accesses the standard "Predistortion Select" dialog with functions to define a new shaping table file, select, or edit an existing one.

The shaping table files are files with predefined extension and file format, see "File format of the correction table file" on page 201.

You can create a shaping table externally or internally.

"Select"   Selects and loads an existing file.

"New"   Creates a file.

"Edit"   Access a standard built-in table editor, see Chapter 6.6.3.3, "Edit predistortion table settings", on page 210.

Remote command:
For AM/AM distortions:
`[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:CATalog?` on page 510
`[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE[:SELect]` on page 510
For AM/PM distortions:
`[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?` on page 510
`[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE[:SELect]` on page 510

Polynomial Coefficients
For "Shaping > Polynomial", accesses a dialog to describe the predistortion function as a polynomial function, see Chapter 6.6.3.4, "Polynomial coefficients settings", on page 211.

Normalized Data
For "Shaping > Normalized", accesses a dialog to describe the predistortion function as a normalized data, see Chapter 6.6.3.5, "Normalized data settings", on page 214.

6.6.3.3   Edit predistortion table settings

The predistortion table is an internal editor where you define the correction values, ΔPower and ΔPhase, in form of a look-up table.

Access:

1. Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM > Predistortion Settings".

2. Select "Shaping > From Table".

3. Select "AM/AM > Shaping Table > Predistortion AM/AM Shaping File > New"

4. Enter the "File Name", e.g. *My_DPD_AM-AM*

   The "Predistortion AM/AM Shaping File" dialog closes.
   The "Shaping Table > My_DPD_AM-AM" confirms that the newly created file is assigned.

5. Select "Shaping Table > Predistortion AM/AM Shaping File > Edit"

6. Define the value pairs "Pin/dBm" and "ΔPower/dB". The order is uncritical.

7. Select "Save".

   The instrument loads the configured values automatically and displays the function of the delta correction values.

8. Select "Predistortion Settings > Interpolation > Linear".

   The display confirms the used interpolation.

Settings:

Pin (dBm), Delta Power (dB)/Pin (dBm), Delta Phase (deg)
Sets the correction value pairs.

"Pin, ΔPower"

Value pairs for the AM/AM predistortion

"Pin, ΔPhase"

Value pairs for the AM/PM predistortion

Remote command:
See `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE[:SELect]`
on page 510
and `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE[:SELect]`
on page 510

Fill Table Automatically
Standard function for filling a table automatically with user-defined values.

"From / Range"

Defines the start line and number of the rows to be filled.

"Select Column to Fill"

Selects the respective value, including the unit.

"Start / End Value"

Default values corresponding to the selected column.

"Increment"   Determines the step size.

"Fill"   Fills the table.
Fill both columns and then save the list. Otherwise the entries are lost.

Goto, Edit, Save As, Save
Standard functions for editing of data lists.

Changed and unsaved values are displayed on a yellow background.

Remote command:
n.a.

6.6.3.4 Polynomial coefficients settings

Alternatively to the look-up table, you can define the predistortion functions as a polynomial function. The R&S SGT calculates the AM/AM and AM/PM predistortion functions and the required correction coefficients out of the defined polynomial.

To access the polynomial coefficients setting and define a higher-order polynomial

1. Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM > Predistortion Settings".

2. Select "Shaping > Polynomial".

3. Select "AM/PM > Polynomial Coefficients".
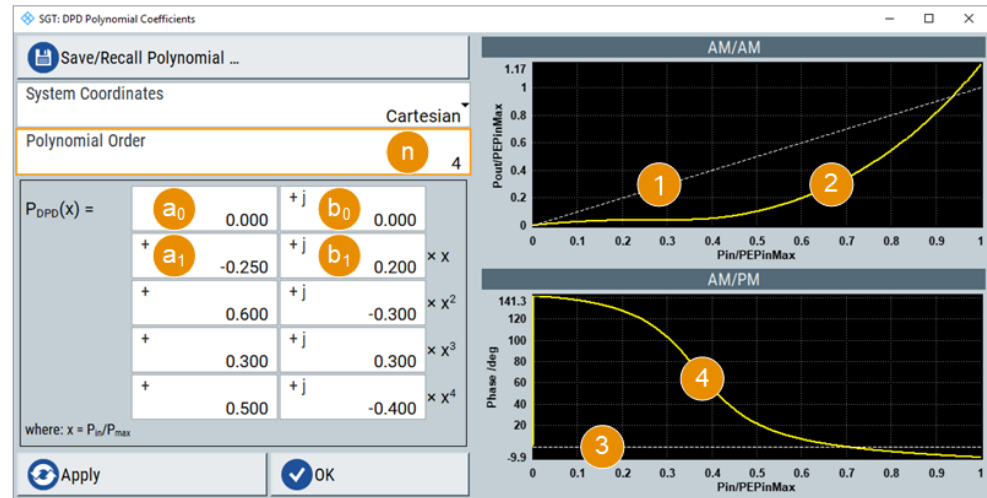
Figure 6-25: Polynomial Coefficients: Understanding the displayed information

n   = Polynomial order
a0, b0, ... = Polynomial coefficients
1   = Ideal AM/AM function (the normalized amplitude is a line).
2   = Resulting AM/AM predistortion function, calculated as AM/AM(x) = abs[P_{DPD}(x)]
3   = Ideal AM/PM function (constant phase at 0 degrees)
4   = Resulting AM/PM predistortion function, calculated as AM/PM(x) = $\tan^{-1}${Im[P_{DPD}(x)]/
              Re[P_{DPD}(x)]}

With the provided settings, you can define a polynomial function with up to 10th order to describe the predistortion function.
The graphical display updates on-the-fly and visualizes the resulting AM/AM and AM/PM functions.

4. Select "Polynomial Order = 4" (n = 4).

5. Set the polynomial coefficients a_0 to b_4.

6. Select "Apply".

The instrument loads the configured values, calculates the correction values, and displays the predistortion functions.
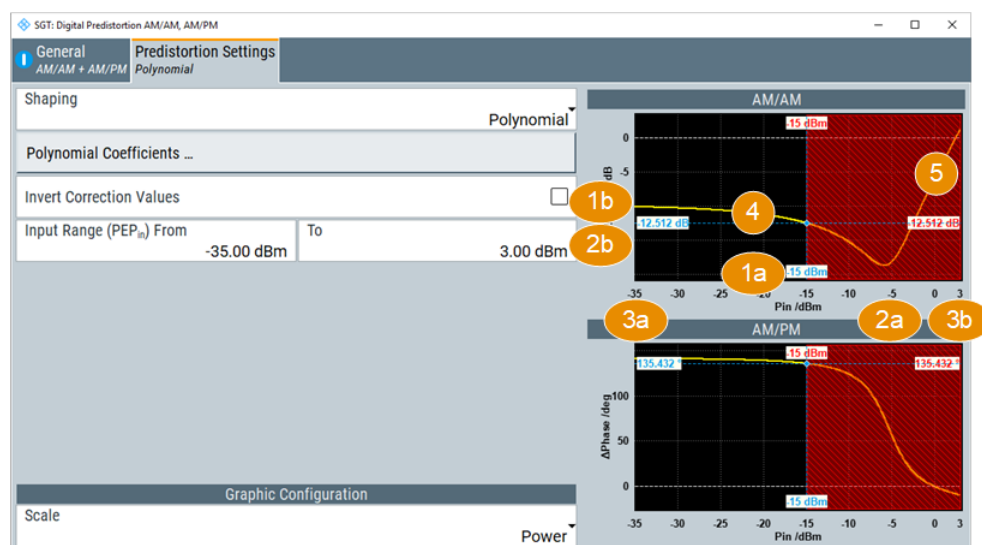
Figure 6-26: Predistortion Settings > Polynomial: Understanding the displayed information

1a	= Normalized value of the current RF RMS power level
2a	= Normalized value of the current PEP of the generated RF signal
1b, 2b	= Correction values
White dashed line	= Ideal zero function; no correction is necessary.
AM/AM yellow curve	= AM/AM correction values, calculated as ΔAM/AM(x) = AM/AM(x) - x
AM/PM yellow curve	= AM/PM correction values, calculated as ΔAM/PM(x) = AM/PM(x)
3a, 3b	= X-axis scale, calculated from the Input Range (PEP$_{in}$) From/To
4	= Negative correction coefficients
5	= Values greater than the PEPin Max are ignored.

7. To store the defined predistortion function:

   a) Select "Save/Recall Polynomial"
   b) Navigate throughout the file system.
   c) Enter a "File Name", e.g. *MyPolynomial_4thOrder*
   d) Select "OK".

8. Select "Polynomial Coefficients > OK" to close the dialog.

Settings:

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

The polynomial files are files with extension `*.dpd_poly`, see "File format of the polynomial file" on page 200. The polynomial function is stored in Cartesian format.

Remote command:
`[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:CATalog?`
on page 512
`[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:LOAD`
on page 512
`[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:STORe`
on page 513

System Coordinates
Defines whether the polynomial function is defined in Cylindrical (Polar) or in Cartesian coordinates.

Remote command:
n.a.

Polynomial Order
Defines the polynomial order `n`, that is the number of polynomial coefficients (see "Polynomial function" on page 200).

The polynomial order defines the degree, complexity, and the number of terms in the polynomial function.

Remote command:
See `[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients`
on page 511.

Apply, OK
Triggers the instrument to adopt the selected function.

Use "OK" to apply the setting and exits the dialog.

Remote command:
`[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients` on page 511

Polynomial coefficients
Sets the polynomial coefficients a_0 to a_n and b_0 to b_n.

In "System Coordinates > Cylindrical", the polynomial coefficients b_0 to b_n are expressed in degrees.

The polynomial coefficients influence the shape of the predistortion function.

Select "Apply" to confirm the settings.

Remote command:
See "Apply, OK" on page 214.

6.6.3.5 Normalized data settings

The normalized data table is an internal editor where you define the correction values, Vin/Vmax, ΔV/V and ΔPhase, in form of a table.

To access the internal editor

1. Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM > Predistortion Settings".

2. Select "Shaping > Normalized Data".

3. Select "Normalized Data".
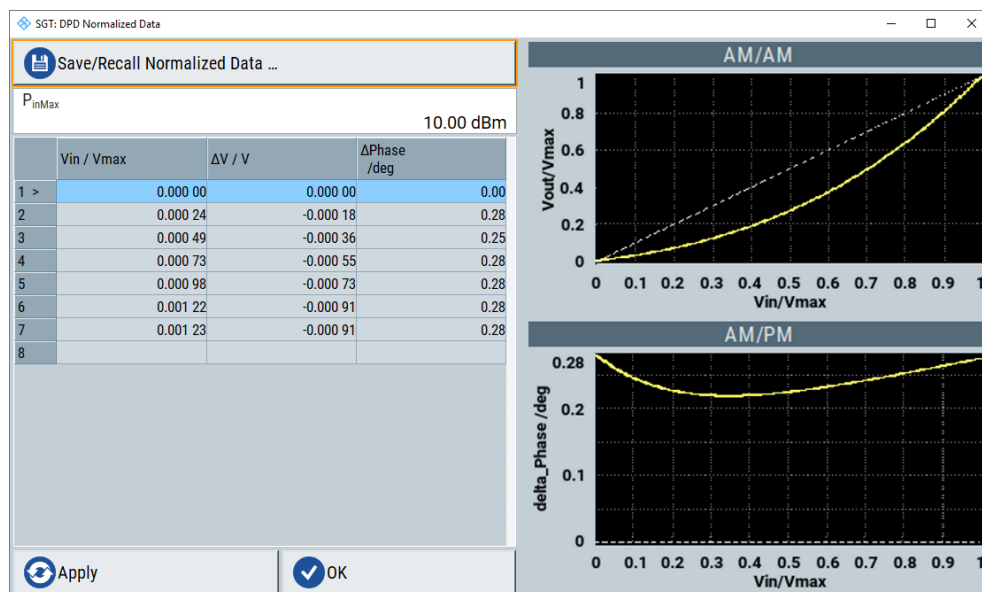
4. Enter the Pin$_{max}$.
   Note: Enter the correction values in the required order. The value range of the subsequent correction values adjusts automatically.

5. To store the setting in a file, select "Save/Recall Normalized Data > Save".
   Enter a "File Name", e.g. *My_DPD_Normalized*.

Settings:

Save/Recall Normalized Data
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 settings are saved in a file with predefined extension. You can define the filename and the directory, in that you want to save the file.

The normalized data files are files with extension `*.dpd_norm`, see "File format of the normalized data" on page 202.

Remote command:
`[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:CATalog?` on page 514
`[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:LOAD` on page 514
`[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:STORe` on page 514

Pin$_{Max}$
Sets the value of the maximum input power level.

Pin$_{max}$ corresponds to a normalized input power of 1, that is the max. allowed value on the x-axis.

Select "Apply" to confirm the settings.

Remote command:
n.a.

Vin/Vmax, Delta V/V, Delta Phase (deg)
Sets the correction as a group of three values.

Select "Apply" to confirm the settings.

Remote command:
See "Apply, OK" on page 216.

Apply, OK
Triggers the instrument to adopt the normalized data.

Use "OK" to apply the setting and exits the dialog.

Remote command:
`[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA` on page 513

6.7 RF settings

6.7.1 Overview of RF signal

Settings for the RF output signal and analog modulation are made under "RF Signal" and "Analog Modulations". These settings can be accessed in the block diagram by the "RF" function block, or by the dialog with the same name which is opened through "SGMA-GUI > Instrument Name > RF".
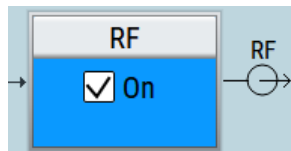
The function block is available for the basic unit R&S SGT without any additional equipment options.

RF On/Off

Activates and deactivates the RF output signal.

The current state of the RF output (activated and deactivated) is indicated in the main panel by the different block color (blue or grey) and the status "On/Off".

Remote command:
:OUTPut[:STATe] on page 374

6.7.2 Operation mode

You can operate the R&S SGT in two modes, normal mode and baseband bypass mode. In baseband bypass mode, an external IF signal fed in at the [I] or [Q] connectors is directly routed to the [RF OUT] connector. The level of the signal can be adjusted.

► To access the "Operation Mode" dialog, select "SGMA-GUI > Instrument Name > RF > Operation Mode".
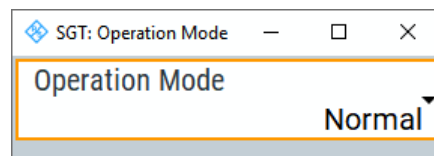
Operation Mode

Sets the operation mode.

"Normal"   The complete signal processing chain is used.

"Baseband Bypass"

The IF signal fed in at the "I" or "Q" connectors is directly routed to the "RF OUT" connector.

Remote command:
[:SOURce]:OPMode on page 391

6.7.3 Frequency / phase

The frequency and phase-related settings are provided in the "Frequency/Phase" dialog.

► To access this dialog, select "SGMA-GUI > Instrument Name > RF > Frequency/Phase".

Configuring the RF frequency

1. To change the RF frequency of the selected instrument, perform one of the following:

   a) To set the frequency at the RF output, select "SGMA-GUI > Instrument Name > Frequency/Phase > Frequency".

   b) To set the frequency, select "SGMA-GUI main panel > Freq".
      If configured, the frequency value includes a frequency offset.

2. To enable frequency offset, for example, to consider the frequency shift of a downstream instrument, set the parameter "Frequency/Phase > Offset".

   Changes of the RF frequency have an immediate effect on the output signal.

Frequency

Sets the RF frequency *at the RF output connector* of the selected instrument.

The displayed value does not consider an enabled frequency offset (Offset).

Remote command:
See `[:SOURce]:FREQuency[:CW|FIXed]` on page 390

Offset

Sets a frequency offset.

The frequency offset value represents the frequency shift of a downstream instrument, as, for example, an attenuator or an amplifier.

Enabled frequency offset does not change the frequency at the RF output (Frequency). It influences the value of the parameter "SGMA-GUI main panel > Freq".

The following applies:

"Freq" = Frequency + "Offset"

In the "SGMA-GUI main panel", enabled frequency offset is also indicated with the keyword "Freq (Offs)".

Remote command:
[:SOURce]:FREQuency:OFFSet on page 390

Delta Phase
Sets the phase of the RF signal. The current phase of the signal is used as the reference. This function allows, for example, the phase of the output signal to be synchronized with the phase of a signal from a second signal generator.

Remote command:
[:SOURce]:PHASe on page 515

Reset Delta Phase Display
Resets delta phase value. The set phase is adopted as the new current phase, i.e. the delta phase value is reset to 0.

Remote command:
[:SOURce]:PHASe:REFerence on page 515

6.7.4 Local oscillator (LO) coupling

The LO coupling function allows you to distribute the local oscillator signal. The signal is distributed in a way that multiple R&S SGTs or other R&S signal generators can be driven by the same LO signal.

A precise synchronization to the same LO signal is mandatory for phase coherent application, e.g. the generation of beamformed signals, and for phase coherent demodulation.

The LO coupling function is available only for instruments equipped with the option R&S SGT-K90 (phase coherence). This option enables phase coherent RF outputs of two or more RF signals. The local oscillator signal is provided at the REF/LO OUT connector. An external signal can be input at the REF/LO IN connector.

6.7.4.1 Phase coherence

Phase coherence of RF signals designates a defined, constant delta phase between two or more RF carrier signals with the same frequency or a multiple of the frequency.
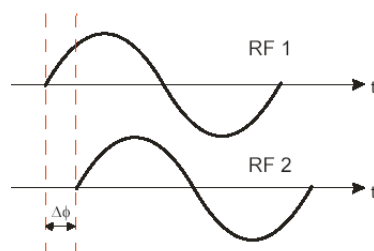
If two signal generators are coupled via their 10 MHz reference, they are generating the same frequency but only in the long-term perspective. Having a closer look into the instantaneous differential phase ("delta phase") of the two RF signals, the phase of the signals are instable due to:

- Phase noise of the two synthesizers
- "Weak" coupling at 10 MHz and a long synthesis chain up to the RF domain
- Temperature differences which cause slightly different phase drifts for the different synthesizers

Most critical for a stable delta phase is the thermal RF phase fluctuation between multiple RF synthesizers. These fluctuations can be minimized by using a common synthesizer (common local oscillator (LO) signal) for all RF carriers.

6.7.4.2   Local oscillator (LO) coupling settings

The LO coupling settings are provided in the "Frequency/Phase" dialog.

► To access this dialog, select "SGMA-GUI > Instrument Name > Frequency/Phase > Local Oscillator (LO) Coupling".

Source

Selects the source of the local oscillator signal.

"Int"   The instrument uses the built-in local oscillator.

"Ext"   The signal fed-in at the [REF/LO IN] input connector is used as signal source.

LO Src Ext	An icon in the block diagram indicates that an external LO source is used.

Note: The local oscillator input/output requires the additional software option R&S SGT-K90.

Remote command:
[:SOURce]:LOSCillator:SOURce on page 391

REF/LO Output

Determines the signal provided at the output connector [REF/LO OUT].

"OFF"   No signal is provided.

"LO"   The signal of the local oscillator (LO) is available at the [REF/LO OUT] connector.

"REF"   The signal of the reference oscillator is available at the [REF/LO OUT] connector.

Remote command:
:CONNector:REFLo:OUTPut on page 359

6.7.5 Reference oscillator

The R&S SGT is equipped with an internal TXCO reference oscillator. If equipped with the additional HW option R&S SGT-B1, an OXCO can be used as an internal reference frequency source for the synthesizer. Moreover, an external reference signal source can be connected to the REF/LO IN connector of the instrument.

► To access this dialog, select "SGMA-GUI > Instrument Name > RF > Reference Oscillator".
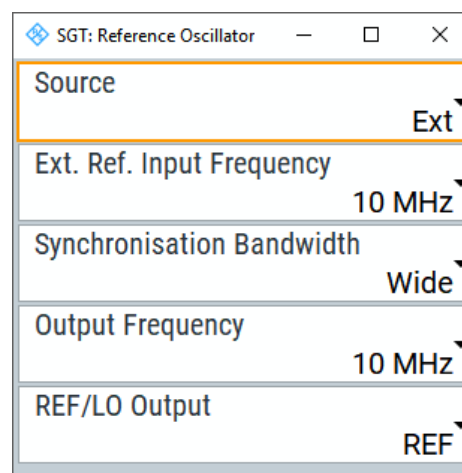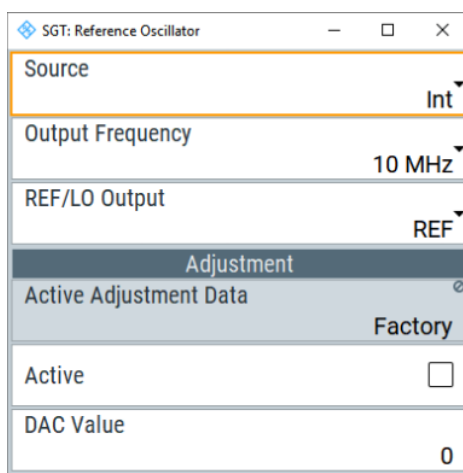
Ext Ref

Ref. Oscillator Source/Ext Ref On/Off

Determines whether the internal built-in oscillator (TXCO or OXCO) is used as a reference source or if an external reference is used.

The internal reference oscillator OCXO requires the additional option R&S SGT-B1.

To feed in an external instrument reference, use the input connector "REF/LO IN". To output the reference frequency at the output "REF/LO OUT", select "SGMA-GUI > Instrument Name > RF > Ref. Oscillator > REF/LO Output > REF".

"Int"　　　　　　　The internal reference signal of 10 MHz is used.

"Ext"　　　　　　　An external reference signal is used. The frequency of the external reference signal must be selected with the parameter "SGMA-GUI > Instrument Name > RF > Ref. Oscillator > Ex. Ref. Input Frequency".

Remote command:
[:SOURce]:ROSCillator:SOURce on page 527

Ext. Ref. Input Frequency

Available only for "Source > Ext".

Selects the frequency of the external reference signal.

Remote command:
[:SOURce]:ROSCillator:EXTernal:FREQuency on page 527

Synchronization Bandwidth

Available only for "Source > Ext".

Selects the synchronization bandwidth for an external reference signal. The wideband setting is provided for using good reference sources of high spectral purity.

"Wide"　　　　　　Synchronization bandwidth is app. 250 Hz.

"Narrow"　　　　　Synchronization bandwidth is app. 40 Hz.

Remote command:
[:SOURce]:ROSCillator:EXTernal:SBANdwidth on page 528

Output Frequency

Selects the output for the reference oscillator signal. The available values depend on the input frequency and the reference oscillator source.

Table 6-12: Output frequency

Reference oscillator source	Input frequency	Output frequency
"Internal"	10 MHz	10 MHz
		1 GHz
"External"	10 MHz	10 MHz, 1 GHz
	13 MHz	13 MHz, 1 GHz
	100 MHz	100 MHz, 1 GHz
	1 GHz	1 GHz

Support of 13 MHz reference frequency requires that the instrument is equipped with hardware module RF board with part number 1419.5308.02.

To find out the RF board installed in the instrument:

- Select "SGMA-GUI > instrument name > Setup > Hardware Config" > "RF Assembly"
- Observe the part number of the assembly "RfBoard".

Remote command:

[:SOURce]:ROSCillator:OUTPut:FREQuency on page 528

REF/LO Output

Determines the signal provided at the output connector [REF/LO OUT].

"OFF"   No signal is provided.

"LO"   The signal of the local oscillator (LO) is available at the [REF/LO OUT] connector.

"REF"   The signal of the reference oscillator is available at the [REF/LO OUT] connector.

Remote command:

:CONNector:REFLo:OUTPut on page 359

Active Adjustment Data

Displays whether the factory or user defined (custom) calibration value is used for the external calibration of the reference oscillator.

Adjusting the calibration value for the OCXO adjustments is a protected service procedure, that requires a "Protection Level 2" password.

Adjustment Active

Available only for "Source > Int".

Selects adjustment mode.

"Off"   Uses the calibrated internal reference frequency. This value is determined at one of the R&S service centers during calibration.

"On"   A user-defined adjustment value is used. The value is entered under DAC Value.
A user-defined value allows the frequency to be impaired freely, for example, to simulate a frequency error.
The instrument is no longer in the calibrated state. However, the calibration value is not changed and the instrument resumes the calibrated state after disabling the adjustment.

Remote command:

[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe] on page 528

DAC Value

Enters a user-defined adjustment value for the internal reference frequency. This value is not used unless "Adjustment Active > On" is selected. "0" represents the calibrated state. The setting range depends on the reference oscillator type and its factory calibration value.

Remote command:

[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue on page 529

6.7.6 RF level settings

This section explains the level settings of the R&S SGT.

Configuring RF level

► To change the RF level of the selected instrument, perform one of the following:

a) Select "SGMA-GUI main panel > Level".
b) Enter the desired value.
c) Select "SGMA-GUI > Instrument Name > RF > Level Settings > RF Level > Level"
d) Enter the desired value.

Changes of the RF level have an immediate effect on the output signal.

6.7.6.1 RF level settings

► To access the RF level settings, select "SGMA-GUI > Instrument Name > RF > Level > RF Level".

This dialog comprises settings like the RF level and level limit.

Level/Level Offset
Sets the RF level at the RF output connector of the selected instrument.

If you set a digital attenuation, while "I/ Q Mod > Modulation Source > Internal Baseband" and "I/ Q Mod > Modulation State > ON", it will be indicated in the R&S SGMA-GUI main panel by a change in the name of this parameter from "Level" to "Level Offset".

Level   -30.00 dBm   Level (Offs)   -30.10 dBm
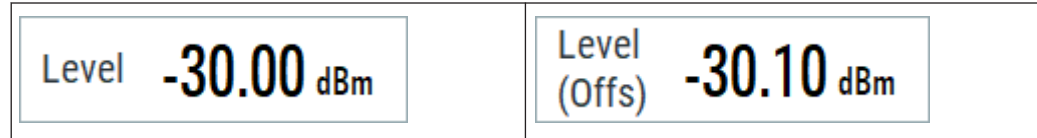
Note: The SCPI command `[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]` sets the level of the "Level" display, that means the level containing offset while `[:SOURce]:POWer:POWer` sets the level at the RF output connector.

Remote command:

`[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]` on page 526

`[:SOURce]:POWer:POWer` on page 523

Digital Attenuation

Available only for "I/Q Mod > State > On" and "I/Q Mod > Source > Internal Baseband".

Attenuates the level of the internal, digitally modulated I/Q baseband signals, and thus the level of the RF signal accordingly.

The function allows fast level changes of the internal I/Q signals, but it has no effect on externally provided I/Q signals.

Note: If you specify a digital attenuation value, the R&S SGT still shows the level as set with "Level/Level Offset" on page 68. That is, the calculated signal level is not displayed, but the level at the RF signal output is higher or lower according to the digital attenuation.

Remote command:

`[:SOURce]:POWer:ATTenuation:DIGital` on page 521

Offset / Offset (Gain)

Sets an RF level offset.

"Offset"   Sets an RF level offset.
                This offset value represents the level shift of a downstream instrument, as, for example, an attenuator or an amplifier, and is indicated in the status bar of the display. It does not change the level at the RF output.

"Offset (Gain)" For a power servoing test, sets the expected level offset, i.e. the gain of the DUT.
                After completion of a power servoing procedure this field shows the actual gain of the DUT. Setting the "Offset (Gain)" close to the true value of the DUT speeds up the procedure.
                The setting is also applied to the level offset configured in "Offset / Offset (Gain)" on page 225.

Remote command:

`[:SOURce]:POWer[:LEVel][:IMMediate]:OFFSet` on page 526

Mode

Allows you to optimize the RF output signal for applications, where improved harmonic distortion or improved wideband noise is required.

"Normal"   In normal mode, the generator provides an RF output signal with high signal to noise ratio and low distortion, according to the data sheet.

"Low Noise"   The setting forces the generator to continue optimizing the signal to noise ratio.

"Low Distortion"

                  In this mode, the generator reduces distortions of the RF signal to a minimum.

Remote command:

[:SOURce]:POWer:LMODe on page 522

Setting Characteristic

Selects the characteristic for the level setting. For some general applications, the instrument operation can be optimized by selecting one of the predefined level setting characteristics.

"Auto"   The instrument provides the highest dynamic range and the fastest setting times according to the data sheet.
                  The RF signal is shortly blanked during the moment that the step attenuator is switched on.

"Uninterrupted Level setting"

                  Suppresses level blanking at frequency and level changes.
                  This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

"Strictly Monotone"

                  Provides level setting without discontinuities. All electronic switches in the RF path are clamped. The operation mode is useful for applications using level-searching algorithms.
                  This mode further reduces the dynamic range of the instrument. The step attenuator is also fixed.

"Constant-VSWR"

                  Suppresses output impedance variations at the [RF Out] connector due to changed level setting.
                  This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

Remote command:

[:SOURce]:POWer:SCHaracteristic on page 523

Level Range

Displays the level range. Within this range, the level settings work properly. The range limits depend on level mode, setting characteristic, crest factor of the I/Q signal and other parameters.

Remote command:

[:SOURce]:POWer:RANGe:LOWer? on page 526
[:SOURce]:POWer:RANGe:UPPer? on page 526

Limit

Sets the level limit.

The value specifies the upper limit of the level at the [RF Out] connector. A message appears if an attempt is made to set a level above this limit and the level at the RF output is confined to the upper limit. However, the level indication is not influenced.

Remote command:
[:SOURce]:POWer:LIMit[:AMPLitude] on page 522

Readjust

Recalculates the instrument internal settings optimized for the current level. Not required for automatic modes.

Remote command:
[:SOURce]:POWer:ALC:SONCe on page 521

6.7.6.2 Attenuator

Access:

► Select "SGMA-GUI > Instrument Name > RF > Level > Attenuator".

SGT: Level						— □ ×
RF Level	Attenuator	Power-On/EMF	ALC	UCOR	Power Servoing	

Mode	
	Auto

SATT Switch-Over Offset	
	0.0 dB

Level Range:	-19.01 dBm ...	0.99 dBm

RF OFF Mode	
	ATT = Max
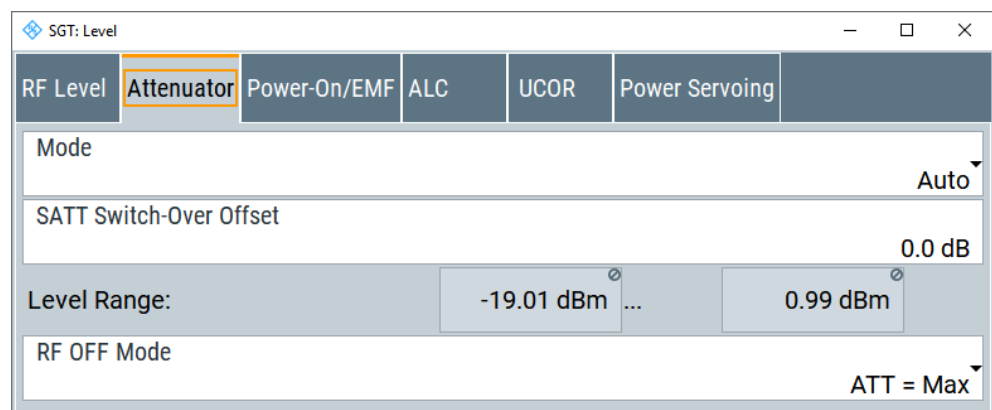
This dialog comprises the settings for the power-on behavior of the instrument.

Mode

Sets the attenuator mode at the RF output.

"Auto"   Standard mode.
The electronically switching attenuator switches with a ~ 6 dB step width at optimized switching points. The entire level range is available.
The level setting is performed by continuous electronic level control combined with switching the step attenuator.

"Fixed"	The level settings are made without switching the attenuator. When this operating mode is switched on, the attenuator is fixed in the current position to provide level settings without interruption. The resulting variation range is defined and displayed with the parameters Level Range.

Note: The function is effective when automatic level control is activated ("ALC State = On").
If the normal variation range is overranged or underranged, level errors increase considerably. The warning "Level under/overrange" appears in the info line.

The spectral purity of the output signal decreases with high attenuation.

"Auto Passive"	The attenuator is switched automatically. The level settings are made only for the passive reference circuits. The high-level ranges are not available.

Remote command:
:OUTPut:AMODe on page 373

SATT Switch-Over Offset
Sets the switch-over offset value of the attenuator.

Remote command:
[:SOURce]:POWer:ATTenuation:SOVer[:OFFSet] on page 522

Level Range
Displays the level range in which the level is set without interruption for the "Attenuator Mode Fixed" setting.

Remote command:
:OUTPut:AFIXed:RANGe:LOWer? on page 373
:OUTPut:AFIXed:RANGe:UPPer? on page 373

RF-Off-Mode
Determines the attenuator's state after the instrument is switched off.

In default setting, the electronic step attenuator switches to highest attenuation when RF is off. By setting the RF-Off mode, the electronic step attenuator can be fixed to keep the output impedance constant during RF off.

Remote command:
[:SOURce]:POWer:ATTenuation:RFOFf:MODE on page 522

6.7.6.3 Power-On settings

Access:

► Select "SGMA-GUI > Instrument Name > RF > Level > Power-On/EMF".
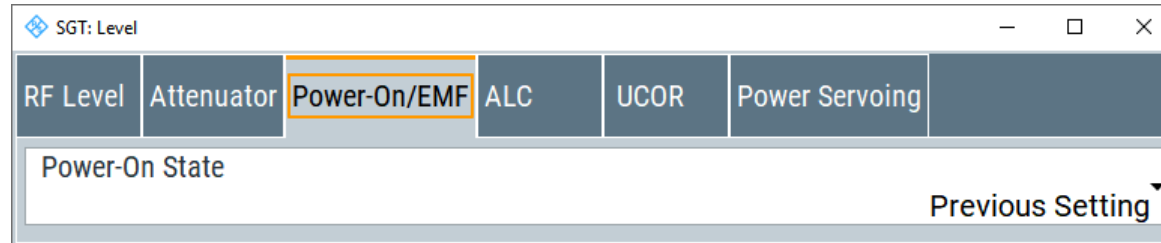
This dialog comprises the settings for the power-on behavior of the instrument.

Power-On State

Selects the state which the RF output takes after the instrument is switched on.

"RF Off"   The output is deactivated when the instrument is switched on.

"Previous Setting"

When the instrument is switched on, the output takes the same state as it had when the instrument was switched off.

Remote command:

:OUTPut[:STATe]:PON on page 374

6.7.6.4 ALC

Access:

► Select "SGMA-GUI > Instrument Name > RF > Level > ALC".
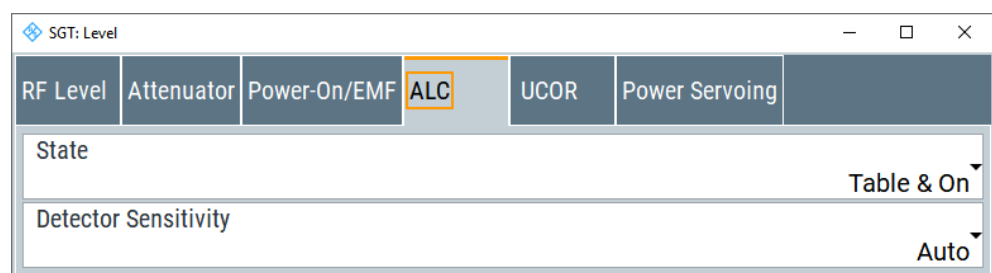
Automatic level control can be used with almost all applications, especially I/Q modulation. Deactivate the function for certain settings in the baseband and when I/Q impairments ("Impairments State On") are activated. Indication is visualized under the respective function.

By default, the instrument operates in "Table & On" mode to provide the highest level accuracy and fastest setting time. Level control can be switched to "Off (Table)" or "On" for particular applications. The "Off (Table)" state (level control Off) is recommended if in CW mode the signal/intermodulation ratio is to be improved for multi-transmitter measurements.

State

Sets the internal level control.

"Table & On"   Default mode.
                First sets the level to the target value using the internal level table. Then activates the level control circuit to achieve maximum level accuracy.

"On"   Internal level control is permanently activated.
                If "On" and "Attenuator Mode Fixed" is selected, the level is recalibrated for every level and frequency setting.

"Off (Table)"   Internal level control is performed according to the ALC table.

Remote command:
[:SOURce]:POWer:ALC[:STATe] on page 521

Detector Sensitivity

Allows you to fix the internal level detector. Use the Auto mode (default).

"Auto"   Automatic detector selection. Recommended mode of operation.

"Low"   Low sensitivity detector selected.
                This setting is intended for signals with high internal electronic levels.

"Med"   Medium sensitivity detector selected.
                This setting corresponds to normal mode. It is intended for signals with medium internal electronic levels.

"High"   High sensitivity detector selected.
                Selects the detector path with high sensitivity, intended for signals with low internal electronic levels.

"Fix"   Fixes the last set sensitivity setting.

Remote command:
[:SOURce]:POWer:ALC:DSENsitivity on page 521

6.7.6.5 User correction settings

Access:

► Select "SGMA-GUI > Instrument Name > RF > Level > UCOR".
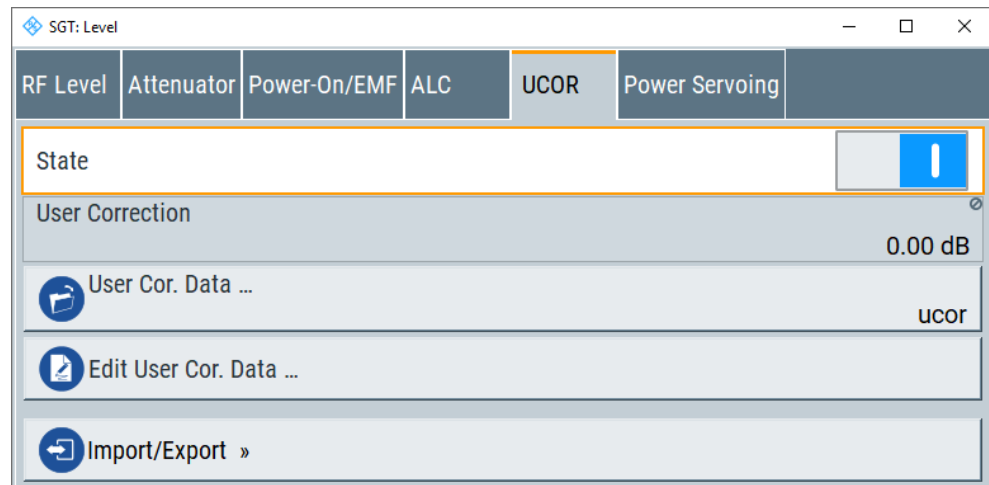
The "User Correction" function is used to create and activate lists in which level correction values predefined by the user are freely assigned to RF frequencies. Correction is performed by the user-defined table values being added to the output level for the respective RF frequency.

With frequencies which are not contained in the list, the level correction is determined by interpolation of the closest correction values.

The lists are created in the "List Editor". Each list is stored in its own file with the predefined file extension `*.uco`. The name of the "User Correction" file can be freely selected. The files are loaded from the "Lists..." file manager. Externally created tables with pairs of frequency and level values can be converted into "User Correction" files using the import function. The external files must have the file extension `*.txt` or `*.csv`. These file formats are provided, e.g., by the Microsoft Excel program. The separators for table columns and for decimal floating-point numerals can be set. In addition, internally created "User Correction" data can be exported into ASCII files using the export function.

If user correction is activated, the "UCOR" display ("User Correction") is shown in the header together with the "Level" display. The RF output level is the sum of both values.

"Level" + "UCOR" = Output level

If activated, user correction is effective in all operating modes.

State
Activates/deactivates user correction.

Remote command:
[:SOURce<hw>]:CORRection[:STATe] on page 477

User Correction
Indicates the current value for level correction.

Remote command:
[:SOURce<hw>]:CORRection:VALue? on page 477

User Cor. Data - User Correction

Calls the "File Select" menu for selecting and creating a list or the "File Manager".

```
Select List
New List
```
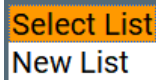
Remote command:

[:SOURce]:CORRection:CSET:DELete on page 472

[:SOURce<hw>]:CORRection:CSET[:SELect] on page 476

Edit User Cor. Data

Calls the editor for editing the selected user correction list.

A list consists of any number of frequency/level value pairs. The currently selected list is displayed.

Each list is saved as a separate file with extension *.uco. The file name and the directory to which the file is saved are user-selectable. For example, Figure 6-27 displays user correction data for the file ucor.uco.

Note: Save list only after filling both columns (frequency and level), otherwise the entries are lost.

Figure 6-27: User correction data for file ucor.uco

"Frequency /Hz"

Enters the frequency to which the level correction value applies.

Note: The "Fill..." function allows you to automatically enter any number of frequencies with freely selectable range and increment.

"Power/dB"   Enters the level correction value to which the specified frequency applies.

"Goto"   Selects row for editing.

Go To First
Go To Last
Go To Row...
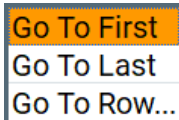
If "Goto Row" is selected, a window opens for entering the requested row.

Navigate
Go To Row
                    1
✓ OK   ✗ Cancel
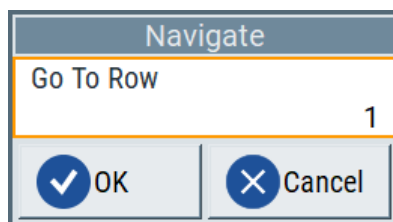
"Edit"   Calls a selection of possible actions described below.

Insert Row before 0
Insert Range...
Fill...
Delete Row 0
Delete Range...
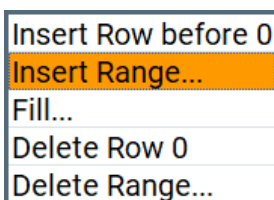
"Insert Range"   Insert new rows before the marked row. The number of rows to be inserted can be defined in an entry window.

Insert Range of Rows
Rows to Insert
                    1
✓ OK   ✗ Cancel
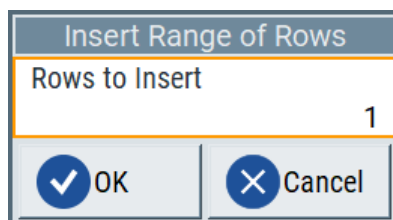
"Insert Row"   Insert a new row before the marked row.

"Fill...."   Opens a sub menu for defining a set of list values to be automatically entered in the ucor list, see Filling the correction list automatically).

"Fill with sensor..."

    Opens a dialog to configure the settings for automatic filling of user correction data with an R&S NRP power sensor, see Chapter 6.7.6.7, "Fill with sensor", on page 237.

"Delete Row"   Deletes the marked row.

"Delete Range..."

> Allows you to delete any number of rows starting with the marked row. The number of rows to be deleted can be defined in an entry window.

> Delete Range of Rows
> Rows to Delete
> 1
> ✓ OK   ✗ Cancel
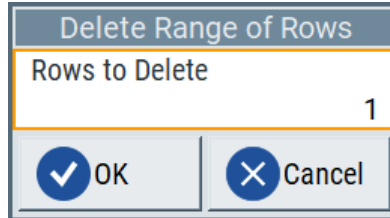
"Save as"   Open the file menu to save the list under a new name.

> **Note:** Save list only after filling both columns (frequency and level), otherwise the entries are lost.

> Each list is saved to the R&S SGT hard disk as a separate file with the file prefix `*.uco`. The file name and the directory to which the file is saved are user-selectable.

"Save"   The list is saved under its current name.

Remote command:
[:SOURce<hw>]:CORRection:CSET[:SELect] on page 476
[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency on page 470
[:SOURce<hw>]:CORRection:CSET:DATA:POWer on page 471

Import/Export >>>
Expands the menu with the area for import and export of user correction files.

Externally edited Excel tables with any number of frequency/level value pairs can be imported as text or `*.csv` files and used for user correction.

Conversely, you can also export internally created user correction lists as text or `*.csv` files.

Mode - User Correction
Selects if user correction lists are imported or exported. The settings offered depend on the selected mode.

Remote command:
[:SOURce<hw>]:CORRection:DEXChange:MODE on page 475

Extension
Selects the file extension of the ASCII file to be imported or exported. Selection "TXT" (text file) or "CSV" (Excel file) is available.

Remote command:
[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension on page 473

Decimal Point
Selects the decimal separator used in the ASCII data between '.' (decimal point) and ',' (comma) with floating-point numerals.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal
on page 474

Column Separator

Selects the separator between the frequency and level column of the ASCII table that the user correction list is exported to or imported from.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn
on page 474

Select ASCII Source/Destination

Calls the "File Manager" for selecting the ASCII file to be imported into a user correction list (source) or the ASCII file the user correction list is exported (destination) in.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect on page 473

Select Destination/Source

Calls the "File Manager" for selecting the user correction list to be exported (source) into an ASCII file or the destination for the ASCII file to be imported (destination) in.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:SELect on page 476

Import/Export

Starts the export or import of the selected file.

When import is selected, the ASCII file is imported as user correction list.

When export is selected, the user correction list is exported into the selected ASCII file.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:EXECute on page 475

6.7.6.6 Filling the correction list automatically

The "Fill Table" menu enables you to set the level correction values automatically.

The start line and the number of rows to be filled are defined under "From" and "Range".

The column to be filled is selected under "Select column to fill". Depending on the selection here, the default for start, end, and increment value are set. As the settings are interdependent, a change of one parameter can result in the automatic change of one or more of the other parameters. The filling of the column with the selected value settings is started with button "Fill".

ⓘ   The correction list entries are only computed when the "Fill" button is pressed.

From
Sets the start value of the index range.

Remote command:
n.a.

Range
Sets the range for filling the table.

Remote command:
n.a.

Select column to fill
Selects either the frequency or the level column to be filled with the value defined below.

Remote command:
n.a.

Start value
Sets the start value for the frequency or the level entries.

Remote command:
n.a.

End value
Displays the end value for the frequency or the level entries.

Remote command:
n.a.

Increment value
Sets the increment for the frequency or the level entries.

Remote command:
n.a.

Fill
Fills the selected column in the set range with values, starting with the start value and using the set increment.

Remote command:
n.a.

6.7.6.7 Fill with sensor

► To access this dialog, select "SGMA-GUI > Instrument Name > Level > UCOR > Edit User Cor. Data> Fill With Sensor".

This dialog describes all parameters for filling a table automatically with sensor readings.

ⓘ Since the settings are interdependent, the affected parameters change accordingly if you set a value.

To fill the table, press the "Execute" button.

To select the sensor and determine its parameters, refer to Chapter 6.7.7.2, "NRP power viewer", on page 245.

Fill User Correction Data with Sensor
- "Sensor"
  Displays connected sensors for selection.
- "List To Fill"
  Indicates the used list.
- "Include Zeroing"
  Performs a zeroing procedure before acquiring the user correction data to improve precision. Since during zeroing no signal can be applied to the sensor, RF is temporarily switched off at the generator.
  When unchecked, the zeroing procedure is skipped. However, the RF signal level can be blanked shortly. This setting is recommended 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 477
[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe
on page 472

Used Instrument Settings For Measurement
Displays the settings relevant for the measurement.

"Modulation"   Indicates the modulation state

"Amplitude"   Shows the currently set level.

"Use SParameter"
                          Indicates whether SParameter correction is used.

"Attenuator Mode"
                          Displays the selected mode of the attenuator.

"Fixed range (PEP) In"
                          Shows the level range.

Remote command:
n.a.

6.7.6.8 Power servoing

Access:

► Select "SGMA-GUI > Instrument Name > RF > Level > Power Servoing".

The tab provides settings to configure power servoing.

RF Level	Attenuator	Power-On/EMF	ALC	UCOR	Power Servoing	

Sensor	2 - NRQ6 S/N 900016
State	◻ **I**
Target	0.00 dBm
Offset (Gain)	-6.05 dB
Tolerance	0.10 dB
Sensor Aperture Time	100 µs
Sensor Bandwidth	25.000 000 MHz
Level Tracking (500 ms)	☐
Start	
	OK

About power servoing

Component tests are complicated by the fact that they can be defined as a function of the DUT output power, e.g. a power amplifier. To the test engineer, this dependency poses a problem because the DUT gain is not necessarily:

- Known beforehand
- Constant over the input power
- Constant over time or temperature

By using the R&S SGT / R&S NRQ6 power servoing and the high-speed remote control of the R&S SGT, setting the desired power typically takes 1 ms to 1.5 ms. The function is much faster than using a traditional SCPI based control loop.

To achieve short setting periods:

- The power sensor measures continuously and sends results using a dedicated serial connection to the signal generator - direct field-programmable gate array (FPGA) to FPGA communication, no SCPI overhead.
- The control algorithm runs on the signal generator - again, no SCPI overhead. The application only needs to set the desired level in one command.

Test setup

Required equipment:

- R&S SGT
- R&S NRQ6 power sensor with power servoing option R&S NRQ6-K2
- Computer equipped with the R&S SGMA-GUI software for control of the R&S SGT
- DUT

In Figure 6-28, the test setup also comprises an optional spectrum analyzer and a power splitter for additional power measurements. For more information, see the application sheet.
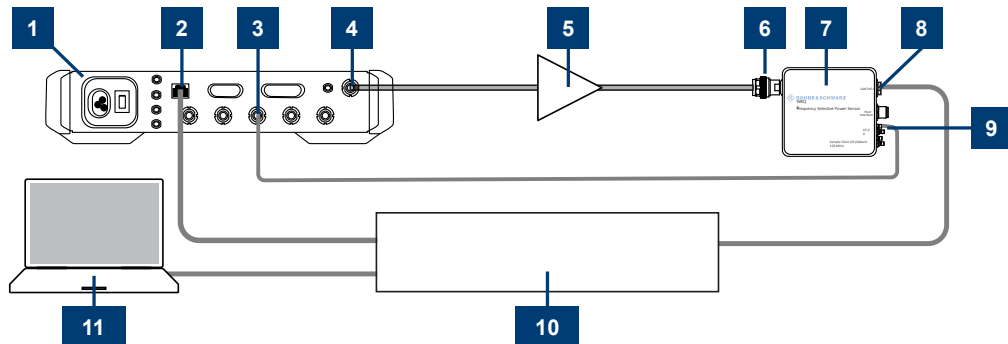
Figure 6-28: Test setup

1 = R&S SGT
2 = LAN interface
3 = USER 2 connector
4 = RF 50 Ω connector
5 = DUT
6 = RF connector
7 = R&S NRQ6 power sensor
8 = LAN PoE+ interface
9 = "TRIG2" connector at the power sensor
10 = Ethernet switch supporting PoE+ power delivery, for example.
11 = Computer

To prepare the R&S SGT for power servoing

1. Connect the instruments as in Figure 6-28.

2. Using the "NRP Sensor Mapping" dialog, detect the power sensor connected at the R&S SGT.
   See Chapter 6.7.7.3, "NRP sensor mapping", on page 253.

3. Activate the RF output, set "RF Off > RF On".

4. Configure power servoing at the R&S SGT:

   a) Open "SGMA-GUI > Instrument Name > RF > Level > Power Servoing".
   b) Select the connected "Sensor".
   c) Define "Target" and "Offset (Gain)", that is the desired output power level and the expected gain of the DUT.
   d) Set the "Sensor Aperture Time".
      The R&S SGT retrieves the "Sensor Bandwidth" automatically from the connected sensor.
   e) Optionally, enable "Level Tracking (500 ms)" to compensate droop effects.
   f) Activate power servoing by setting "Power Servoing > State > On".
   g) Start power servoing procedure by pressing "Start".

For more information, see the application sheet "R&S NRQ6 Power Servoing".

Settings

Sensor

Sets the power sensor from a list as detected in the "NRP Sensor Mapping" dialog.

If the list has only one entry, this power sensor is displayed automatically.

Remote command:

[:SOURce]:POWer:SERVoing:SENSor on page 524

State

Activates/deactivates power servoing.

Remote command:

[:SOURce]:POWer:SERVoing:STATe on page 525

Target

Sets the desired output power level required at the DUT.

Remote command:

[:SOURce]:POWer:SERVoing:TARGet on page 525

Offset / Offset (Gain)

Sets an RF level offset.

"Offset"   Sets an RF level offset.
                This offset value represents the level shift of a downstream instru-
                ment, as, for example, an attenuator or an amplifier, and is indicated
                in the status bar of the display. It does not change the level at the RF
                output.

"Offset (Gain)" For a power servoing test, sets the expected level offset, i.e. the gain
                of the DUT.
                After completion of a power servoing procedure this field shows the
                actual gain of the DUT. Setting the "Offset (Gain)" close to the true
                value of the DUT speeds up the procedure.
                The setting is also applied to the level offset configured in "Offset /
                Offset (Gain)" on page 225.

Remote command:

[:SOURce]:POWer[:LEVel][:IMMediate]:OFFSet on page 526

Tolerance

Sets the tolerance level interval, in which the "Target" output power level of the DUT lies.

A large tolerance accelerates the power servoing procedure but also reduces the accuracy of the target output power level.

Remote command:

[:SOURce]:POWer:SERVoing:TOLerance on page 525

Sensor Aperture Time

Sets the aperture time (size of the acquisition interval) of the power sensor during power servoing.

For periodic signals, set "Sensor Aperture Time" to multiples (twice or more) of the signal period.

Remote command:

[:SOURce]:POWer:SERVoing:SENSor:APERture on page 524

Sensor Bandwidth

Displays the measurement bandwidth of the set "Sensor".

The bandwidth is automatically retrieved from the detected sensor.

Remote command:
n.a.

Level Tracking (500 ms)

Activates/deactivates continuous level tracking.

Activate level tracking to compensate droop effects.

Remote command:

[:SOURce]:POWer:SERVoing:TRACking on page 526

Start

Triggers the start of the power servoing procedure.

The status is displayed below the "Start" button.

Remote command:

[:SOURce]:POWer:SERVoing:SET? on page 524

6.7.7 Using power sensors

The R&S SGT works with any of the R&S NRP power sensors and thus supports various application tasks. Using power sensors, you can for example determine attenuation characteristics of downstream equipment or cables. You can use the measured values to compensate the losses with internal control functions or with an external control circuit in real time.

R&S NRP power sensors are highly accurate standalone measuring devices, suitable for a wide range of applications. The power sensors communicate directly with the signal generator, calculate the average or peak power internally, include S-parameter correction and return the measurement results to the generator.

The R&S SGT supports up to four R&S NRP, allowing up to four power measurements simultaneously.

Check the firmware version of the R&S NRP sensors regularly. Update the firmware, if necessary.

For updates, see the Rohde & Schwarz website http://www.rohde-schwarz.com in section "Power Meters & Voltmeters".

6.7.7.1 Connecting R&S NRP power sensors to the R&S SGT

R&S NRP sensors are connected to the R&S SGT in the following ways:

- Connection to the USB IN connector

  Requires a USB Adapter Micro-A to A and the following cables, depending on the used sensor type:

  – R&S NRP-ZK6 and an R&S NRP-Z3 with external power supply for R&S NRPxx power sensors

  – R&S NRP-Z3 with external power supply for sensors of the R&S NRP-Zxx family

- Connection via R&S NRP-Z5 sensor hub, see Using the R&S NRP-Z5 sensor hub.
- Connection via USB hub with external power supply unit, see Using USB hub.
- Connection via LAN for R&S NRPxxxSN 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.

Using the 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.

Figure 6-29 illustrates the connection as principle. For details, see the description R&S®NRP®Series Power Sensors getting started.
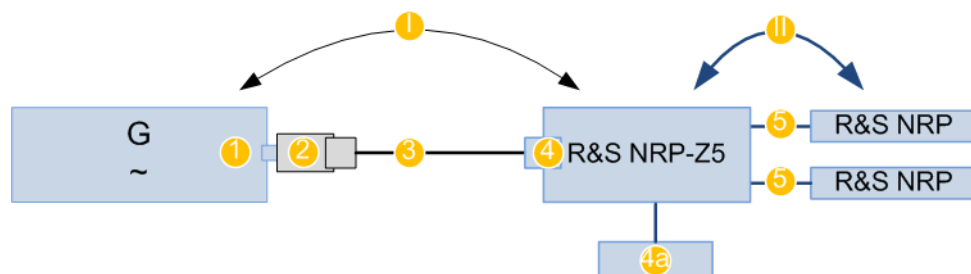
Figure 6-29: Connecting power sensors to the R&S SGT via R&S NRP-Z5 sensor hub

I, II = Connection order
G   = Signal source (R&S SGT)
1   = USB type Micro-A connector
2   = USB Adapter Micro-A to A
3   = Standard USB cable with USB type A and USB type B connectors
4   = USB type B connector
4a = External power supply unit, incl. power cable (supplied with the R&S NRP-Z5)
5   = Cable R&S NRP-ZK6 per sensor of the R&S NRPxx power sensor family; no further adapter cables for
       sensors of the R&S NRP-Zxx family

Using USB hub

Figure 6-30 illustrates the connection as principle. For details, see the description
R&S®NRP®Series Power Sensors getting started.
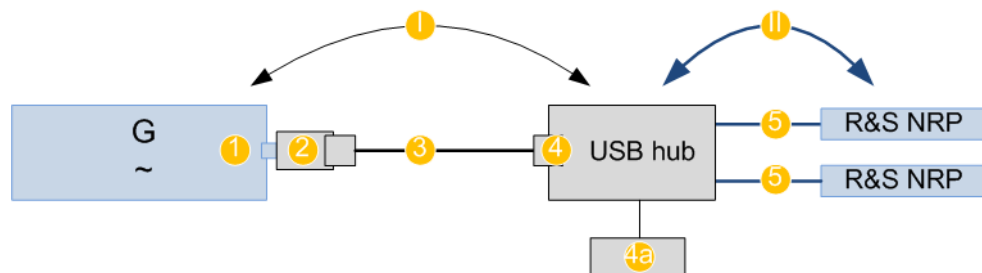
Figure 6-30: Connecting power sensors to the R&S SGT via USB hub

I, II = Connection order
G   = Signal source (R&S SGT)
1   = USB type Micro-A connector
2   = USB Adapter Micro-A to A
3   = Standard USB cable with USB type A and USB type B connectors
4   = USB type B connector
4a = External power supply unit and extra power cable
5   = Cable R&S NRP-ZKU per sensor of the R&S NRPxx power sensor family; R&S NRP-Z3 or R&S NRP-
       Z4 USB adapter cables for sensors of the R&S NRP-Zxx family

Connection order

Always connect the equipment in the following order:

1. Connect the R&S NRP-Z5 sensor hub or the USB hub to the power supply and to
    the R&S SGT

2. Switch on the R&S SGT

3. Connect/disconnect the R&S NRP sensors

Detection and mapping

The R&S SGT automatically detects a connected R&S NRP power sensor and indi-
cates it in the "NRP Power Viewer" and "NRP Sensor Mapping" dialogs.

You can change the default mapping, see Chapter 6.7.7.3, "NRP sensor mapping",
on page 253.

ⓘ On connection, the R&S SGT immediately starts the measurement of a detected R&S NRP power sensor. If you perform an instrument preset, the R&S SGT stops the measurements. The connection and the mapping of the power sensors remain, the measurements must be restarted.

6.7.7.2 NRP power viewer

The R&S SGT features the power viewer function for measuring or monitoring signals with R&S NRP power sensors.

About

The R&S SGT can perform up to four power measurements simultaneously.

The measured signals can be the RF output power or other selected signal sources.

Depending on the signal characteristic (CW, AM, pulsed, etc.) or the parameter to be measured (average, peak, etc.) a suitable R&S power sensor must be used.

About the measuring principle, averaging filter, filter length, and achieving stable results

A sensor measures the average or peak RF power of the source continuously. The measurement results are displayed in the "NRP Power Viewer" dialog.

The power viewer function uses **averaging filters** for getting a stable readout.

Measurement results could be interfered, for instance, by too much noise in your setup, by a bad suppression of harmonics or non-harmonics or when you reach the sensitivity level of your power sensor.

Measurements are continuously repeated in a predefined time window. The measurement result is obtained by averaging the measured values for the last 2N time windows. This approach is referred as a **two-step averaging process**.

The factor of 2 in the formula arises because the output signals from the microwave detector are chopped at the same rate as the time windows to suppress low-frequency noise. An independent measured value can only be obtained from two consecutive values.

The variable N in the formula indicates the **filter length**. The filter length then directly influences the measurement time. The filter length can be selected automatically or it can be manually set to a fixed value.

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:
  NRP power viewer settings
- Software version of the connected power sensor:
  `:SENSe<ch>[:POWer]:TYPE?` on page 389
- Acquisition of level correction data:
  Chapter 6.7.6.5, "User correction settings", on page 230.

Additional information

See the Rohde & Schwarz website http://www.rohde-schwarz.com, section "Power Meters & Voltmeters" for:

- R&S NRP power sensor manual.
- Information on the R&S NRP-Z5 sensor hub and the available accessories.
- Sensor software updates.

NRP power viewer settings

Access:

1. Select "Instrument" > "RF" > "NRP Power Viewer".

The "Overview" tab shows the list of detected sensors, and provides a separate tab per sensor.

2. Select a sensor tab.

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 10.13, "SENSe, READ, INITiate and SLISt subsystems", on page 375, including the triggering of the measurement and the retrieval of measurement results.

Settings:

Sensor type and serial number

The side tab label indicates type and serial number of an R&S NRP power sensor and its mapping index.

The Level (Peak) / Level (Average) values display the current readings of the sensor.

Remote command:

:SENSe<ch>[:POWer]:TYPE? on page 389

:SENSe<ch>[:POWer]:SNUMber? on page 387

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 381

:SENSe<ch>:UNIT[:POWer] on page 381

Sensor Mapping

Accesses the NRP sensor mapping dialog.

Sensor

Indicates the connector the sensor is connected to.

Sensor Settings

One tab per sensor provides the corresponding setting parameters.

State ← Sensor Settings

Enables level measurement of the R&S NRP power sensor.

Remote command:

:INITiate<hw>[:POWer]:CONTinuous on page 380

To query the availability of a sensor at a given connector, use the command :SENSe<ch>[:POWer]:STATus[:DEVice]? on page 388.

Zero ← Sensor Settings

Activates the auto zeroing.

For details, see "About zeroing" on page 246.

Remote command:

:SENSe<ch>[:POWer]:ZERO on page 389

Display ← Sensor Settings

Sets the display mode for power readings.

Permanent ← Display ← Sensor Settings
Activates the permanent indication of the power measurement result in the block diagram.

The task bar label shows the measurement result, the channel, the sensor is mapped to and its serial number. Optionally, "(Offset,Peak)" appear when you have set these parameters.

You can activate the permanent display for several sensors.

Remote command:
:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe on page 383

Display ← Display ← Sensor Settings
Sets the display of results on mean or peak power.

Remote command:
:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority on page 383

Source ← Sensor Settings
Selects the source for measurement.

"RF"   Assigns the signal to the RF path of the R&S SGT.
               The R&S SGT 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 SGT. 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 388

Frequency ← Sensor Settings
Defines the frequency value if "Source > User" is used.

Remote command:
:SENSe<ch>[:POWer]:FREQuency on page 386

Level Offset State,Level Offset ← Sensor Settings
Activates and defines a level offset which is considered in the power measurement result. The level offset value is always expressed in dB, irrespective of the display of the measurement result.

This function allows you to consider, for example, an attenuator in the signal path.

Remote command:
:SENSe<ch>[:POWer]:OFFSet on page 387
:SENSe<ch>[:POWer]:OFFSet:STATe on page 387

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 245.

"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 Content. 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 386

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 384
:SENSe<ch>[:POWer]:FILTer:LENGth[:USER] on page 384

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 245.

Remote command:
:SENSe<ch>[:POWer]:FILTer:SONCe on page 385

Noise Content ← Sensor Settings

For Filter > Fixed Noise, sets the noise content.

Remote command:
:SENSe<ch>[:POWer]:FILTer:NSRatio on page 385

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 385

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 382

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 382

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 383
`:SENSe<ch>[:POWer]:CORRection:SPDevice:LIST?` on page 383
`:SENSe<ch>[:POWer]:CORRection:SPDevice:SELect` on page 382

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 387

6.7.7.3 NRP sensor mapping

The "NRP Sensor Mapping" lists the sensors detected by the instrument.

Any R&S NRP sensor that supports the USB legacy protocol and is connected to one of the USB interfaces, is detected automatically and added to the list. When you disconnect a power sensor, the R&S SGT removes it from the list accordingly.

R&S NRP sensors that are connected in the LAN or use the USBTMC protocol are only detected by the scan search function.

Access:

► Select "Instrument" > "RF" > "NRP Sensor Mapping".

The dialog lists all detected R&S NRP sensors for selection and mapping. You can also browse the network for sensors.
The list informs on the sensor type with serial number, specific features and the revision of the sensor firmware.
For each sensor, you find the used protocol and the connector icon of the interface. In the "Mapping" column, you can assign a mapping index to enable the sensor for use. The list can contain several entries but the R&S SGT can only use up to four sensors simultaneously.

Settings

Sensor Mapping List

Shows the sensors that are connected to the R&S SGT.

The table informs on the sensor type, specific features and the installed sensor firmware. It also shows the interface the sensor is connected to, including the communication protocol and the mapping index.

Remote command:

:SLISt[:LIST]? on page 378

:SLISt:ELEMent<ch>:MAPPing on page 380

:SLISt:SENSor:MAP on page 380

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 378

Clear

Removes the selected sensor from the sensor mapping list.

Remote command:

:SLISt:CLEar:LAN on page 379

:SLISt:CLEar:USB on page 379

:SLISt:CLEar[:ALL] on page 380

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 SGT over USB or LAN.

Add LAN Sensor settings ← Add Sensor settings

Configures settings to add sensors connected to the R&S SGT over LAN.

"IP Address or Host Name"

Displays the host name or the IP address of a R&S NRP power sensor.
If the R&S SGT 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 378

Add USB Sensor settings ← **Add Sensor settings**
Configures settings to add sensors connected to the R&S SGT 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 SGT 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 SGT 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 379

6.7.8 Pulse modulation

This section explains the pulse modulation settings of the R&S SGT.

To configure and perform a pulse modulation, you need to select the modulation signal source and provide the corresponding settings.

Modulation signal sources

The R&S SGT provides the following signal sources for the signal modulation:

- **Internal**: A high-performance pulse generator, that allows you to generate either single or double pulse signals
- **Externally supplied signal:** the instrument expects the pulse modulation signals at the [TRIG] connector.

Pulse modulation signal waveforms

The high-performance pulse generator enables you to generate single or double pulse signals.
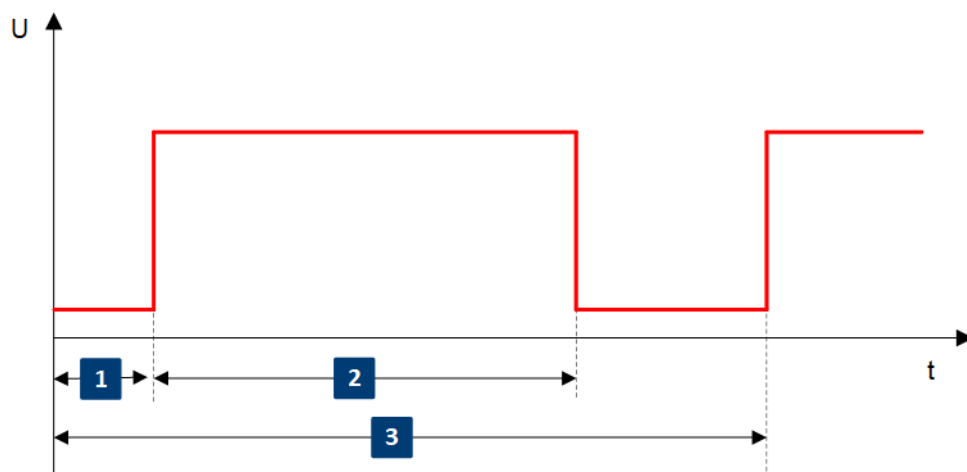
Figure 6-31: Pulse generator - single pulse mode

1 = Pulse period
2 = Pulse width
3 = Pulse delay
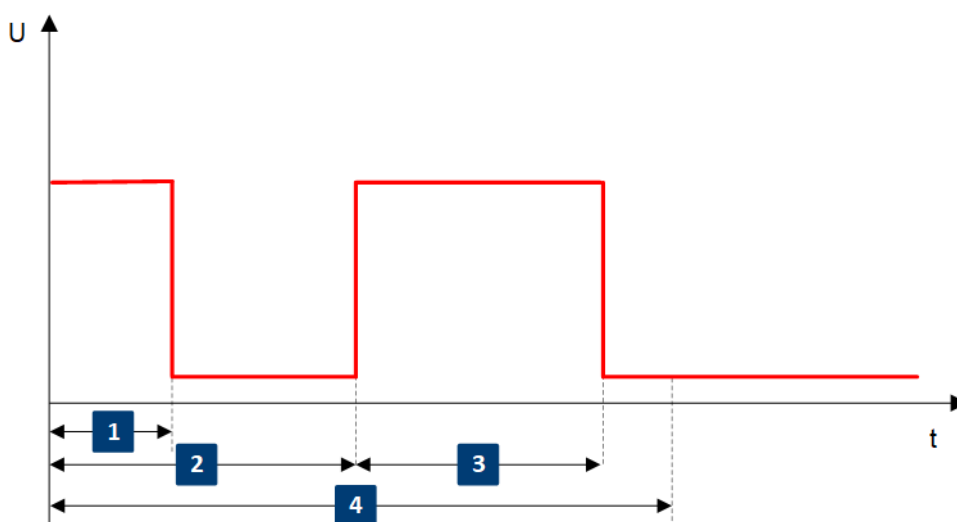
Figure 6-32: Pulse generator - double pulse mode

1 = Pulse period
2 = Pulse width
3 = Double pulse width
4 = Double pulse delay

6.7.8.1   Pulse modulation settings

► To access the pulse modulation settings, select "SGMA-GUI > Instrument Name >
RF > Pulse Modulation".
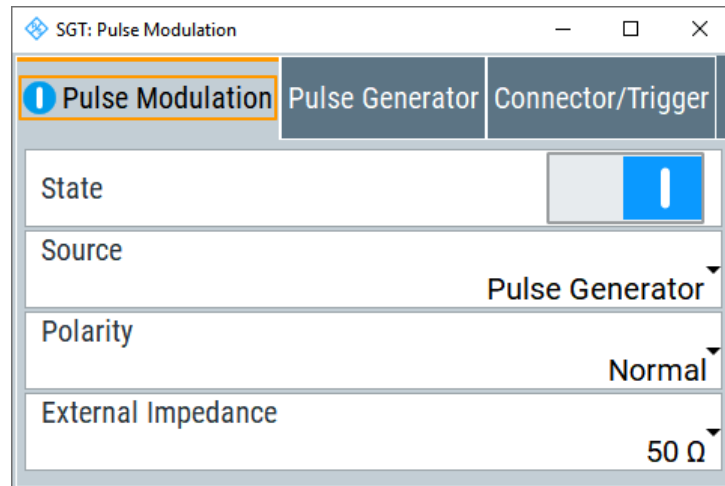
The "Pulse Modulation" dialog contains all parameters required to configure pulse
modulation and pulse signal generation.

State
Activates pulse modulation.

The R&S SGMA-GUI indicates an activated pulse modulation as follows:
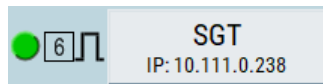
Remote command:
[:SOURce<hw>]:PULM:STATe on page 519

Source
Selects between the internal "Pulse Generator", or an "External" pulse signal for the
modulation. In the later case, the instrument expects the pulse modulation signals at
the [USER 2] connector.

Remote command:
[:SOURce<hw>]:PULM:SOURce on page 518

Polarity
Sets the polarity of the active slope of the modulation signal for "Source > External".

Remote command:
[:SOURce<hw>]:PULM:POLarity on page 518

External Impedance
Selects the input impedance for an external pulse modulation signal.

Remote command:
[:SOURce<hw>]:PULM:TRIGger:EXTernal:IMPedance on page 519

6.7.8.2 Pulse generator settings

► To access the pulse connector/trigger settings, select "SGMA-GUI > Instrument Name > RF > Pulse Modulation > Connector/Trigger".
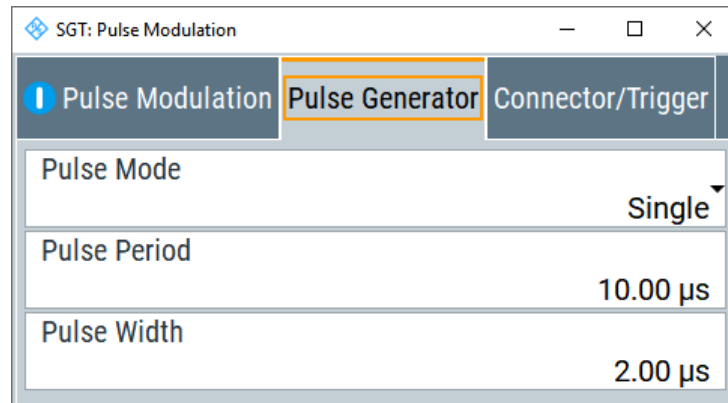
Comprises the settings necessary to configure the internal pulse modulation signal.

Pulse Mode
Sets the operating mode of the pulse generator.

"Single"   Generates a single pulse in one pulse period

"Double"   Generates two pulses in one pulse period.

Remote command:
[:SOURce<hw>]:PULM:MODE on page 517

Pulse Period
Sets the repetition rate of the generated pulse signal.

Remote command:
[:SOURce<hw>]:PULM:PERiod on page 518

Pulse Width
Sets the pulse duration of the generated pulse signal.

Remote command:
[:SOURce<hw>]:PULM:WIDTh on page 520

Double Pulse Width
Sets the width of the second pulse.

Remote command:
[:SOURce<hw>]:PULM:DOUBle:WIDTh on page 517

Double Pulse Delay
Sets the delay between the start of the first pulse and the start of the second pulse.

Remote command:

`[:SOURce<hw>]:PULM:DOUBle:DELay` on page 517

6.7.8.3 Pulse connector/trigger settings

► To access the pulse connector/trigger settings, select "SGMA-GUI > Instrument Name > RF> Pulse Modulation > Connector/Trigger".
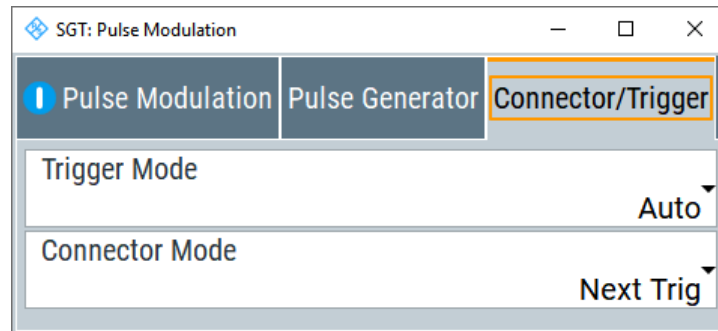
Comprises the settings necessary to configure the signal at the multi-purpose [TRIG] connector in the external trigger mode.

Mode

Selects the mode for the correspondent connector. Some settings are only available for connector "USER 2".

"Marker 1/2"   Output for a defined marker signal.

"Trigger/ Trigger Out"

Input/output for an external trigger signal.

"Clock In/Out"   Input/Output for a clock signal.

"Sync In/Out"   Input/Output for SYNC signals used for SYNC-Mode in baseband.

"Next Trigger"   Input next segment for triggering of multi-segment waveform files.

"Signal Valid"   Output of high signal to mark valid frequency and level settings.

"Not Signal Valid"

Output of high signal to mark the transition state when frequency and level change.

"Pulse Video Out"

Available only for "USER 2".
Output of the internally generated pulse video (modulating) signal.
The video signal level corresponds to the RF envelope.

"Pulse Gen Ext Trigger"

Available only for "USER 2".
Input for an external trigger signal, used to trigger the pulse generator.

"Pulse Mod Ext Source"

> Available only for "USER 2".
> Input for an externally provided pulse modulation signal.
> Used when an external pulse modulator source is provided at the connector.

Remote command:
:CONNector:USER<ch>:OMODe on page 359

Trigger Mode

Selects between continuous pulse modulation or pulse modulation triggered by an external signal.

"Auto"   Generates the modulation signal continuously.

"Ext Single"   Generates the signal each time an external trigger event occurs.

"Ext Gated"   Generates the signal triggered by an external gate signal.

Remote command:
[:SOURce<hw>]:PULM:TRIGger:MODE on page 520

Ext. Trigger Input Slope

Available only for "Trigger Mode > Ext Triggered"

Sets the polarity of the active slope of an applied external trigger signal.

Remote command:
[:SOURce<hw>]:PULM:TRIGger:EXTernal:SLOPe on page 519

Gate Input Polarity

Available only for "Trigger Mode > Ext Gated"

Sets the polarity of the active slope of an applied gate signal.

Remote command:
[:SOURce<hw>]:PULM:TRIGger:EXTernal:GATE:POLarity on page 519

6.8 Connectors

The "USER 1/2" connectors of the R&S SGT can be used for multiple purposes. In the "Connector" dialog, the correct mode for each connector can be set, and additional settings for some modes.

► To access this dialog select "SGMA-GUI > Instrument Name > Connectors"

Mode

Selects the mode for the correspondent connector. Some settings are only available for connector "USER 2".

"Marker 1/2" Output for a defined marker signal.

"Trigger/ Trigger Out"
Input/output for an external trigger signal.

"Clock In/Out" Input/Output for a clock signal.

"Sync In/Out" Input/Output for SYNC signals used for SYNC-Mode in baseband.

"Next Trigger" Input next segment for triggering of multi-segment waveform files.

"Signal Valid" Output of high signal to mark valid frequency and level settings.

"Not Signal Valid"
Output of high signal to mark the transition state when frequency and level change.

"Pulse Video Out"
Available only for "USER 2".
Output of the internally generated pulse video (modulating) signal.
The video signal level corresponds to the RF envelope.

"Pulse Gen Ext Trigger"
Available only for "USER 2".
Input for an external trigger signal, used to trigger the pulse generator.

"Pulse Mod Ext Source"

Available only for "USER 2".

Input for an externally provided pulse modulation signal.

Used when an external pulse modulator source is provided at the connector.

Remote command:

:CONNector:USER<ch>:OMODe on page 359

Trigger Slope

Sets the polarity of the active slope of the externally applied signal.

Remote command:

:CONNector:USER<ch>:TRIGger:SLOPe on page 360

Clock Slope

Sets the polarity of the active slope of the externally applied signal.

Remote command:

:CONNector:USER<ch>:CLOCk:SLOPe on page 360

Impedance

Selects the input impedance for the modulation signal.

Remote command:

:CONNector:USER<ch>:TRIGger:IMPedance on page 360

:CONNector:USER<ch>:CLOCk:IMPedance on page 360

Threshold

Sets the high/low threshold of the signal.

Remote command:

:CONNector:USER<ch>:THReshold on page 360

6.9 External baseband signal - baseband input

The R&S SGT makes it possible to feed an external digital baseband signal into the signal path.

User-specific wanted signals or interference signals can be frequency and offset shifted, detuned or loaded with noise (see Chapter 6.2, "Additive white Gaussian noise (AWGN) - noise generator", on page 141).

The R&S SGT is equipped with the [DIGITAL IQ IN] interface at the rear of the instrument as input connector for the external digital signal.

This interface provides direct communication with other R&S instruments.

The Chapter 6.9.2, "BB input block", on page 264 describes the settings for configuring an input signal.

6.9.1　Important signal parameters

The correct signal processing of input signals in the instrument requires information of some signal parameters. Among these parameters are sampling rate, crest factor and signal level, that is expressed as peak or as RMS level value.

- **Sample rate**
  The sample rate of the input signal can be defined manually or automatically retrieved from the input signal.

- **Crest factor**
  Test setups can require feeding of external signal to the digital/analog input of the R&S SGT. If you want to transfer an I/Q signal between two instruments, make sure that the crest factors match. At the source instrument, transfer an output signal with a crest factor that matches with the crest factor at the input interfaces of the receiving instrument.
  The crest factor gives the difference in level between the peak level and RMS level value in dB. The R&S SGT uses the crest factor value for the calculation of power levels. The general principle is, that the R&S SGT compensates the RMS levels of the externally supplied signal by the crest factor.
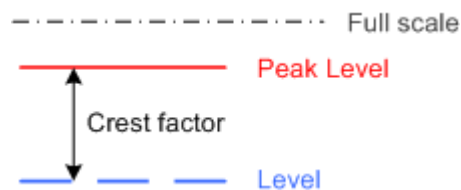
Figure 6-33: Relation between the level settings

In the instrument, level values are represented relative to the full scale.

Fulfilling the prerequisites for a correct signal processing of the externally supplied baseband signal

In the instrument, the **crest factor, peak level and RMS level** values can be adjusted in one of the following ways:

- Adjusted manually
  If you know these values, it is best to enter them directly (see Crest Factor)

- Estimated automatically by the internal measurement function
  Use the function Auto Level Set to trigger the R&S SGT to measure the input signal, estimate the peak level and RMS level and calculate the crest factor out of them.
  Tip: For accurate level measurements, set the measurement period to a time value that is long enough to capture several periods of the input signal.

- Determined automatically (digital baseband input only)
  The R&S SGT 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 RMS level of the signal over the digital input interface. To enable the R&S SGT to receive these values, trigger the DIG IQ Auto Setting function.

In the two automatic ways, the R&S SGT 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 shown in Figure 6-34.
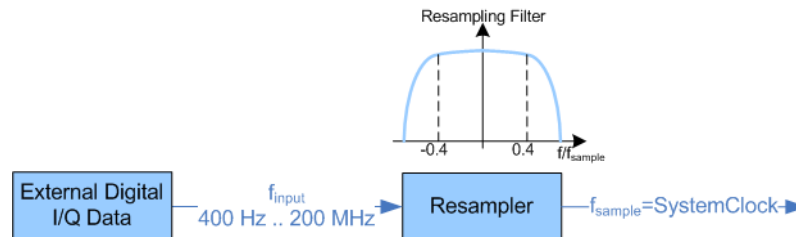
Figure 6-34: Resampling of external digital baseband signals

The R&S SGT can process digital signals with sample rate from 400 Hz to 200 MHz, whereas the internal signal processing is based on a sample rate with 300 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:

   – 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.

   – Estimated sample rate
   Enable the instrument to evaluate the received I/Q data clock

Maximum modulation bandwidth

● A baseband signal with a sample rate that is smaller than the used system clock is interpolated (see Figure 6-34). The resulting modulation bandwidth is calculated as *Sample Rate * 0.8*, i.e. with a sample rate of exactly 200 MHz, the modulation bandwidth is 160 MHz.

6.9.2 BB input block

The settings for signal routing, frequency offset and phase offset are available in the "BB Input" function block.
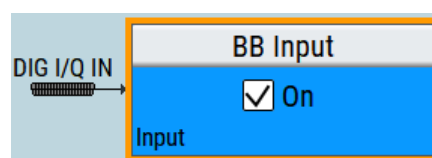
The external baseband signal is activated by switching on in the "Baseband Input Settings" dialog and by ticking the checkbox of the "BB Input" function block.

6.9.2.1 Baseband input settings menu

This dialog comprises the settings necessary to adjust the signal parameters, like the sample rate, the baseband input level and to perform simple signal monitoring.

Baseband input general settings

► To access this dialog, select "SGMA-GUI > Instrument Name > BB Input > Digital BB In >General".
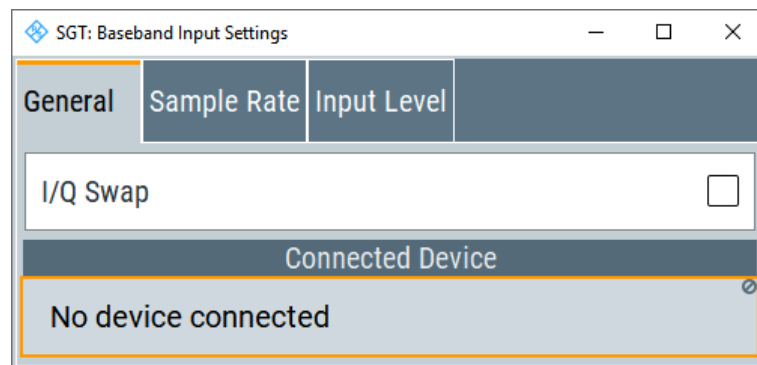
In this section, you can activate the baseband input and get information about the connected devices.

State
Switches On/Off the feeding of an external digital signal into the signal path.

"On"   Switches On the external I/Q input signal of the "BB In" block. The input symbol displays the active signal mode.

"Off"   Switches Off the external I/Q input signal.

Remote command:
[:SOURce<hw>]:BBIN:STATe on page 462

I/Q-Swap
Activates swapping of the I and Q signal components, which mirrors the spectrum at the f=0 line and inverts the sign of the frequency.

Remote command:
[:SOURce<hw>]:BBIN:IQSWap[:STATe] on page 457

Connected Device
Indicates the ID of a connected R&S Instrument or R&S device.

If supported by the transmitter, also the transmitter sample rate is shown.

Note: The connected instrument is indicated only, if the connection is properly established and signal transmission is active.

Remote command:
[:SOURce<hw>]:BBIN:CDEVice? on page 456

Sample rate

► To access this dialog, select "SGMA-GUI > Instrument Name > BB Input > Digital BB In > Sample Rate".
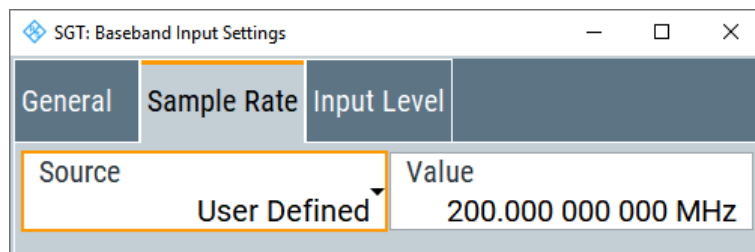
In this section, you can set the sample rate of the external digital baseband signal.

Sample Rate Source

Selects the source for estimating the sample rate or defining it by the user.

"User Defined"　　Enables the user to define the sample rate in the entry field value.

"Digital I/Q In"　　Estimates the sample rate on the digital I/Q input and displays the value in the value field.
Note: Estimation works best if the sample rate is close to the user-defined value.

Remote command:

[:SOURce<hw>]:BBIN:SRATe:SOURce on page 461

Sample Rate Value

Sets the sample rate of the external digital baseband input signal.

Remote command:

[:SOURce<hw>]:BBIN:SRATe[:ACTual] on page 461

Baseband input level

► To access this dialog, select "SGMA-GUI > Instrument Name > BB Input > Digital BB In > Sample Rate".
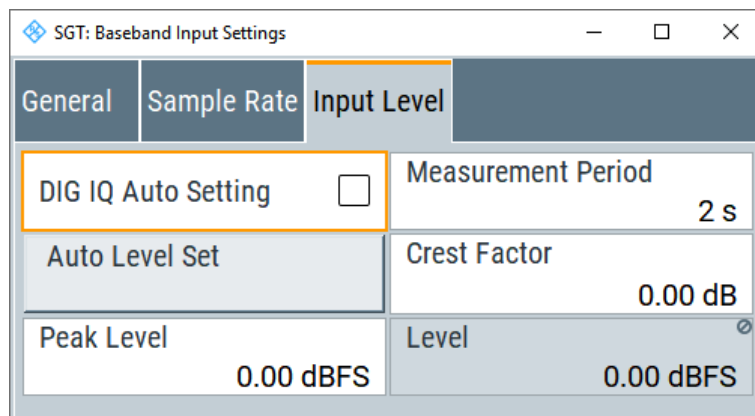
The crest factor and the peak power of the external baseband signal are entered in the section "Baseband Input Level". These values are necessary for a correct internal signal processing in the R&S SGT. They can also be automatically estimated by a measurement using the "Auto Level Set" button.

DIG IQ Auto Setting
Activates automatic adjustment of the baseband input signal.

The R&S SGT 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 456

Measurement Period
Sets the recording duration for measuring the baseband input signal by "Auto Level Set". 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 458

Auto Level Set
Starts measuring the input signal. The measurement estimates the crest factor, the peak power and the rms power. The estimated values are automatically entered into the input fields "Crest Factor", "Peak Level" and "Level". Using these estimated values the internal gain control adjusts the input signal gain to achieve an optimal dynamic range.

Remote command:
[:SOURce<hw>]:BBIN:ALEVel:EXECute on page 455

Crest Factor
Sets the crest factor of the external analog or digital baseband signal. Indicates the crest factor acquired with "Auto Level Set".

Remote command:
[:SOURce<hw>]:BBIN:CFACtor on page 456

Peak Level
Enters the peak level of the external digital baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

Indicates the peak level acquired with "Auto Level Set".

Remote command:
[:SOURce<hw>]:BBIN:POWer:PEAK on page 460

Level
Indicates the estimated rms level acquired with "Auto Level Set".

Remote command:
[:SOURce<hw>]:BBIN:POWer:RMS? on page 460

Signal monitoring

The section "Signal Monitoring" indicates an overload.

Overflow

Indicates that the I/Q input is overloaded.

If overload is indicated, either the amplitude of the external signal is too high (full scale of 0.5 V) and must be reduced or the entered "Peak Level" (in dB full scale) value does not correspond with the real value and must be corrected. It also can be evaluated automatically with button "Auto Level Set".

Remote command:
[:SOURce<hw>]:BBIN:OLOad:STATe? on page 459

Overflow Hold

Indicates an overload since last reset for evaluating the measurement.

The Overload Hold state can be reset via the "Reset" button next to the LED, or is reset automatically by starting a new measurement ("Auto Level Set") or by setting new values (Crest Factor, Peak Level, Level).

Remote command:
[:SOURce<hw>]:BBIN:OLOad:HOLD:STATe? on page 459

Reset

Executes a reset of the "Overflow Hold" state.

Remote command:
[:SOURce<hw>]:BBIN:OLOad:HOLD:STATe? on page 459

6.9.2.2 BB in offset

► To access this dialog, select "SGMA-GUI > Instrument Name >BB Input/Output > Frequency/Phase Offsets".
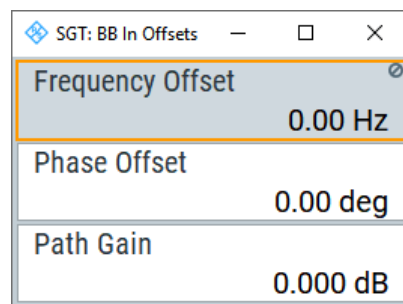
A frequency and phase offset can be set in this dialog.

Frequency Offset

Enters the frequency offset for the external baseband signal and shifts the useful baseband signal in the center frequency.

Remote command:

[:SOURce<hw>]:BBIN:FOFFset on page 456

Phase Offset

Enters the phase offset for the external baseband signal. The offset affects the signal on the output of the "Baseband In/Out" block.

Remote command:

n.a.

7 General instrument settings and instrument setup

This section describes the general settings of the instrument that do not directly affect signal generation.

Access:

1. Select "SGMA-GUI > Instrument Name > Setup".

2. Select the required dialog.

Setup	▶	Internal Adjustments...
Diagnostic / Test	▶	Hardware Config...
Service	▶	Software / Options...
		Manage Licenses...
		NRP Info...
		Protection...
		Security...
		Maintenance...
		Network Settings...
		Remote...
		LXI Status...
		Emulations...
		Date & Time...
		Factory Preset...

Settings:

7.1 Internal adjustments

Access:

► Select "Setup > Internal Adjustments".

The dialog provides settings for internal adjustments of the R&S SGT.

All internal adjustments for which no external measuring equipment is needed can be started in the "Internal Adjustments" dialog. The adjustments with external measuring equipment are described in the service manual.

Deciding whether to run internal adjustments

1. Select "Setup > Internal Adjustments".

2. Observe the status and color indication in the section "Since Last Full Adjustment".

    Green: Internal adjustments are not required.
    Red: Internal adjustments are required. Observe also the indication in the "Information" field.

3. We recommend you to run internal adjustments in the following cases:
    ● Before starting any application that requires a maximum of level accuracy and frequency accuracy
    ● When a long period of time has passed since the last adjustments
    ● If the ambient temperature of the instrument significantly differs from the one of the last adjustments

4. Proceed as described in

Running internal adjustments

1. **NOTICE!** Adjustments can be invalid if performed when the instrument is not warmed-up.

Wait until the instrument has reached its operating temperature before you start the adjustment procedure.

The warm-up time is up to 30 minutes.

2. Select "Setup > Internal Adjustment > Adjust All".

   The adjustment process starts.

3. Do not interrupt the adjustment process.
   The extent of the adjustments depends on the installed options. It can last up to 2 hours.

   A progress indicator shows the status of the adjustment process. If errors occur the process aborts. An error message appears in the "Info" line.

Settings

Adjust All

Starts all internal adjustments for which no external measuring equipment is needed. The adjustments with external measuring equipment are described in the service manual.

Remote command:
:CALibration:ALL[:MEASure]? on page 355

Adjust I/Q Modulator at Current Frequency

Starts the adjustment for the I/Q modulator for the currently set frequency. The I/Q modulator is adjusted regarding carrier leakage, I/Q imbalance and quadrature.

The adjustment is only possible when "RF > On" and "I/Q Mod > State > On".

Adjustment for only the set frequency is considerably faster than adjustment across the entire frequency range. An adjustment of the entire range is possible with the I/Q Modulator button of this dialog.

Remote command:
:CALibration:IQModulator:LOCal? on page 356

Synthesis

Performs all adjustments which affect the frequency.

Remote command:
:CALibration:FREQuency[:MEASure]? on page 355

Level

Performs all adjustments which affect the level. The acquired correction values improve the settling time and the signal quality.

Remote command:
`:CALibration:LEVel[:MEASure]?` on page 356

I/Q Modulator

Starts the adjustment procedure for the I/Q modulator and/or the baseband for the entire frequency range. The I/Q modulator is adjusted regarding carrier leakage, I/Q imbalance and quadrature.

To accelerate the adjustment procedure, you can enable performing adjustments for the I/Q modulator and the baseband separately.

Remote command:
`:CALibration:IQModulator:FULL?` on page 356

I/Q Modulator ← I/Q Modulator

Acitvates/deactivates a separate internal adjustment procedure for the I/Q modulator.

Remote command:
`:CALibration:IQModulator:IQModulator[:STATe]` on page 356

Baseband ← I/Q Modulator

Acitvates/deactivates a separate internal adjustment procedure for the baseband.

Remote command:
`:CALibration:IQModulator:BBANd[:STATe]` on page 355

7.2 Hardware configuration

Querying information about the installed assemblies

► Select "SGMA-GUI > Instrument Name > Setup > Hardware Config".

In the "Hardware Config" dialog, the installed assemblies together with their variants and revision states can be displayed for servicing purposes.

The dialog is a table that lists the installed assemblies. It is divided into the sections:

● "Common Assembly"
● "RF Assembly"

Settings:

Assembly

The tables list the installed assemblies.

"Assembly"   Name of the assembly

"Part Number"   Part number of the assembly

"Serial Number"

              Serial number of the assembly

"Revision"   Revision state of assembly

Remote command:
R&S SGT: n.a.

7.3 Software and hardware options

To check the software packages and installed options

► Select "SGMA-GUI > Instrument Name > Setup > Software/Options".

The "Software / Options" dialog shows the firmware version of the instrument software and all installed hardware and software options.

The dialog is divided into the following sections:
- "Firmware"
- "Hardware"
- "Software"
- "WinIQSIM"
- "Loaded Modules"

Software options purchased at a later stage can be activated with a keycode. The activation code is supplied with the software option. An instruction on how to install options is described in the service manual. You can install most hardware options at an authorized Rohde & Schwarz service center.

Settings:

Software

Shows the software/firmware version and the version of the software platform.

Note: Your instrument is delivered with the latest firmware version available. Firmware updates and the release notes are provided on the Internet at the download site of the instrument's home page. This home page always offers the latest information on your instrument, e.g. also on changes of the firmware update procedure.

Hardware / Software / WinIQSIM

The tables in the sections "Hardware" and "Software" list the installed hardware and software options.

"Option"	Short name of the option
"Designation"	Name of the option
"Licenses"	Number of licenses
"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.

Loaded Modules

Section "Loaded Modules" is provided for service purposes. It lists all loaded software modules with their versions and offers a short description of each module.

Show Open Source Acknowledgments

Accesses the list of the used open-source software packages and the corresponding verbatim license texts.

For R&S SGMA-GUI, the list shows the open-source acknowledgement for software with Windows® operating system.

For R&S SGU/SGS/SGT, the list shows the open-source acknowledgement for software with Linux® operating system.

LucasFonts RSCorpid EULA

Accesses copyright information on LucasFonts font type RSCorpid EULA.

7.4 Manage license keys

The dialog comprises settings for enabling newly purchased and/or newly registered options. You can also execute instrument-related steps during the process of unregistration and/or moving of licenses.

An option is ready to operate after it is enabled by a license key code 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.
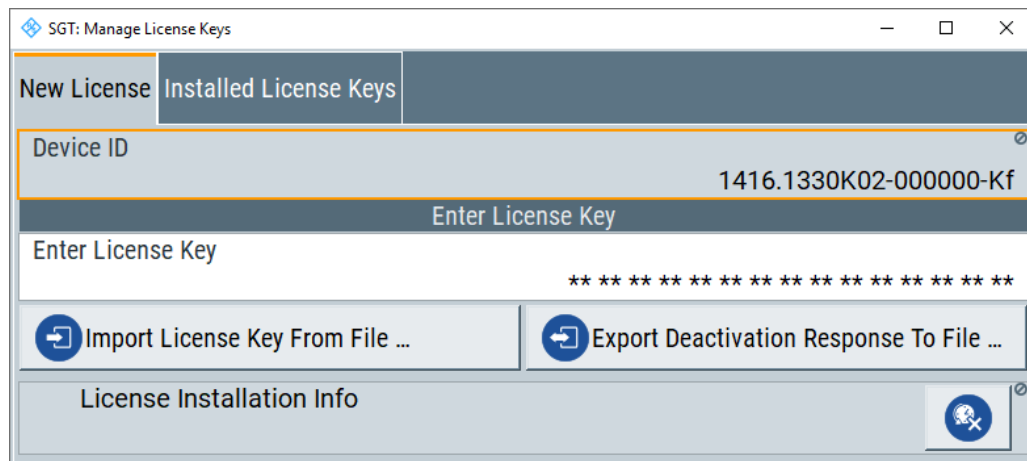
ℹ️ **License registration**

If your purchased license is delivered unregistered, you must register it before you can activate the option.

For detailed information about the license registration, refer to the installation instructions provided with the option (Supplement A) and the documentation of the online tool "Manage Licenses" (https://extranet.rohde-schwarz.com/service).

ℹ️ Only if the R&S SGT is equipped with an older firmware version, a firmware update before enabling the software option can be required. The information on the valid firmware versions for the purchased software option is provided together with the option.

Example: Moving 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 instrument and the browser.

ℹ️ We assume knowledge about the handling of the R&S License Manager online tool and the description of the whole process.

1. In your browser, open 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 "Setup > Manage License Keys > Device ID".

Device ID

1416.1330K02-000000

b) On the target instrument, select "Setup > Manage License Keys > Device ID".
c) In the browser, select "Manage Licenses > Move Portable License > Select Devices".
d) Enter the device IDs.

3. On the source instrument, select "Setup > Manage License Keys > Installed License Keys table".
Navigate to the portable license that you want to move and click the "Export License to File" column, e.g. R&S SGT-K540.

A standard file manager dialog opens. Enter a user-specific filename and save the exported license key, e.g. `k540_portable_key_to_move.xml`.

SGT-100004: Manage License Keys

New License   **Installed License Keys**

Show Inactive ☑   Show Deactivated ☑   Manage Waveform Packages …

	Export License Key To File	Option	License Count	License Type
1	0797554642158004266407919457783…	SGT-KB106	1	Permanent
2	4116932595382310568622655668911…	SGT-K200	50	Quantified (free 32)
3	2785565290007815812829204331821…	SGT-K510	1	Permanent

4. In the browser, select "Manage Licenses > Move Portable License > Select License (from file)".

5. Select the exported license key.

6. Check "Show Deactivated", to create the deactivation key.

7. Save the deactivation key to a file.

8. On the source instrument, select "Setup > Manage License Keys > Import License Keys from File".

9. Select the transferred deactivation key.

10. On the source instrument, select "Manage License Keys > Export Deactivation Response to File".

The instrument confirms the deactivation of the option. The deactivation key response is exported under the selected name, e.g.
`K540_portable_decat.txt`.

11. In the browser, go the step "Manage Licenses > Move Portable License > Install Deactivation Key (from file)".

12. Enter the deactivation response of the instrument.

   The license is deactivated for the source instrument.

13. In the section "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.

14. In the target instrument, select "Setup > Manage License Keys > Import License Keys from File".

15. Select the created license key file.

   The portable option is installed on the target instrument.

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 Moving 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.

In case the unregistered option is a portable one, it can be afterwards registered at another instrument (see Moving a portable license).

Status Information
Displays status information.

Show Inactive Licenses

Enables/disables the display of the inactive (expire) licenses in the License Table.

Show Deactivated Licenses

Enables/disables the display of the deactivated licenses in the License Table.

See Moving a portable license for information on how to activate deactivated licenses.

Manage Waveform Packages

Opens the "Manages Waveform Packages" dialog.

Waveform package licenses are provided for the registration of waveforms. The licenses enable the instrument to play registered waveform files generated with the software R&S WinIQSIM2. You do not need to equip the R&S SGT with the corresponding software option R&S SGT-Kxy/-K2xy.

One waveform packages license per waveform is required. Once registered license cannot be moved to another instrument.

Note: One waveform package license per segment is required for the registration of a multi-segment waveform.

"Number of Licenses/Waveforms"

Displays the number of the available and used R&S SGT-K200 licenses.

"Select Waveform"

Opens standard dialog to select the waveform to be registered.

"License Table"

Gives an overview of the registered waveforms, the registration date and the number of used licenses.

Register Selected Waveform

Registers the selected waveform to the instrument.

License Table

Provides information about the currently installed options.

"Export License Key to File"

Opens dialog to save the generated license key file. This file is required during the unregistration process. In case the unregistered option is a portable one, it can be afterwards registered at another instrument (see Moving a portable license).

"Option"   Displays the option short designation.
                    Tip: Open the Chapter 7.3, "Software and hardware options",
                    on page 275 dialog to retrieve more information about the installed options.

"License Count"

Displays the number of the licenses for the selected option key.

"License Type"   Display the type of license.
A license type is a joint qualification for the duration of applicability and the portability of a license. The following license types are provided: evaluation, permanent, portable, quantified, timed with duration of 1, 3, 6 or 12 months. A license can also be in the states deactivated and expired.
For time-limited licenses, the left time of applicability is displayed too.

"Registrations"   Opens the "Waveform Packages License" dialog (see Manage Waveform Packages).

7.5 Protection

The "Protection" dialog provides access to the unlocking of protected service functions (authorized personnel of R&S service departments only).

Unlocking protected service functions

1. Select "SGMA-GUI main panel > Instrument Name > Setup > Protection".

    The "Protection" dialog provides access to the unlocking of protected service functions (authorized personnel of R&S service departments only).

2. To deactivate the protection, enter the correct password. After booting the instrument, protection levels 1 to 4 are active.
    Enter "Protection Level 1 > Password > 123456".

    Protection Level 1 is activated.
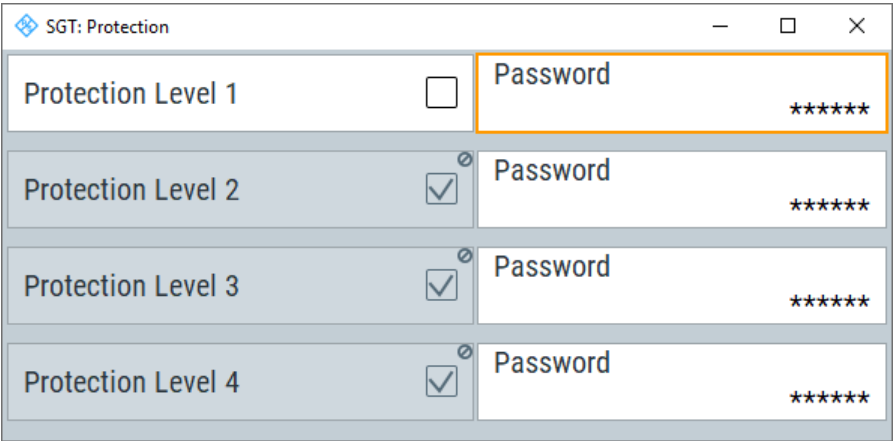
Settings:

Protection Level / Password
"Protection Level 1" can be activated to expand the functionality of the internal adjustment. The password is 123456.

The other protection levels 2 to 4 provide access to protected service functions. Only the authorized personnel of R&S service departments can access these functions.

7.6 Security

The R&S SGT employs a security concept based on a user password and the security password. Use the security password to configure critical settings, like performing firmware updates.

The "Security" dialog provides settings to configure the following security settings:

- Accessing connected USB storage devices.
- Saving information on the internal memory.
- Enabling or disabling the LAN interface.
- Managing the user password and security password.

Access:

1. Select "SGMA-GUI" > "<Instrument name>" > "Setup" > "Security".

2. Select "General".

General	ⓘ LAN Services	Password Management	
		Disk & Memory	
USB Storage *is Enabled*			☑
Volatile Mode			☐
Security Password			✓ Accept
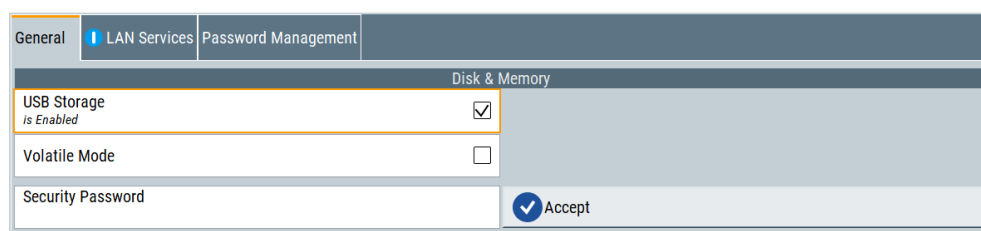
The "General" tab covers security functions to protect the instrument from unauthorized access to USB storage devices. The volatile mode prevents writing information permanently to the internal memory of the instrument.

3. Select "LAN Services".

General	ⓘ LAN Services	Password Management	
LAN Interface			▮
Security Password			✓ Accept
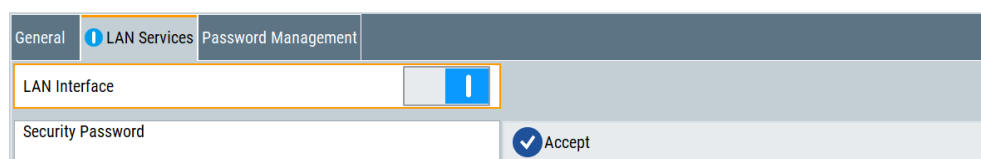
In the "LAN Services" tab, you can disable the LAN interface, see

4. Select "Password Management".
   The functions in this tab provide secure 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.

a) To configure the user-defined password, select the "User Password" side-tab.

b) To configure the security password, select "Security Pasword".

Disabling the LAN interface

Remote control over LAN requires that you have enabled the LAN interface.

1. Select "LAN Services".

2. **NOTICE!** Risk of loosing access over LAN. Disabling the LAN interface locks the remote access to the instrument.

   If needed, disable the LAN interface. Do not disable the interface while you operate the R&S SGT remotely.

3. To confirm disabling, proceed as follows:

   a) Enter the security password.
   b) Select "Accept".

   If disabled, the connection state of the R&S SGT is gray on the main panel of R&S SGMA-GUI, see "Instrument/Connection State" on page 67. Also, on the front panel of the R&S SGT, the LAN LED is gray.
   Proceed with the following steps for troubleshooting a disabled LAN interface.

4. To reestablish a remote control connection, you can use a USB connection between R&S SGT and the host PC, see Chapter 3.1.13.4, "Connecting a controller via USB", on page 31.

5. If you have locked the access accidentally, you have the following options:
   - Update the instrument firmware using ISO image
     (`<instrument>_<version-number>.iso`).
     Note: A firmware update with the ISO image resets the instrument. The instrument reset dismisses user-specific configurations and deletes user data. Contact the Rohde & Schwarz (https://www.rohde-schwarz.com/support) to get the ISO image.
   - Ship the instrument to your local service department. The service center experts can enable the remote access over LAN without loosing user-specific settings and data.
     See http://www.services.rohde-schwarz.com.

The remote commands required to define these settings are described in Chapter 10.16, "SYSTem subsystem", on page 533.

Settings:

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.

Note: All modified settings in this dialog are not applied until you enter the Security Password and confirm with Accept.

USB Storage ← General

Enables the access to external USB storage media.

The instrument does not recognize any device connected to the USB interface when the interface is disabled.

To apply the change: enter the security password and confirm with "Accept". Otherwise the change has no effect.

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 ← General
Enables volatile mode. Use the mode to ensure that no user data can be written to the internal memory permanently. Internal memory is, e.g., a microSD or a solid-state drive (SSD).

For further information and sanitizing procedures, see the "Instrument Security Procedures" document.

Remote command:
:SYSTem:SECurity:VOLMode[:STATe] on page 550

Security Password ← General
Enters the password that is required to enable or to disable the settings protected by a security password. The default is '123456'.

Note: It is highly recommended to change the default security password before connecting the instrument to the network. To change the security password, select "SGMA-GUI > Instrument Name > Setup > Security > Change Security Password".

The settings are only accepted after the "Accept" button is pressed.

Accept ← General
Accept a new entry or selection and change the settings accordingly.

LAN Services
Provides settings to enable or disable the LAN interface.

How to: "Disabling the LAN interface" on page 283

LAN Interface ← LAN Services
Enables the LAN interface.

Note: It is not possible to access the instrument via LAN while the LAN connection is disabled. An enabled LAN connection is a prerequisite for the remote control of the instrument via FTP or SMB.

How to: "Disabling the LAN interface" on page 283

Remote command:
:SYSTem:SECurity:NETWork[:STATe] on page 548

User Password
The user name and password are required for remote access to the instrument over VNC, FTP or SAMBA.

Note: We recommend that you change the default user password before connecting the instrument to the network.

Note: Note that you cannot reset the password to factory state.
If you encounter problems with the password, contact the Rohde & Schwarz customer support, see Chapter 12.5, "Contacting customer support", on page 584.

User Name ← User Password

Indicates the user name used for access to the Linux operating system and valid for VNC, FTP and SAMBA access.

Old Password ← User Password

Enter the currently used user password. The default password is "instrument".

New Password ← User Password

Enter the new user password.

Confirm Password ← User Password

Enter the new password for conformation.

The new password is only valid after the "Change Password" button is pressed.

Change Password ← User Password

Changes the password accordingly.

Security Password

The security password is, for example, required when changing the status of the USB and LAN interface or other security settings.

Note: We recommend that you change the default security password before connecting the instrument to the network.

Note: Note that you cannot reset the password to factory state.
If you encounter problems with the password, contact the Rohde & Schwarz customer support, see Chapter 12.5, "Contacting customer support", on page 584.

Old Password ← Security Password

Enter the currently used security password. The default password is '123456'.

New Password ← Security Password

Enter the new security password. The security password can only contain decimal characters.

Confirm Password ← Security Password

Enter the new password for conformation.

The new password is only valid after the "Change Password" button is pressed.

Change Password ← Security Password

Changes the password accordingly.

7.7 Network settings

The instrument is equipped with a network interface and can be connected to an Ethernet LAN (local area network). The "Network Settings" dialog provides access to the network settings.

Access:

► Select "SGMA-GUI > Instrument Name > Setup > Network Settings".
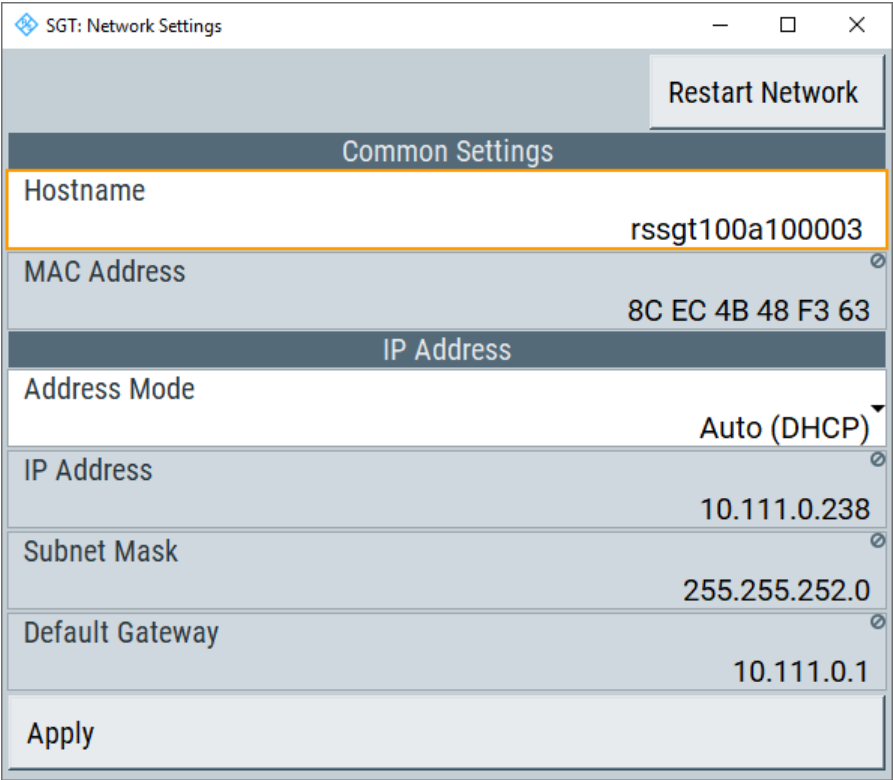
The dialog provides access to the network settings, like settings about the general network environment and specific identification of the computer in the network. The dialog also displays an indication whether the instrument is connected to the network or not.

Settings:

Restart Network

Shuts down the network connection of the instrument and then re-establishes the connection.

This function can be used to resolve network problems.

Note: Only the connection of the instrument to the network restarts, the network itself is not affected.

Hostname

Displays the individual computer name of the instrument.

A predefined name is indicated and can be used for network connections, see Chapter 5.5.3, "Finding out the default hostname of the instrument", on page 74.

It is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors can affect the entire network.

Remote command:

:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname on page 540

MAC Address

Indicates the MAC address of the network adapter.

Address Mode

Selects if the IP address is assigned automatically or manually.

It is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors can affect the entire network.

Note: Lost LAN connection to an instrument.
If the connection to an instrument configured to use static IP addresses is lost, press the [LAN LED] on the instrument front panel.

Pressing triggers a reset of the assignment mode ("Address Mode > Auto (DHCP)").

"Auto (DHCP)"   The IP address is assigned automatically.
                  The network used must support automatic assignment of IP address via DHCP or APIPA (Zeroconf) to use this function.

"Static"   The IP address is assigned manually.

Remote command:

:SYSTem:COMMunicate:NETWork:IPADdress:MODE on page 539

IP Address

Displays the IP address. To enter the IP address manually, select "Address Mode > Static".

If there is manual input of the IP address, it is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors can affect the entire network.

Remote command:

:SYSTem:COMMunicate:NETWork:IPADdress on page 539

Subnet Mask

Displays the subnet mask. This number is used together with the IP address to identify the network segment the instrument is in.

It is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors can affect the entire network.

To enter the subnet mask manually, select "Address Mode > Static".

Note: When assigning the subnet mask manually, make sure that the address matches with the subnet mask of the controlling host interface.

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK` on page 541

Default Gateway

Displays the IP address of the default gateway. To enter the default gateway manually, select "Address Mode > Static".

This address identifies the router on the same network as the instrument that is used to forward traffic to destinations beyond the local network.

It is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors can affect the entire network.

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway` on page 540

Apply

Applies the network settings to the instrument.

7.8 Remote channels

Access:

► Select "SGMA-GUI > Instrument Name > Setup > Remote".
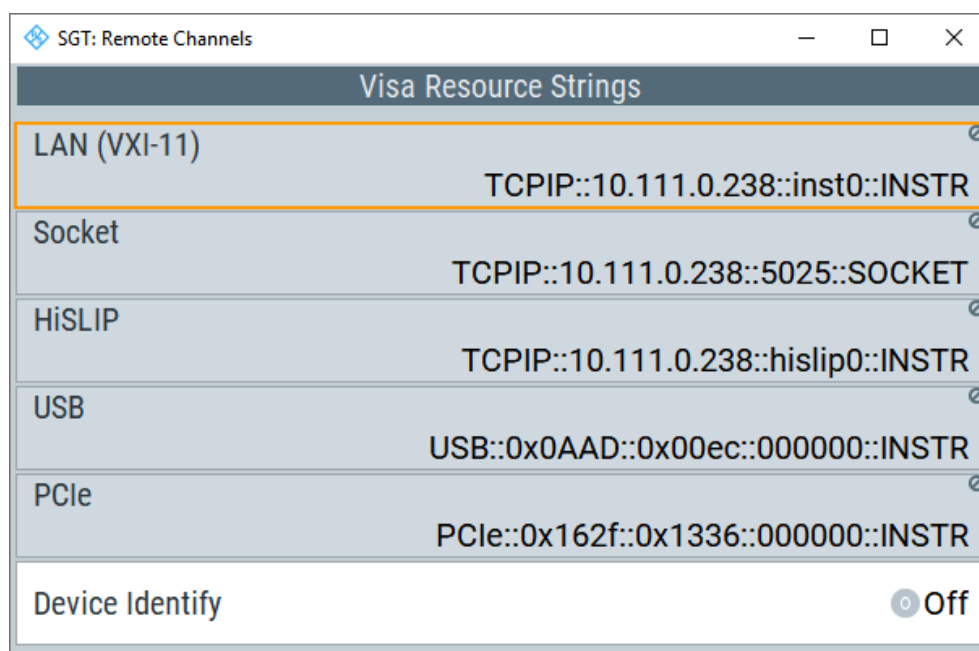
The "Remote" dialog provides access to the settings for remote control.

Settings:

Visa Resource Strings

Indicates the VISA resource strings used for remote control of the instrument. A separate string is provided for remote control via the different interfaces.

Note: For background information and description of the syntax of the VISA resource strings, refer to the description of the corresponding interface in Chapter 9.1, "Remote control interfaces and protocols", on page 312.

Remote command:

`:SYSTem:COMMunicate:HISLip:RESource?` on page 542

`:SYSTem:COMMunicate:NETWork:RESource?` on page 541

`:SYSTem:COMMunicate:SOCKet:RESource?` on page 543

`:SYSTem:COMMunicate:USB:RESource?` on page 543

`:SYSTem:COMMunicate:PCIexpress:RESource?` on page 542

Device Identity

Triggers the device identification function. The [LAN] LED on the front panel of the selected instrument blinks.

See also Chapter 5.5.4, "Bidirectional instrument identification", on page 74.

7.9 LXI status

The "LXI Status" dialog displays the settings and status of the LAN and allows you to reset the LAN connection.
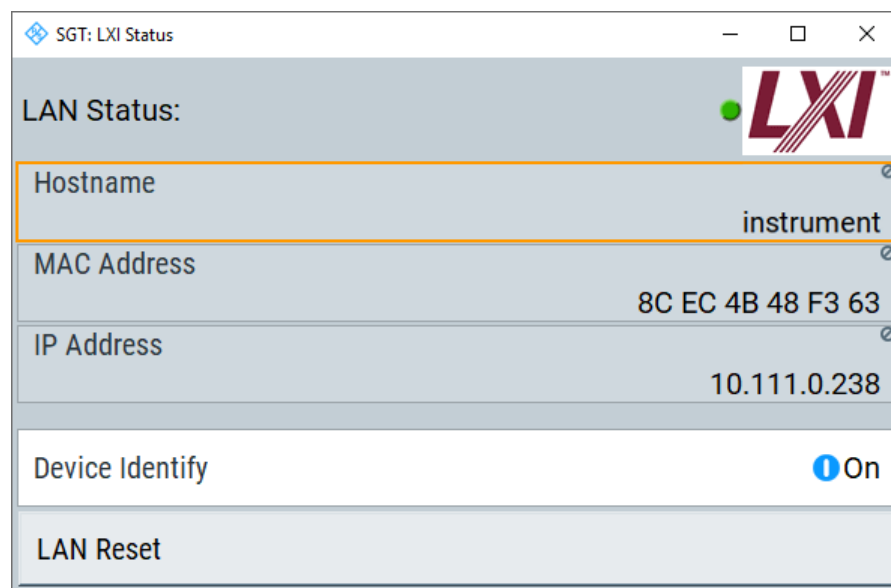
Settings:

LAN Status

The LED indicates the LXI status.

The LAN status is also indicated with the LED "LAN Status" on the front panel of the instrument.

"green"	Normal operation
"green (flash-ing)"	device identification
"red"	LAN fault

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, an LAN reset must place the following network settings to a default state:

Parameter	Value
"TCP/IP Mode"	DHCP + Auto IP Address
"Dynamic DNS"	Enabled
"ICMP Ping"	Enabled
Password for LAN configuration	"LxiWebIfc"

The LAN reset for the instrument also resets the following parameters:

Parameter	Value
"Hostname"	`Instrument-specific host name`
"Description"	Vector signal generator
"Negotiation"	Auto detect
"VXI-11 Discovery"	Enabled

To open the "Instrument Home Page" (welcome page), type the instrument's computer name (host name) or IP address in the address field of the browser on your PC, e.g. *http://10.111.10.175*.

Note: Do not add the missing zeros in the IP address, while opening the instrument home Page.

Device Identity

Triggers the device identification function. The [LAN] LED on the front panel of the selected instrument blinks.

See also Chapter 5.5.4, "Bidirectional instrument identification", on page 74.

7.10 Emulations

You can control the R&S SGT remotely via the command set of another signal generator, for example the R&S SMATE generator. With this function you can, for example, replace a signal generator with an R&S SGT in an automated test setup, without adjusting the command scripts used.

For more information on this topic, see also application note 1GP109.

You find all the remote control command sets supported by the R&S SGT in a selection list.

The selected instrument also defines the identification string that is retrieved with query `*IDN?`. In addition to the preset values, you can enter a user-defined identification string, for example to provide individual identification for each generator, like 'MY_R&S SGT' (see Identification Mode and IDN String).

As any other parameter, you can also change the remote control command set to be emulated via the Language command. However, once you have switched to an emulation, the R&S SGT-specific command set is disabled, that means this command is no longer effective. To return, you need to know the corresponding remote control command of the simulated instrument.

Access:

► Select "SGMA-GUI > Instrument Name > Setup > Emulations".
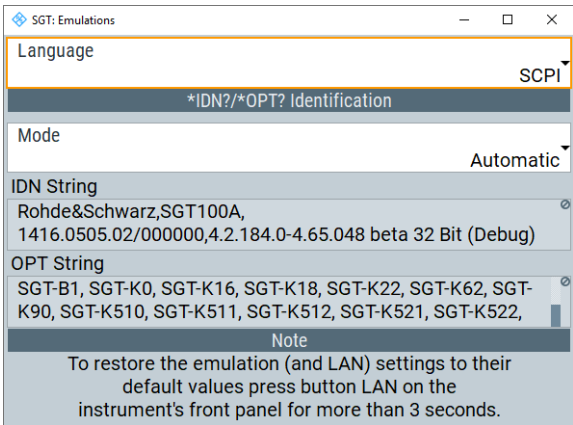
Settings:

Language

Selects the instrument whose remote command set is emulated by the R&S SGT.

Remote command:
`:SYSTem:LANGuage` on page 544

Identification Mode

Selects the way that the instrument identification is performed.

"Automatic"   The "IDN String" and the "OPT String" are set automatically for the instrument selected with the parameter Language.

"User Defined"   Enables the selection of user definable "IDN String" and "OPT String" for the instrument selected with the parameter Language.

Remote command:
`:SYSTem:IDENtification` on page 544

Set to default

Overwrites the user-defined `*IDN` and `*OPT` strings with default strings.

Remote command:
n.a.

IDN String

Indicates the identification string of the instrument when queried with the common command `*IDN?`.

In addition to the preset values, a user-defined identification string can be entered, e.g. to provide individual identification for each generator, like 'MY_R&S SGT' for instance.

Remote command:
`*IDN?` on page 349

OPT String

Indicates the option string of the instrument as queried with the common command `*OPT?`.

If "Mode > User Defined" is selected, a user-defined option string can be created also to the automatically created one.

Remote command:
`*OPT?` on page 350

7.11 Date and time

The "Date/Time" dialog provides access to setting a date and time.

Access:

► Select "SGMA-GUI > Instrument Name > Setup > Date/Time".
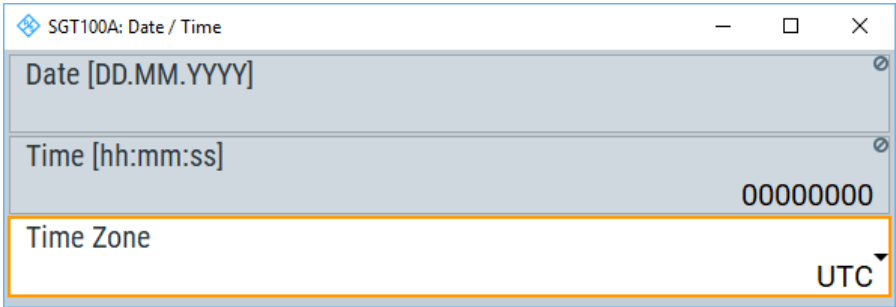
Settings:

Date

Indicates the date in the format day.month.year.

To prevent accidental changes, this parameter is protected. It can be accessed with protection level 1, see Chapter 7.5, "Protection", on page 281.

Remote command:
n.a.

Time

Indicates the time in the format hour.minute.second.

To prevent accidental changes, this parameter is protected. It can be accessed with protection level 1, see Chapter 7.5, "Protection", on page 281.

Remote command:
n.a.

Time Zone

Selects a time zone from a list.

Remote command:
:SYSTem:TIME:ZONE on page 549
:SYSTem:TIME:ZONE:CATalog? on page 549

7.12 Factory preset

The "Factory Preset" dialog provides a function to reset the instrument's settings to their factory states.

Access:

1. Select "SGMA-GUI > Instrument Name > Setup > Factory Preset".
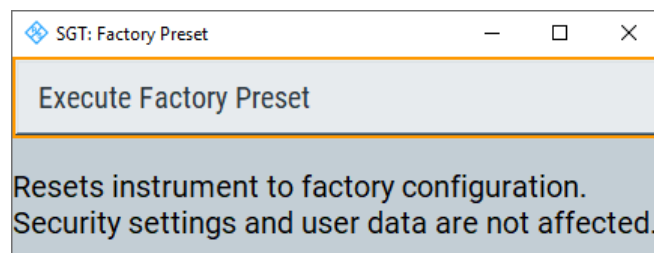
2. Select "Execute Factory Preset".

   The instrument's settings are reset to their factory states. Security settings and user data are not affected.

Settings:

Execute Factory Preset

Reset the instrument's settings to their factory state.

Note: Because "Factory Preset" resets the "Remote Channel Settings" and "Network Settings" to the default values, executing factory preset via remote control can terminate the connection to the instrument, if these settings had been configured to values different to the default ones.

The factory preset function resets nearly all instrument settings. In addition to the regular preset, a "Factory Preset" resets also the following values:

- Power on settings ("Level" dialog)
- Network settings including hostname ("Setup > Network Setting" dialog)
- Remote Channel settings ("Setup > Remote Channel" dialog)

To maintain security, password settings and all settings protected by these passwords like disabled USB and LAN connections are not changed.

Not affected by the "Factory Preset" are also user data, lists or instrument settings files, created, for example, with the "File Save As" function and currently saved on the instrument's hard disc.

Remote command:
`:SYSTem:FPReset` on page 354

7.13 Standby and restart

See Chapter 8.7, "How to switch between operating states", on page 306.

7.14 Diagnostic and tests

This section describes the settings provided for diagnostic and test purposes.

Access:

► Select "SGMA-GUI > Instrument Name > Setup > Diagnostic / Test".

Diagnostic / Test	▶	Self Test...
Service	▶	Connector Test...
		Keyboard Test...
		Power Servoing Test...
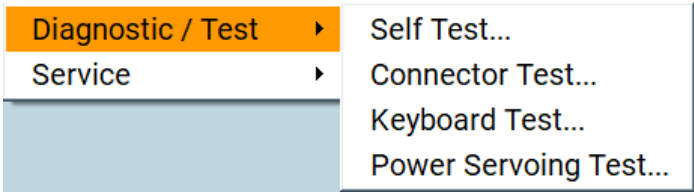
The selection provides the following settings.

Settings:

7.14.1 Selftest

Access:

► Select "SGMA-GUI" > "<Instrument name>" > "Diagnostic / Test" > "Self Test".

SGT: Self Test		− ☐ ✕
Start Selftest ...		Running
Testcase	Result	
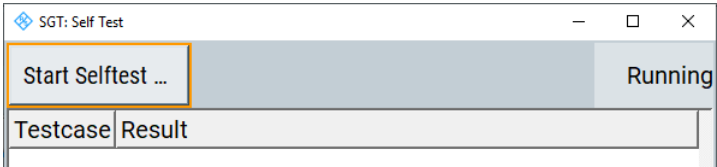
To run a selftest

1. Select "SGMA-GUI" > "<Instrument name>" > "Diagnostic / Test" > "Self Test".

2. To trigger a selftest execution, select "Start Selftest".

SGT: Self Test		− ☐ ✕
Start Selftest ...		Running
Testcase	Result	
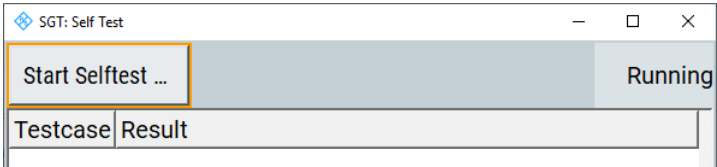
Performs a self test on all installed hardware options.

The result of the selftest, succeeded or failed, is displayed. The list of the numeric results of the performed test cases is protected by protection level 2.

Settings:

Start Selftest

Triggers execution of a selftest off all installed hardware options.

How to: "To run a selftest" on page 296

Remote command:
:TEST:ALL:STARt on page 551
:TEST:ALL:RESult? on page 551

7.14.2 Connector test

Access:

► Select "SGMA-GUI > Instrument Name > Diagnostic Tests > Connector Test".
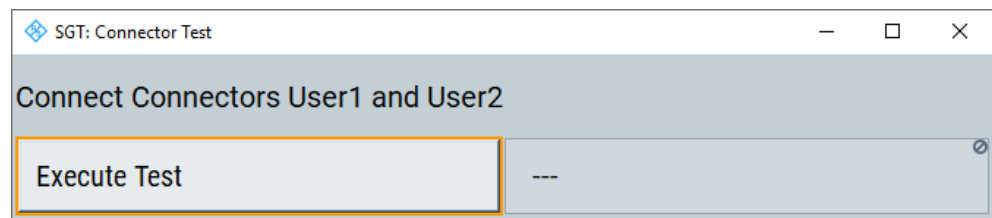
The "Connector Test" dialog provides settings for testing the connection to an external IQ device and performing a selftest of the baseband input.

Settings:

Execute Connection Test

Performs a connection test between the connectors [USER1] and [USER2].

Remote command:
:TEST:BB:CONNection? on page 552

7.14.3 Keyboard tests

Access:

► Select "SGMA-GUI > Instrument Name > Diagnostic Tests > Keyboard Test".
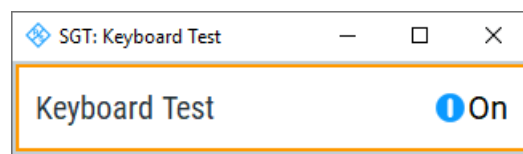
Use this function to check the proper operation of all front panel elements.

If "Keyboard Test" is enabled, all front panel LEDs except the [POWER ON] are orange.

The exact test procedure is described in the service manual.

SCPI command:

`:TEST:KEYBoard[:STATe]` on page 551

7.14.4 Power servoing test

Access:

► Select "SGMA-GUI > Instrument Name > Diagnostic Tests > Power Servoing Test".
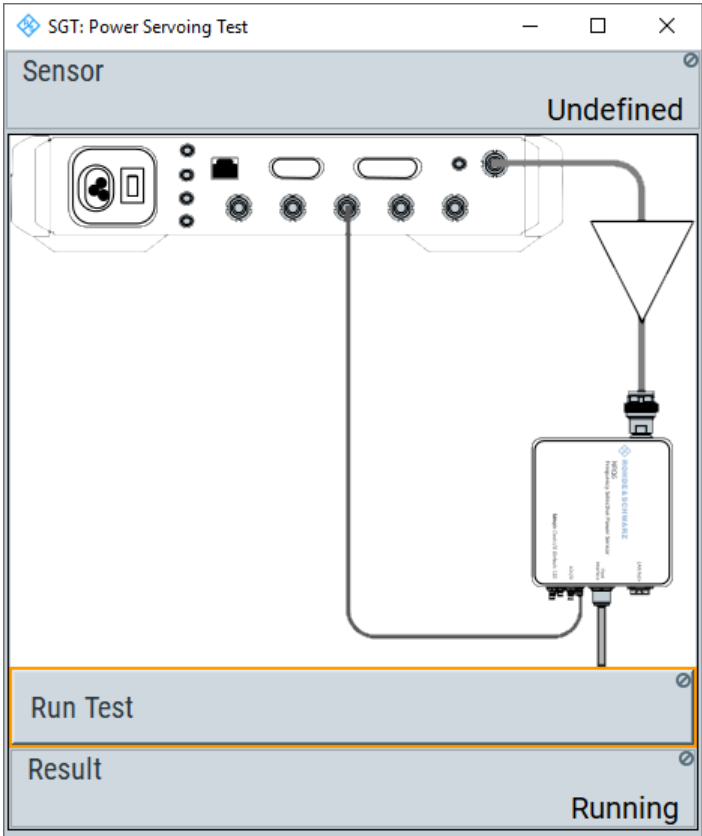
Use the test to check connections and settings of the power servoing function.

See also Chapter 6.7.6.8, "Power servoing", on page 238.

Settings:

Sensor

Sets the power sensor from a list as detected in the "NRP Sensor Mapping" dialog.

If the list has only one entry, this power sensor is displayed automatically.

Remote command:
[:SOURce]:POWer:SERVoing:SENSor on page 524

Run Test

Executes a power servoing test.

Remote command:
[:SOURce]:POWer:SERVoing:TEST? on page 525

Result

Displays the state of the power servoing test

"Stopped"	Initial state before executing "Run Test".
"Running"	Intermediate state during test execution.
"Pass"	Final state after successfully performing the test.
"Failed"	Final state with errors during the test.

7.14.5 Simulation

The function is protected and can be used only in simulation mode. Simulation mode requires creation of a virtual R&S SGT instrument.

Use the function for demonstration purposes, e.g. to show a specific hard- and software configuration of the R&S SGT in the block diagram.

Access:

1. In the SGMA-GUI, create a virtual R&S SGT instrument:

   a) Select "SGMA-GUI > Setup > Instruments > New".
   b) Select "Instrument Type = SGT".

   You can leave the other settings in the dialog.

2. Select "SGMA-GUI > Setup > Protection".

3. Enter the "Protection Level 1" password *123456*.

4. Select "SGMA-GUI main panel > virtual instrument name > Setup > Diagnostic / Test > Simulation".
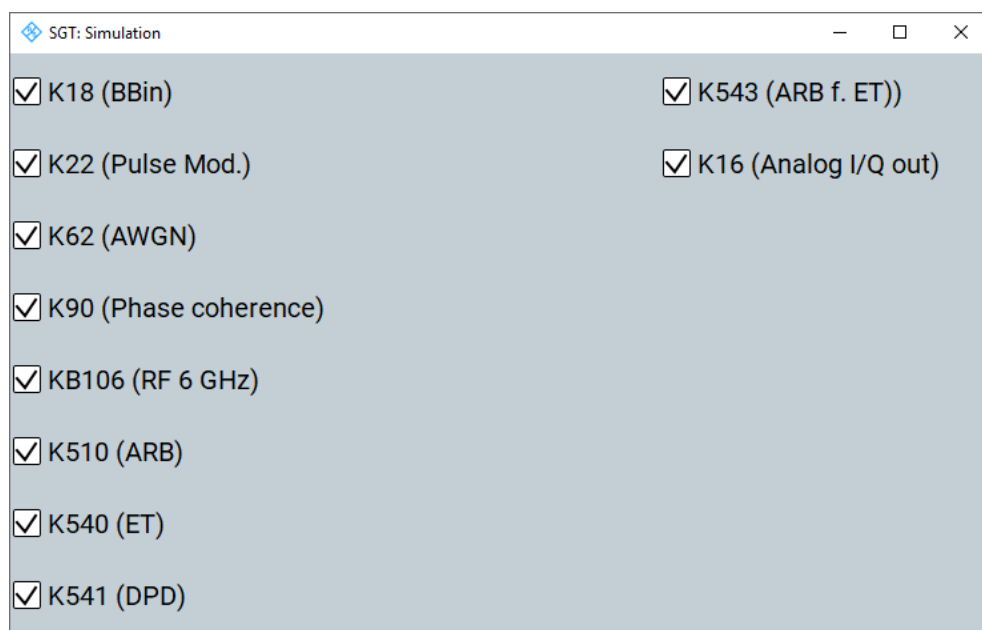
The dialog displays a list of software options.

5. Enable the option to be simulated.

   The block diagram and the provided signal generator settings are updated accordingly. You can open dialogs, interact with functions or observe the influence of settings as if the virtual instrument is equipped with the selected options.
   The signal generation function is disabled. The dialog and all unlicensed settings disappear, if a connection to a physical instrument is detected.

7.15 External adjustments

The external adjustment is a protected service procedure that requires "Protection Level 2" password. For a detailed test procedure, see the R&S SGT service manual.

Access:

► Select "SGMA-GUI > Instrument Name > Service > External Adjustments".
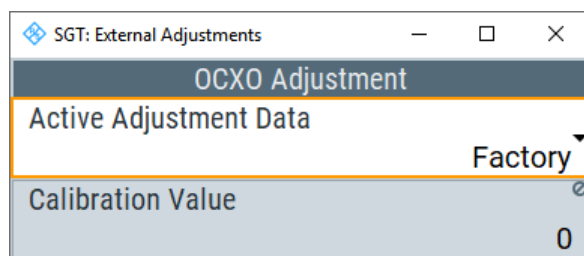
Depending on the installed options, the R&S SGT is equipped with a TCXO or OCXO reference oscillator. The reference oscillator is factory calibrated to a specific calibra-

tion value. In the external adjustment dialog, you can select a different (custom) calibration value.

Settings:

Active Adjustment Data

Selects whether the factory provided or a user-defined calibration value is used to adjust the reference oscillator.

Remote command:
:CALibration:ROSCillator:DATA:MODE on page 357

Calibration Value

Sets a user-definable calibration value.

The permanent storage of this value in the instrument's memory is a password-protected function. The parameter is restored to its permanently stored value by "Preset" and instrument restart.

Remote command:
:CALibration:ROSCillator[:DATA] on page 357

8 Performing configuration tasks

This section provides a general explanation on how to operate the instrument manually via the R&S SGMA-GUI software.

We assume, that the R&S SGT is connected to a remote PC. The R&S SGMA-GUI software is installed on this remote PC and the instrument has to be added to the list of "Available Instruments".

For information on how to fulfill these requirements, refer to:

- "Connecting to the network" on page 29
- Chapter 3.1.13.1, "Installing the R&S SGMA-GUI software", on page 27
- "Adding instruments to R&S SGMA-GUI" on page 31

8.1 How to configure the reference oscillator source

To use the internal reference frequency source

1. To enable the instrument to use its internal reference frequency source, perform one of the following:

   a) Select "SGMA-GUI main panel > Ext Ref Off".
   b) Select "SGMA-GUI > Instrument Name > RF > Reference Oscillator > Source > Int".

2. In the "Reference Oscillator" dialog, set the "REF/LO Out > REF".

   The "Output Frequency" can be configured to either 10 MHz or 1 GHz.

   The instrument uses the internal reference signal. The [REF EXT] LED at the front panel of the instrument is off.

To output the reference frequency (internal or external) at the REF/LO OUT connector of the instrument, select "Reference Oscillator > REF/LO Output > REF".

To use an external reference frequency source

To improve measurement accuracy, provide one external reference frequency signal to all the instruments in the test setup. Alternatively, distribute the internal reference signal of the R&S SGT to the remaining instruments.

1. Provide the signal of an external reference frequency source to the REF/LO IN connector of the instrument.

2. To enable the instrument to use the external reference frequency source, perform one of the following:

   a) Select "SGMA-GUI main panel > REF > Ext Ref On".

b) Select "SGMA-GUI > Instrument Name > RF > Reference Oscillator > Source > Ext".

3. In the "Reference Oscillator" dialog, set the parameter "Ext. Ref. Input Frequency" to the value of the fed external reference frequency.

Now, the instrument uses an external reference signal. The green [REF EXT] LED at the front panel of the instrument indicates that the instrument is synchronized to the external reference signal.

If the instrument is configured to use an external reference signal but no signal is fed in at the "REF IN" connector, the [REF EXT] LED on the front panel of the instrument is red and an error message is displayed in the "Info" line.

8.2 How to configure the local oscillator coupling source

For local oscillator (LO) coupling, the R&S SGT can use two frequency sources: An internal and an external frequency source. The first possibility is to use the output signal of the internal synthesizer. If an external LO signal is provided at the "REF/LO IN" connector, this signal can alternatively be directly routed to the LO input of the I/Q modulator.

To use an external LO source

1. Provide the signal of an external LO source to the "REF IN" connector of the instrument.

   Note: The local oscillator input/output requires the additional software option R&S SGT-K90.

2. Select "SGMA-GUI > Instrument Name > Frequency/Phase > LO Coupling Source > Ext".

   Tip: When you select "Source > Ext", the icon LO Scr Ext appears in the R&S SGMA-GUI.

   The signal provided by the external frequency source is directly routed to the input of the I/Q modulator and used as carrier frequency.

To use the internal LO source

► Select "SGMA-GUI > Instrument Name > Frequency/Phase > LO Coupling Source > Int".

   The output signal of the internal synthesizer is used.

8.3 How to define the signal at the REF/LO OUT connector

The reference oscillator and the LO use the same "REF IN" connector. Hence, it is not possible to use both an external reference source and an external LO source signal at the same time.

The signal at the "REF OUT" connector also depends on the selected reference oscillator and LO sources. The following table gives an overview of this dependency.

Table 8-1: Selection available at the REF/LO OUT connector depending on the LO and reference oscillator sources

	LO coupling source	
Ref. oscillator source	**Int**	**"Ext"**
"Int"	"OFF/REF/LO"	"OFF/LO"
"Ext"	"OFF/REF/LO"	Combination not possible

To define the signal at the REF/LO OUT connector

1. In the "Frequency / Phase > Local Oscillator (LO) Coupling" dialog, select the "LO Source" as required.

2. In the "Reference Oscillator" dialog, select the "Ref. Oscillator Source" as required.

3. In the "Frequency / Phase > Local Oscillator (LO) Coupling" dialog, set the "REF/LO Output".
   For dependencies, see Table 8-1.

8.4 How to create and save ARB test signals

If your test case requires a simple sine or square test file, consider to use the provided ARB test signals.

1. Select "Baseband > ARB >General"

2. Select "Create Test Signal > Sine".

3. In the "Sine Test Signals"dialog, adjust the settings as required.

4. To create the test signal file, proceed as follows:
   a) Select "Generate Signal File".
   b) Navigate through the directory tree (e.g. `/var/user/`).
   c) Enter a file name (e.g. `sine_waveform`).
   d) Select "Save".

   The R&S SGT saves the generated waveform file and automatically loads it in the ARB.

5. Select "ARB > State > On".

   The R&S SGT processes the waveform file.

8.5 How to load and play waveform files

Irrespective of the way a waveform file is generated, you can transfer it to the instrument, load it in the ARB and play it.

To load and play a waveform file from the instrument

1. To transfer an externally created waveform file to the instrument, see Chapter 4.2, "Managing files on the R&S SGT", on page 50.

2. Select "Baseband > ARB > General".

3. Set "Waveform Location > Instrument".

4. To load the waveform file, proceed as follows:

   a) Select "Load Waveform".
   b) Navigate to the directory in which you saved the file.
   c) Select the waveform file (e.g. /var/user/lte_waveform).
   d) Click "Select" to finish loading.

   The "ARB" dialog confirms that the waveform file is loaded.

5. Select "ARB > State > On".

   The R&S SGT processes the waveform file.

To load and play a waveform file from an external computer

1. Connect the R&S SGT and a Windows PC with an installed R&S SGMA-GUI to the same network.

2. On the remote PC, select "SGMA-GUI > Instrument Name > Baseband > ARB > General".

3. Set "Waveform Location > Local file system".

4. To load the waveform file, proceed as follows:

   a) Select "Load Waveform".
   b) Navigate to the directory in which you saved the file.
   c) Select the waveform file (e.g. /var/user/lte_waveform).
   d) Click "Select" to finish loading.

   Note: You can also select an external USB connected to the PC at the available local file directories.
   The "ARB" dialog confirms that the waveform file is loaded.

5. Select "ARB > State > On".

The R&S SGT processes the waveform file.

8.6 How to restore the LAN connection

If you lose the LAN connection of the instrument, for example, after assigning a static IP address, proceed as follows:

► On the front panel of the instrument, press the [LAN] LED for more than 3 seconds.

Pressing trigger a reset of the LAN settings. In particular, the "Address Mode" on page 288 switches to "DHCP".

If your network supports automatic assignment of IP address, the new IP address is assigned to the instrument automatically.

8.7 How to switch between operating states

The Figure 8-1 gives an overview of the operating states of the instruments and how to trigger the switch-over between them.
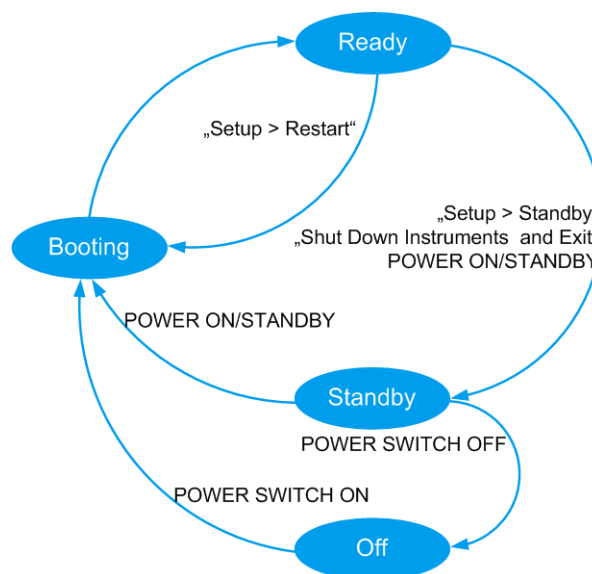
Figure 8-1: Operating states

"Setup" > "Standby", "Setup" > "Restart","Shut Down   = R&S SGMA-GUI controls
Instruments and Exit"
[POWER ON/STANDBY], power switch [I/0]   = Hardkey controls on the front/rear panel of the instrument

The Table 8-2 provides a short description of the operating states and their indication.

Table 8-2: Indication of the operating states

Operating state	Description	Indication
Off	The instrument is shut down.	All LEDs on the front panel of the instrument are off.
Booting	The instrument boots the operating system and starts the instrument firmware. If the previous session was terminated regularly, the instrument uses the last setup with the relevant instrument settings.	The green [POWER ON/STANDBY] key blinks.
Standby	In this state, it is safe to switch off the AC power and disconnect the instrument from the power supply. The remote control system is **not** active.	In the R&S SGMA-GUI, the status indicator in front of the instrument name is red. The orange [POWER ON/STANDBY] key is on.
Ready (normal operation)	The instrument is ready for operation. All modules are power-supplied.	In the R&S SGMA-GUI, the status indicator in front of the instrument name is green. The green [POWER ON/STANDBY] key is on.

To switch the instrument to standby state

► Use one of the following:

    a) On the remote PC, select "SGMA-GUI > Instrument Name > Setup > Standby".

    b) Press the [POWER ON/STANDBY] key on the front panel of the instrument.

    c) Send the SCPI command:

       `:SYSTem:REBoot`

The current instruments settings are automatically saved. The instrument switches to a power-saving mode.
In the R&S SGMA-GUI, the standby state is indicated by the red state symbol in front of the corresponding instrument's name, on the front panel, by the orange [POWER ON/STANDBY] button.

To return the instrument from standby to ready state

► Use one of the following:

    a) On the remote PC, select "SGMA-GUI > Instrument Name > Setup > Restart".

    b) Press the orange [POWER ON/STANDBY] key on the front panel of the instrument.

The instrument loads the last setup with all instrument settings, switches to ready state and is ready for normal operation.
In the R&S SGMA-GUI, the ready state is indicated by the green state symbol in front of the instrument's name.
On the front panel, the ready state is indicated by the green [POWER ON/STANDBY] button.

To switch all connected instruments to standby state and close the R&S SGMA-GUI

► In the R&S SGMA-GUI main panel, select "File > Shut down instruments and exit".

The R&S SGMA-GUI quits and switches the connected instruments to standby state.

For description on how to terminate work and shut down the instrument regularly, see Chapter 3.1.10, "Switching on or off", on page 24.

8.8 How to use computer names

If there is a name server in the network, alternatively to the IP address each PC or instrument connected in a LAN can be accessed via an unambiguous computer name. Each instrument is delivered with an assigned computer name, but this name can be changed.

For instruction on how to find out the default computer name, refer to Chapter 5.5.3, "Finding out the default hostname of the instrument", on page 74.

To query and change a computer name

To avoid violations and to use easy identification provided by the computer name, we recommend that you to keep the default hostname unchanged.

1. Open "SGMA-GUI > Instrument Name > Setup > Network Settings" dialog.

   The computer name is displayed under "Hostname".

2. Select "SGMA-GUI > Instrument Name > Setup > Protection"

3. Enable the "Protection Level 1".

   The parameter "Hostname" in the "Network Settings" dialog is now enabled for configuration.

4. Change the "Hostname".

5. Press the [POWER ON/STANDBY] key to restart the instrument.

   Note: The "Factory Preset" function restores the factory value of the parameter "Hostname".

8.9 How to install a new firmware version on the instrument

You can update the firmware of the R&S SGT.

Firmware installation via R&S SGMA-GUI

ⓘ Install or update the firmware of the R&S SGT before installing or updating the software R&S SGMA-GUI.

1. Select "SGMA-GUI main panel > Instrument Name > Setup > Maintenance > Operation > Install firmware package".

2. Press "Select Package" and navigate to the directory of the new firmware.

3. If several instruments require a firmware update, enable "Update All" to accelerate the update procedure.

   All instruments that are in active state and are connected to this controller are updated simultaneously.

4. Enter the "Security Password".

5. Confirm the update with "Accept".

   The software transfers the firmware file and automatically starts the update procedure. During the update, the message "Updating Firmware" is displayed in the "Info" line. The update process is indicated by an LED running light.

   Note: The update procedure requires a restart of the instrument. The restart is performed automatically. The instrument is not accessible during that time.

6. Wait until the message "Updating Firmware" disappears. After the message disappears, the update is complete.

   The [POWER ON/STANDBY] LED is green.

7. If necessary, install the new R&S SGMA-GUI.
   For detailed description, refer to Chapter 3.1.13.1, "Installing the R&S SGMA-GUI software", on page 27

8. If you connect the instrument and the controller/PC over the PCIe interface and the external PC does not support hot-plugging, restart the external PC.

Firmware update through a session control protocol (SCP)

ⓘ Install or update the firmware of the R&S SGT before installing or updating the software R&S SGMA-GUI.

1. Connect the R&S SGT and a Windows PC to the same network.

2. On the PC, open a windows explorer window.

3. To connect to the R&S SGT, enter the name of the instrument or its IP address in the windows taskbar.
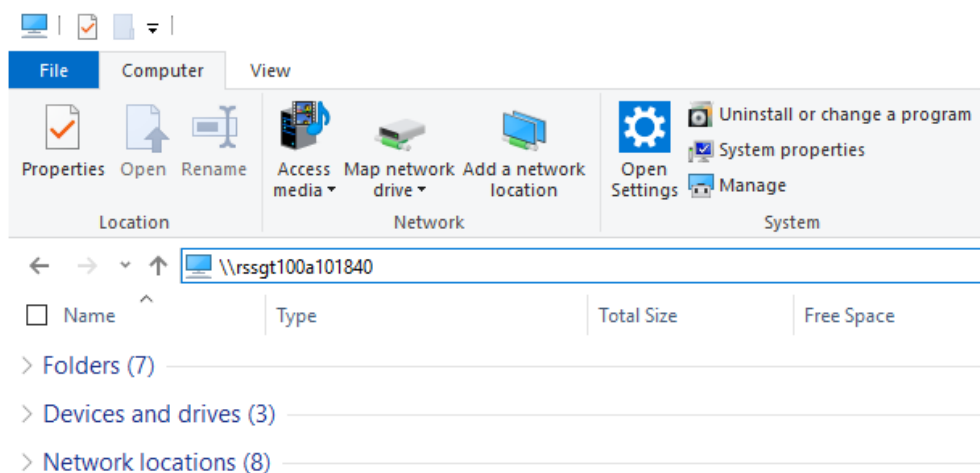
4. Enter the user name and password to connect to the R&S SGT. The default user name is *instrument* and the password is *instrument*.
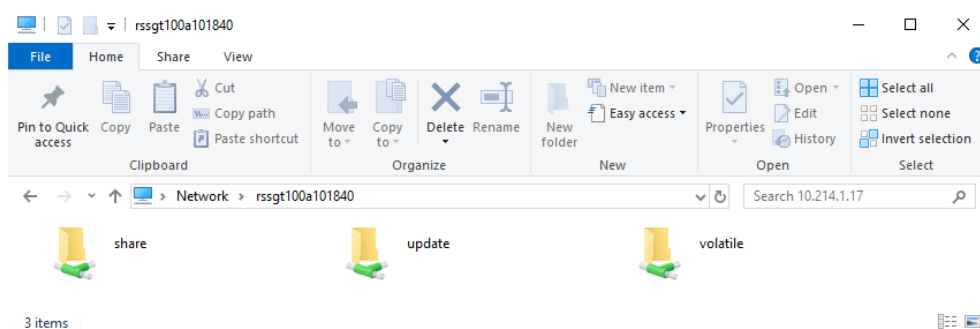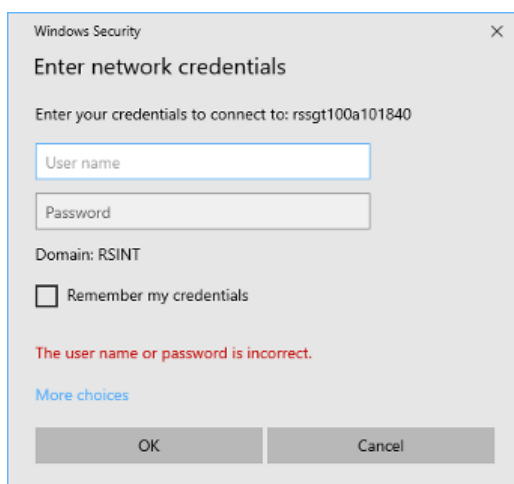
A folder opens, containing the `share` and the `update` folder.

5. Open the `update` folder.

6. Copy the new firmware update file into the folder.

The update starts automatically.

Unsuccessful or erroneous firmware update

An erroneous or unsuccessful installation of firmware update package is indicated by a combination of one orange and red LEDs on the front panel.

Refer to the service manual for a description of the displayed error code or contact the customer support center, see Chapter 12.5, "Contacting customer support", on page 584.

8.10 How to activate options

A firmware update before the activation of the SW option can be required.

Refer to the description of the SW option for the required firmware version.

See also Chapter 8.9, "How to install a new firmware version on the instrument", on page 308 for instruction on how to update the firmware version.

1. Select "SGMA-GUI main panel > Instrument Name > Setup > Install SW-Options".

2. Select "Option Key".

3. Enter the key code delivered with the new option.

4. Restart the instrument.

   The new option is now enabled and ready for operation.

9 Network operation and remote control

As an alternative to operating the R&S SGT interactively via the R&S SGMA-GUI, you can operate the R&S SGT also from a remote location.

ⓘ **Information on network operation and remote control**

The following descriptions provide information required for operating the R&S SGT remotely. The information applies to all applications and operating modes supported by the instrument. Definitions specified in the SCPI standard are not provided.

For basic knowledge on remote control operation and additional information, see the following documents, available on the Rohde & Schwarz website:

- Remote control via SCPI
- 1GP72: Connectivity of Rohde&Schwarz Signal Generators
- 1MA208: Fast Remote Instrument Control with HiSLIP

9.1 Remote control interfaces and protocols

The instrument supports several interfaces for remote control. The following table gives an overview.

Table 9-1: 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]`
	• **VXI-11**
	`TCPIP::host address::inst0[::INSTR]`
	Library: VISA
	• **Socket communication** (Raw Ethernet, simple Telnet, Fast Socket)
	`TCPIP::host address[:: LAN device name]::<port>::SOCKET`
	Library: VISA or socket controller
		A LAN connector is located on the rear panel of the instrument.
		
		The interface is based on TCP/IP and supports various protocols.
		
		For details, see Chapter 9.1.2, "LAN interface", on page 316

USB	**USBTMC** `USB::<vendor ID>::<product ID>:: <serial number>[::INSTR]` Library: VISA	A USB connector is located on the rear panel of the instrument. For details, see Chapter 9.1.3, "USB interface", on page 319

Interface	Protocols, VISA[*)] address string and Library	Remarks

PCIe	**Proprietary**
	
	`PCIe::<vendor ID>::<product ID>::`
	`<serial number>[::INSTR]`
	
	Library: PCIe controller
		A PCIe connector is located on the rear panel of the instrument.
		
		For details, see Chapter 9.1.4, "PCI Express interface", on page 319

GPIB (IEC/ IEEE Bus Interface)	– • `GPIB::<address>[::INSTR]` (no secondary address) VISA	The instrument is not equipped with GPIB bus interfaces. Use a GPIB-to-LAN or GPIB-to-USB adapter instead. For details, see Chapter 9.1.5, "GPIB interface (IEC/IEEE bus interface)", on page 320

[*)] VISA is a standardized software interface library that provides 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) or USB. However, no VISA installation is necessary for remote control while using socket communication. For more information about VISA, refer to the user documentation.

Rohde & Schwarz provides the standardized I/O software library R&S VISA for communication 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.

SCPI (Standard Commands for Programmable Instruments)

SCPI commands 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 (R&S order number 0002.3536.00) offers detailed information on concepts and definitions of SCPI.

9.1.1 Remote control programs and libraries

The Figure 9-1 provides a schematic illustration of the remote control capabilities of the instrument.
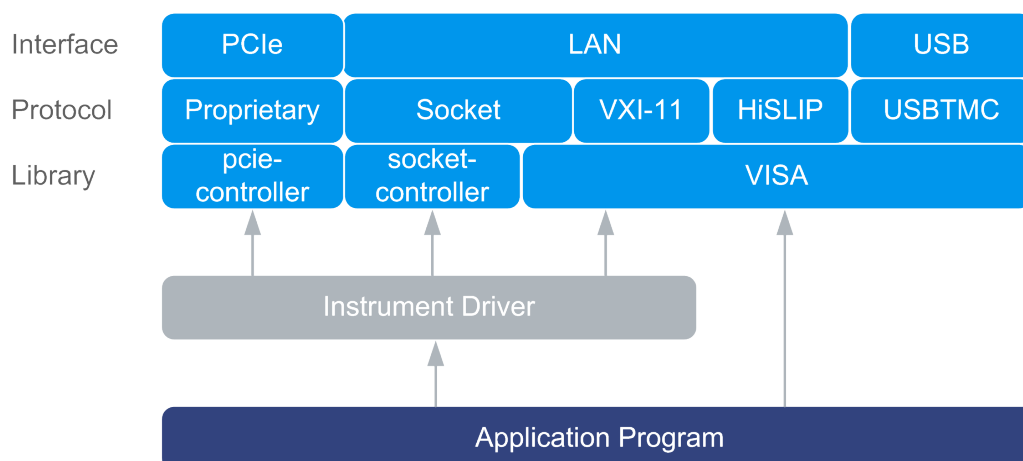
Figure 9-1: Remote control interfaces, protocols and libraries

The following examples give an overview of the dependencies between the available libraries, the possible interfaces and protocols, and whether an instrument driver is pro-vided. The involved parts are **highlighted**.

- Remote control program using VISA
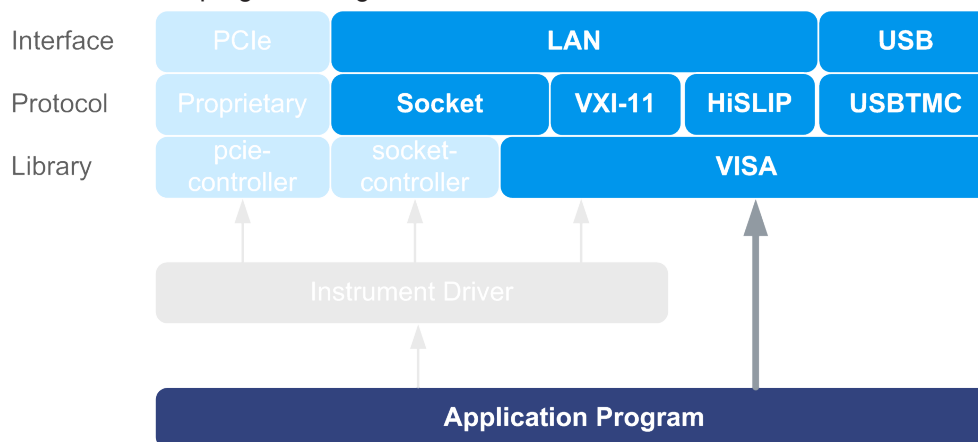
Figure 9-2: Remote control program using VISA

Protocol	Remote control program
Socket	viOpen (..., "TCPIP:rssgt100a100010::5025::SOCKET", ...) viPrintf (..., "SOUR:FREQ 2GHz\n")
VXI-11	viOpen (..., "TCPIP:rssgt100a100010::inst0::INSTR", ...) viPrintf (..., "SOUR:FREQ 2GHz\n")
HiSLIP	viOpen (..., "TCPIP:rssgt100a100010::hislip0::INSTR", ...) viPrintf (..., "SOUR:FREQ 2GHz\n")
USBTMC	viOpen (..., "USB::0x0aad::0x00EC::1000010::INSTR", ...) viPrintf (..., "SOUR:FREQ 2GHz\n")

- Remote control program using instrument driver (VISA available)
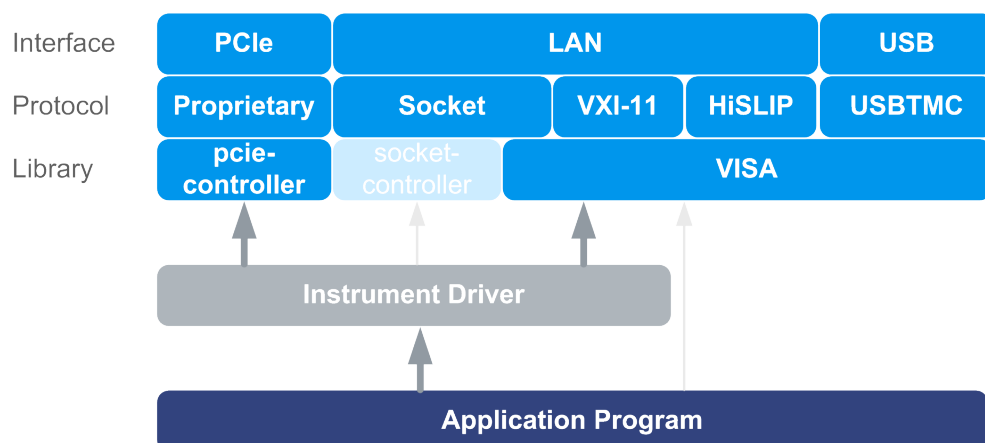
Figure 9-3: Remote control program using instrument driver (VISA available)

Protocol	Remote control program
Socket	`rssgt_init ("TCPIP:rssgt100a100010::5025::SOCKET", ...)` `rssgt_SetFrequency (..., 2e9)`
VXI-11	`rssgt_init ("TCPIP:rssgt100a100010::inst0::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`
HiSLIP	`rssgt_init ("TCPIP:rssgt100a100010::hislip0::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`
USBTMC	`rssgt_init ("USB::0x0aad::0x00EC::1000010::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`
PCIe	`rssgt_init ("PCIe::0x162f::0x1336::1000010::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`

● Remote control program using instrument driver (VISA not available)
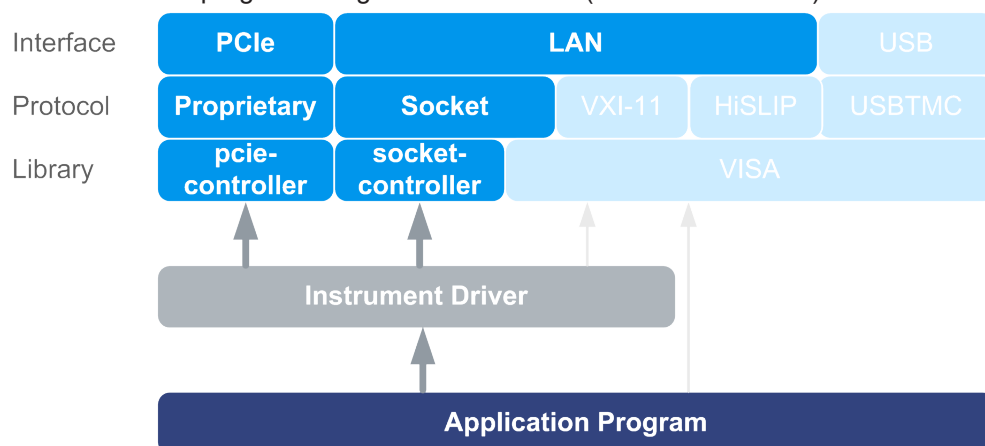
Figure 9-4: Remote control program using instrument driver (VISA not available)

Protocol	Remote control program
Socket	`rssgt_init ("TCPIP:rssgt100a100010::5025::SOCKET", ...)` `rssgt_SetFrequency (..., 2e9)`
PCIe	`rssgt_init ("PCIe::0x162f::0x1336::1000010::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`

9.1.2 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. They are connected using an RJ45 cable (shielded or unshielded twisted-pair category 5). The TCP/IP network protocol and the associated network services are preconfigured on the instrument. Software for instrument control and (for specified protocols only) the VISA program library must be installed on the controller.

> **Identifying instruments in a network**
>
> If several instruments are connected to the network, each instrument has its own IP address and associated resource string. The controller identifies these instruments by the resource string.

9.1.2.1 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 used
- **Host address** is the IP address or host name of the device
  See also Chapter 5.5.3, "Finding out the default hostname of the instrument", on page 74.
- **[::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 that the device is registered on the network. Alternatively, you can also assign its **LAN device name**.

You can find the IP address in the "SGMA-GUI > Instrument Name > Setup > Remote" dialog, and also adjust it manually, if necessary.

See below 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 9.1.2.2, "HiSLIP protocol", on page 317.

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 9.1.2.3, "VXI-11 protocol", on page 318.

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 9.1.2.4, "Socket communication", on page 318.

Example:

● Instrument has the IP address *10.113.11.91*; the valid resource string using VXI-11 protocol is:
```
TCPIP::10.113.11.91::INSTR
```
● The DNS host name is *rssgt100a100021*; the valid resource string is:
```
TCPIP::rssgt100a100021::hislip0
``` (HiSLIP)
```
TCPIP::rssgt100a100021::inst0
``` (VXI-11)
● A raw socket connection can be established using:
```
TCPIP::10.113.11.91::5025::SOCKET
```

9.1.2.2 HiSLIP protocol

The High Speed LAN Instrument Protocol (HiSLIP) 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 instrument handshake returns. However, using HiSLIP, data is sent to the instrument using the "fire and forget" method with immediate return. Thus, a successful return of a VISA operation such as `viWrite()` guarantees only that the command is delivered to the instrument's TCP/IP buffers. There is no confirmation, that the instrument has started or finished the requested command.

For more information see also the application note:

1MA208: Fast Remote Instrument Control with HiSLIP

9.1.2.3 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.

9.1.2.4 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 require a VISA installation on the remote controller side.

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 communication with the software on a command-by-command basis.

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 instruments 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 running on a connected PC.

The instrument also supports the fast socket channel. For details, see Chapter 9.4, "Advanced remote control using fast socket", on page 327.

9.1.3 USB interface

For remote control via USB connection, the PC and the instrument must be connected via the USB 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.

USB resource string

The syntax of the used USB resource string is:
`USB::<vendor ID>::<product ID>::<serial number>[::INSTR]`, where:

- **USB** denotes the used interface
- **<vendor ID>** is the manufacturer ID for Rohde&Schwarz
- **<product ID>** is the product identification of the R&S instrument
- **<serial number>** is the individual serial number on the rear of the instrument
- **[::INSTR]** indicates the instrument resource class (optional)

You can retrieve the USB resource string from the "SGMA-GUI > Instrument Name > Setup > Remote" dialog.

Example:

`USB::0x0AAD::0x00EC::100021::INSTR`

0x0AAD is the vendor ID for Rohde & Schwarz.

0x00EC is the product ID for the R&S SGT.

100021 is the serial number of the particular instrument.

9.1.4 PCI Express interface

A PCI Express (PCIe) connector is provided on the rear panel of the instrument.

Refer to Chapter 9.3, "Advanced remote control using PCIe", on page 322 for a description of how to set up a remote control connection via PCIe and the permitted cables.

Via PCI Express some commands can be sent to the instrument with optimized speed (memory-mapped remote control), e.g. frequency or level settings. Speed optimization allows minimum setup time.

PCIe resource string

The syntax of the used PCIe resource string is:
`PCIe::<vendor ID>::<product ID>::<serial number>[::INSTR]`, where:

- **PCIe** denotes the used interface
- **<vendor ID>** is the manufacturer ID for Rohde & Schwarz

- **<product ID>** is the product identification of the R&S instrument
- **<serial number>** is the individual serial number on the rear of the instrument
- **[::INSTR]** indicates the instrument resource class (optional)

You can retrieve the PCIe resource string from the "SGMA-GUI > Instrument Name > Setup > Remote" dialog.

Example:
```
PCIe::0x162f::0x1336::100021::INSTR
```
0x162f is the vendor ID for Rohde & Schwarz.

0x1336 is the product ID for the R&S SGT.

100021 is the serial number of the particular instrument.

9.1.5 GPIB interface (IEC/IEEE bus interface)

The R&S SGT is not equipped with an IEC/IEEE bus interface.

To be able to control the instrument via the GPIB bus:

1. Connect a GPIB-to-LAN or a GPIB-to-USB adapter to the instrument.

2. Use a GPIB bus cable to connect the instrument and the controller.

3. Provide the GPIB bus card, the card drivers and the program libraries for the programming language in the controller.

4. In the "SGMA-GUI > Setup > Instruments > instrument name > Remote Control", set the "GPIB Address".
   See "GPIB Address" on page 61.

5. If the controller has several GPIB bus cards, define the used "Board Number".

GPIB address

The controller must address the instrument with the GPIB bus channel. GPIB provides channel addresses from 0 to 30.

The GPIB resource string is `GPIB::<address>[::INSTR]`, where:

- **GPIB** denotes the used interface.
- **<address>** indicates the used channel.
- **[::INSTR]** indicates the instrument resource class (optional).

Note: If the VISA implementation supports the GPIB interface, you can optionally define the VISA instrument control resource (INSTR). It is used to define the basic operations and attributes for a device, such as reading, writing, or triggering.

Any connected IEC bus cable must be terminated by an instrument or controller.

9.2 Starting a remote control session

To start a remote control session, connect the instrument and the controller with a suitable cable and switch on both of them.

A remote control program must open a connection to the instrument, before it can send commands to and receive device responses from the instrument.

Instrument address

To operate the instrument via remote control, it must be addressed using the defined interface address.

See Chapter 9.1.2, "LAN interface", on page 316, Chapter 9.1.3, "USB interface", on page 319 or Chapter 9.1.4, "PCI Express interface", on page 319 for details.

The VISA resource strings are indicated in the "SGMA-GUI main panel > Instrument name > Setup > Remote Channels" dialog.

9.2.1 How to find the VISA resource string

To find the VISA resource strings of your instrument:

► Select "SGMA-GUI main panel > Instrument name > Setup > Remote Channels".

The "Remote Channel Settings" dialog shows all specified resource strings of the supported remote control interfaces.

9.2.2 Remote control over LAN using socket communication

This section provides an example of how to establish a remote control connection over telnet protocol and a simple sockets-based program example that can be further developed (see also Chapter A, "Telnet program examples", on page 587).

Basic knowledge of programming and operation of the controller are assumed. A description of the interface commands can be obtained from the relevant manuals.

Refer to the getting started manual for an example of how to set up remote control connection over LAN using VXI-11 protocol.

To set up a Telnet connection

To control the software, only a telnet program is required. The telnet program is part of every operating system.

1. To establish a Telnet connection with the R&S SGT, start the telnet program.

2. Enter the socket address.

The socket address is a combination of the IP address or the host name of the R&S SGT and the number of the port configured for remote-control via telnet.
Tip: The R&S SGT uses the port number 5025 for remote connection via Telnet.

The connection to the instrument is set up and remote-control commands can be sent.

3. Even if the cursor is not visible on the screen, enter blind a remote-control command.

4. Confirm with "Enter".

9.3 Advanced remote control using PCIe

The PCIe bus is a high-speed serial bus, composed of point-to-point serial links. A pair of serial links, one transmitting and one receiving link, make up a lane.

Fast settings

The PCIe interface can be utilized not only to transfer text messages, e.g., SCPI commands but also to carry register based remote control messages. The latter mode is

called fast settings mode. The specially for this purpose provided instrument's driver is mandatory for the instrument control with fast settings. This instrument driver contains special functions for fast setup.

ⓘ To use the advantage of the fast settings, the following prerequisites must be fulfilled:

- Using the PCIe interface is mandatory (see also Chapter 9.3.1, "Setting up a remote control connection via PCIe", on page 323)
- The fast settings must be enabled with the function `rssgt_useFastSettings` (see also Chapter 9.3.5, "Enabling fast settings", on page 327).

The instrument driver automatically uses the fast settings method whenever possible - currently only for the parameters frequency, level, RF state, modulator state - and sends SCPI messages in all other cases.

Remote control programs written for PCIe will, without modifications, also run if one of the other control channels, LAN or USB is used.

9.3.1   Setting up a remote control connection via PCIe

To set up a remote control connection vie PCIe, perform the following steps:

1. Download the drivers: See 9.3.2.

2. Configure the controller: See 9.3.3

3. Connect the controller and the instrument: See 9.3.4

4. Enable fast settings: See 9.3.5.

9.3.2   Downloading the drivers

All required driver files are available for download on the product page at:

http://www.rohde-schwarz.com/product/SGT100A.html > "Downloads" > "Drivers"

Provided are the following files:

- `LabWindows/CVI, Linux/OSX driver rssgt (InstrumentDriver)`
  `C` source code files which provide a functional application programming interface (API) to R&S SGT instruments. Required if you want to control an instrument via PCIe.
- `Low-Level SGT drivers`
  Archive file that contains the following:
  - `KernelDriver`
    `C` source code files from which you can build a Linux kernel mode driver for the R&S SGT PCIe remote control interface.
  - `SgtDriverDemo`
    `C` source code module for a demo program using the instrument driver API.

- `SharedLibraries-Dlls`
  Shared libraries (`*.dll` files) for remote control channels Socket and PCIe. To be used with the instrument driver.
- `VXIplug&play x64/x86 driver rssgt`

Download the required archive and extract the files on a remote PC.

9.3.3 Configuring the controller

This section lists the steps necessary to configure a controller with Linux or Windows operating system.

9.3.3.1 Building and installing the hardware driver

The hardware driver defines the way to communicate with the instrument via PCIe interface.

ⓘ For Windows operating systems, the hardware driver is installed automatically together with the installation of the R&S SGMA-GUI software.

See also section "Installation of R&S SGMA-GUI Software" in the getting started manual.

For Linux operating system, the source code of the driver is included in the `Low-Level SGT drivers` file.

To build and install this driver, root authority is required.

1. Copy folder `KernelDriver` to your `hdd`

2. Go to directory `host`.

3. On the command line, enter `make`.

   The driver `sgshost.ko` is automatically built.

4. Enter `make install`.

   Device nodes `sgtX` are created under the folder `/dev` (X from 0 to 31).
   The module `sgthost` is loaded.

5. Enter `lsmod` to verify the module.

9.3.3.2 Making shared libraries accessible

Two library files per operating system are included in `SharedLibraries-Dlls` file:

- For Linux operating system
  `libsocketcontroller.so` and `libpciecontroller.so`
- For Windows operating system
  `SocketController.dll` and `PCIeController.dll`

These libraries act as the dynamic link libraries for programs using the socket or PCIe interface.

Linux operating system

► To make the libraries accessible, perform one of the following:

  a) Append the environment variable LD_LIBRARY_PATH with the path of these two files, e.g., by changing the `/etc/environment` file.
  b) Move these two files to `/usr/lib` or `/lib` directory.

Windows operating system

► To make the libraries accessible, perform one of the following:

  a) Copy these two files to the folder of your executable.
  b) Copy these two files to the `WINDOWS\system32` folder.

9.3.3.3 Building a program

The help file `rssgt_vxi.chm` shows all functions of the instrument which you can use in your own remote control program.

An example file is provided (`SgtDriverDemo.c`), too.

Building the example program (Linux)

1. Copy folders `InstrumentDriver` and `SgtDriverDemo` to your hard disk.

2. Go to folder `Build`

3. On the command line, enter `cmake ..`

4. Enter `make`

   Folder `Build` contains the executable `SgtDriverDemo`.

Building the example program (Windows)

1. Copy folders `InstrumentDriver` and `SgtDriverDemo` to your hard disk.

2. Open `SgtDriverDemo.vcproj` with Visual Studio.

3. Build the program.

Running the example program

► On the command line, enter `./SgtDriverDemo RESOURCESTRING [cmd]`.
  Where
  ● `RESOURCESTRING` is the (VISA) resource string of your instrument, e.g. `TCPIP::ipaddress::5025::SOCKET` or `PCIE::0x162f::0x1336::serialno::INSTR`.
    Where `ipaddress` is the IP address or hostname of your instrument and `serialno` is its serial number.

● `cmd` is an optional command (see table).

The following table list the available commands.

Command	Description
?	Usage
q	Quit
f value	Set frequency
f?	Query frequency
l value	Set level
l?	Query level
rvalue	Set RF state (value = `0` | `1` | `ON` | `OFF`)
r?	Query RF state

If you enter an additional optional command, `SgtDriverDemo` executes it and enters a loop waiting for further commands.

Example:

`TCPIP::10.111.11.44::5025::SOCKET ?`

Lists the available commands.

9.3.4 Connecting the controller and the instrument

The "PCIe" connector is located on the rear panel.

ⓘ **Permitted PCIe cables**

PCIe extension cables must fulfill the following requirements:
● **Single lane connectors**
● **Maximum cable length of 5 m.**

For example: OSS-PCIe-CBL-x1 cable from One Stop Systems or 74576-000x cable from Molex.

Connecting an external PC that does not support hot-plugging

1. Switch off the external PC and the instrument.
   See also Chapter 3.1.10, "Switching on or off", on page 24.

2. **NOTICE!** Risk of device failure. The R&S SGT is equipped with a single lane PCIe interface that supports hot plugging.
   Do not connect an external PC to the PCIe connector of the instrument during operation if this external PC does not support hot-plugging.

   Connect the instrument and the controller with a permitted PCIe cable as specified in "Permitted PCIe cables" on page 326.

3. Switch on the instrument.

4. Wait until the instrument has completed the booting (the "POWER" LED on the instrument's front panel is constantly on).

5. Switch on the external PC.

9.3.5 Enabling fast settings

► To enable the special PCI express feature fast settings, enable the function `rssgt_UseFastSettings (ViSession instrumentHandle, ViBoolean fastEnabled, ViBoolean asynchronousEnabled)` included in the instrument driver.

Settings for some parameters like level and frequency accelerate.

To disable the fast settings, call the function `rssgt_UseFastSettings` with argument `fastEnabled=false`.

9.4 Advanced remote control using fast socket

Fast settings

The socket interface can be utilized not only to transfer text messages, e.g., SCPI commands but also to carry register based remote control messages. The latter mode is called fast settings mode. The fast socket communication is based on the Ethernet protocol which does not support routing. Therefore a controller PC can only control devices within its own network segment using the fast socket method.

To use the advantage of the fast settings, the following prerequisites must be fulfilled:
- On Windows operating systems, the fast socket driver must be installed.
- The application program must be run with root/administrator rights.
- The fast settings must be enabled with the function `rssgt_useFastSettings` (see also Chapter 9.3.5, "Enabling fast settings", on page 327).

The instrument driver uses the fast settings method whenever possible. Fast settings apply for the parameters frequency, level, RF state, I/Q modulator state, IQ wideband state, digital attenuation, frequency offset, phase offset, trigger, segment trigger, next segment index. In all other cases, SCPI messages are sent.

9.4.1 Setting up a remote control connection via fast socket

Download the required archive and extract the files on a remote PC, as described in Chapter 9.3.2, "Downloading the drivers", on page 323.

Windows operating systems

To set up a remote control connection via fast socket for Windows operating systems, perform the following steps:

1. Connect the controller and the instrument: See Chapter 3.1.13.2, "Connecting a remote PC via LAN", on page 28.

2. Install the protocol driver to the controller: See Chapter 9.4.2, "Installing the protocol driver", on page 328.

3. On the controller, start the driver by using one of the following:

   a) Start the Windows console user interface as an administrator.
      Excute the command `net start SGMANDISPROT`.
   b) Use a program for opening the driver.
      See, for example, the example file `SgtDriverDemo.c`.

4. Start the application with administrator rights.

5. Enable fast settings: See Chapter 9.4.3, "Enabling fast settings", on page 329.

Linux operating systems

To set up a remote control connection via fast socket for Linux operating systems, perform the following steps:

1. Connect the controller and the instrument: See Chapter 3.1.13.2, "Connecting a remote PC via LAN", on page 28.

2. Start the application as root.

3. Enable fast settings: See Chapter 9.4.3, "Enabling fast settings", on page 329.

9.4.2 Installing the protocol driver

The protocol driver defines the way to communicate with the instrument via the LAN fast socket interface.

For Linux operating system, no special driver is needed.

For Windows operating systems, the `SGMANDISPROT` driver is required. The protocol driver is installed automatically together with the installation of the R&S SGMA-GUI software. It is also provided in the `Low-Level SGT drivers` file.

To install the driver manually on a Windows operating system:

1. Open "Control Panel > Network and Sharing Center".

2. Select the network adapter on which you want to install the driver.

The "Local Area Connection Status" dialog opens.

3. Click "Properties" to open the "Local Area Connection Properties" dialog.

4. Click "Install" to open the "Select Network Feature Type" dialog.

5. Select "Protocol".

6. Select "Add".

7. In the "Select Network Protocol" dialog, select "Have Disk".

8. To select the driver, navigate to its storage directory.

9. Click "OK" to install the driver.

9.4.3 Enabling fast settings

► To enable the fast settings for the fast socket, call function
`rssgt_UseFastSettings (ViSession instrumentHandle, ViBoolean fastEnabled, ViBoolean asynchronousEnabled)` included in the instrument driver.

Settings for some parameters like level and frequency accelerate.

To disable the fast settings, call the function `rssgt_UseFastSettings` with argument `fastEnabled=false`.

9.5 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.

9.5.1 Hierarchy of the status registers

The Figure 9-5 shows the hierarchical structure of information in the status registers (ascending from left to right).

Figure 9-5: 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 SGT uses the following status registers:

● **Status Byte** (STB) and **Service Request Enable** (SRE), see Chapter 9.5.3, "Status byte (STB) and service request enable register (SRE)", on page 333.

- **Standard Event Status**, i.e. the Event status Register (ESR) and the Event Status Enable (ESE), see Chapter 9.5.4, "Event status register (ESR) and event status enable register (ESE)", on page 334.

- **Questionable Status** and **Operation Status**, the (SCPI status registers, see Chapter 9.5.2, "Structure of a SCPI status register", on page 331, Chapter 9.5.5, "Questionable status register (STATus:QUEStionable)", on page 334 and Chapter 9.5.6, "Operation status register (STATus:OPERation)", on page 335.

- **Output-Queue**
  The output queue contains the messages that 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 command.

9.5.2 Structure of a SCPI status register

Each SCPI status register consists of five 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 9-6: The status-register model

Description of the five status register parts

The five parts of a SCPI status register have different properties and functions:

- **CONDition**
  The CONDition part is written directly by the hardware or it mirrors 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.

9.5.3 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 9-2: 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.
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 (main status summary bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this 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.

9.5.4 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 9-3: 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.
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.

9.5.5 Questionable status register (STATus:QUEStionable)

This register contains information on questionable instrument states. Such states can 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 9-4: Meaning of the bits used in the questionable status register

Bit No.	Meaning
0–15	Not used

9.5.6 Operation status register (STATus:OPERation)

This condition part contains information on the actions that the instrument currently executes. The event part contains information on the actions that the instrument executed since the last readout of the register.

To read the register, use the query commands `STAT:OPER:COND?` or `STAT:OPER[:EVEN]?`.

Table 9-5: 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	Not Used
4–15	Not used

9.5.7 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. For correct operation, the controller receives and evaluates the information of all devices. The status reporting system uses the following standard methods:

- **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**

9.5.7.1 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, set all bits 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 sets the instrument and initiates a service request if malfunctions occur. The program reacts appropriately to the service request.

9.5.7.2　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.

9.5.7.3　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.

9.5.7.4　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 regu-

larly since faulty commands from the controller to the instrument are recorded there as well.

9.5.8 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 for `*RST` and `SYSTem:PRESet` affect the functional instrument settings. In particular, `DCL` does not change the instrument settings.

Table 9-6: 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 TERMINA-TOR> clears the output buffer.

9.6 LXI configuration

"LAN eXtensions for Instrumentation" (LXI) is an instrumentation platform for measuring instruments and test systems that is based on standard Ethernet technology. LXI is intended to be the LAN-based successor to GPIB, combining the advantages of Ethernet with the simplicity and familiarity of GPIB.

On the R&S SGT, the LXI functionality is already installed and enabled. 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 of the instrument
● Performing SCPI remote diagnostics

9.6.1 Default network settings

According to the LXI standard, an LCI must set the following parameters to a default state.

Parameter	Value
TCP/IP mode	DHCP + Auto IP Address
Dynamic DNS	Enabled
ICMP ping	Enabled
Password for LAN configuration	LxiWebIfc

The LAN reset also resets the following parameters for the R&S SGT:

Parameter	Value
Hostname	<Instrument-specific host name>
Description	Signal generator
Negotiation	Auto detect
VXI-11 discovery	Enabled

The LAN settings are configured using the instrument's LXI browser settings.

9.6.2 LXI browser settings

You can access LXI borowser settings via a web browser.

Access:

► Type in the instrument's host name or IP address in the address field of the browser on your PC, for example "http://10.111.0.97".
Note: Do not add the missing zeros in the IP address, while opening the instrument home page.

The instrument home page (welcome page) opens.

The navigation pane of the browser interface contains the following elements:
● "LXI"
    – "Home" opens the instrument home page.
      The home page 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 in the browser dialog. 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 Chapter 9.6.3, "LAN configuration", on page 339.
    – "Status" displays information about the LXI status of the instrument.
    – "Utilities" provides access to the LXI event log functionality required by the LXI standard.
● "Diagnostics"
    – "SCPI Remote Trace" records messages exchanged via the remote control interface, see Chapter 9.6.3.4, "SCPI remote trace", on page 342.
● "Help"
    – "Glossary" explains terms related to the LXI standard.
    – www.rohde-schwarz.com opens the Rohde & Schwarz home page.

9.6.3 LAN configuration

The "LAN Configuration" web page displays all mandatory LAN parameters and allows their modification.

It comprises the following navigation entries.

9.6.3.1 IP configuration

The "IP configuration" web page displays all mandatory LAN parameters and allows their modification.

The "IP Address Mode" selects a configuration mode for the IP address of the instrument. With static configuration, the entered IP address, subnet mask, and default gateway are used. With dynamic configuration via DHCP or dynamic link local addressing (automatic IP), the instrument IP address is assigned automatically.

Password protection

Changing the LAN configuration is password protected and requires the security password. The default password is "instrument".

9.6.3.2 Advanced Config

The "Advanced Config" web page provides LAN settings that are not declared mandatory by the LXI standard.

The following advanced parameters are available:

- "mDNS and DNS-SD": The additional protocols "multicast DNS" and "DNS service discovery" are used for device communication in zero configuration networks, working without DNS and DHCP.

- "ICMP Ping": Must be enabled to use the ping utility.
  If you disable this setting, the instrument does not answer ping requests. The setting does not affect the LXI ping client. You can ping other hosts from the instrument, even if the setting is disabled.

- "VXI-11 Discovery": Must be enabled to detect the instrument in the LAN.
  If you disable this setting, the instrument cannot be detected by the VXI-11 discovery protocol mechanism. The setting does not affect other detection mechanisms. Setting up a VXI-11 connection via the IP address or the host name is independent of this setting.

ⓘ **Password protection**

Changing the LAN configuration is password protected and requires the security password. The default password is "instrument".

9.6.3.3 Ping client

The "Ping Client" page provides the ping utility to verify the connection between the LXI-compliant instrument and another device.

The ping is initiated from the instrument. Using the ICMP echo request and echo reply packets, the 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 10.111.0.125).

2. Select "Submit".

9.6.3.4 SCPI remote trace

The remote trace functionality allows you to trace input and output strings at the remote control interface of the R&S SGT, see Chapter 9.6.4, "How to record SCPI commands and messages via LXI", on page 344.

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 a SCPI command in hex format (also possible by double\-clicking a message)

Columns

The following columns are available if no column filter is applied:

- "Rec": record number of the message within the message log
- "MT": indicates the type of the message. Possible values and related message contents are:
  - > = incoming command
  - < = outgoing response to a query
  - E = error message, highlighted by red color
  - T = execution time, i.e. time required by the instrument to process the command internally

- **I**: number of the subinstrument
- "message": indicates the type of the message. Possible values and related message contents are:
  - \> = incoming command
  - < = outgoing response to a query
  - E = error message, denoted in red
  - T = execution time, i.e. time required by the instrument to process the command internally

9.6.4 How to record SCPI commands and messages via LXI

The remote trace functionality allows you to trace commands and messages exchanged via a remote control interface of the R&S SGT.

To activate the SCPI remote trace:

1. Start a web browser that supports html5 (W3C compliant).

2. Enter the IP address of the R&S SGT in the browser's address bar.

   The R&S SGT's welcome page is displayed.

3. In the navigation pane, select "Diagnostics > SCPI Remote Trace".

4. 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 SGT 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 stores 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 store the log in a file.

9.7 Monitoring remote control operation with R&S SGMA-GUI

The R&S SGMA-GUI can be used to monitor the behavior of one or more instruments while they are remote controlled.

A typical configuration consists of one monitor, controllers and instruments. The monitor is the remote PC on which the R&S SGMA-GUI is installed and the controller is the remote PC on which the application program runs.

Simultaneous control of an instrument from a controller and a monitor can lead to collisions whenever both the controller and the monitor utilize the same remote channel. These collisions are indicated by an error message in the "Info" line, e.g. "Query interrupted" or "Resource locked". Simultaneous monitoring and control over the same remote channel is only possible, if the used protocols support `viLock()/viUnlock()` and the remote program use these functions.

The Table 9-7 shows whether a collision-free communication over a particular combination of remote channels is possible or not and if there are any restrictions.

Table 9-7: Cross reference between used remote channels and collision-free communication

Monitor/ Controller	LAN (VXI-11)	LAN (HiSLIP)	USB	LAN (Socket)	PCIe
LAN (VXI-11)	OK*	OK	OK	OK	OK
LAN (HiSLIP)	OK	OK	OK	OK	OK
USB	OK	OK	`viLock/viUnlock`	OK	OK
LAN (Socket)	OK	OK	OK	X	OK
PCIe	OK	OK	OK	OK	X

Where:

- **OK**: communication possible, no collisions
  *) the R&S SGMA-GUI always uses the LAN device name **instr1**, see also Chapter 9.1.2.3, "VXI-11 protocol", on page 318.

- **X**: communication is not possible without collisions

- `viLock/viUnlock`: communication is only possible, if the remote control commands are enclosed in a `viLock () - viUnlock()` pair.

The R&S SGMA-GUI uses the `viLock()/viUnlock()` functions.

The figure below shows an example of configuration where the monitor and the controller are two different computers, connected to the same instrument over two different hardware interfaces.

Figure 9-7: Example of a setup for remote control monitoring

Connecting and configuring the monitoring PCs

In the "Setup > Security > Security Settings" dialog, check the state of the LAN and USB interfaces and enable them if necessary.

1. Connect the monitoring PC to the instrument.

   Note: Choose the hardware interface considering the limitations described in Table 9-7.

2. Configure the instrument in the R&S SGMA-GUI: See Chapter 5.5.2, "Managing instruments with R&S SGMA-GUI", on page 71.

3. In the "SGMA-GUI > Setup > Instruments > Edit Instruments" dialog, disable "Exclusive Access".

   Note: The two functions "Exclusive Access" and monitoring are mutually exclusive.

4. Send remote control commands from the controller to the instrument.

5. Open the corresponding dialogs in the R&S SGMA-GUI. Observe the status of the parameters.

10 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 the following sections:

- "Information on network operation and remote control" on page 312
- Chapter 9.5, "Status reporting system", on page 329

Conventions used in SCPI command descriptions

The following conventions are used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.

- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.

- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S SGT 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.

Commands

10.1 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 devi-
ces. 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>"

Example: `Rohde&Schwarz,SGT100A,`
                    `1412.0000K02/000000,3.1.17.1-03.01.158`

Usage: Query only

Manual operation: See "IDN String" on page 293

*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 293

---

*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.

---

*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

---

*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.

---

*SRE <Contents>

Service request enable

Sets the service request enable register to the indicated value. This command determines under which conditions a service request is triggered.

Parameters:

<Contents>   Contents of the service request enable register in decimal form.
                     Bit 6 (MSS mask bit) is always 0.

                     Range: 0 to 255

---

*STB?

Status byte query

Reads the contents of the status byte in decimal form.

Usage: Query only

---

*TRG

Trigger

Triggers all actions waiting for a trigger event. In particular, *TRG generates a manual trigger signal. This common command complements the commands of the `TRIGger` subsystem.

`*TRG` corresponds to the `INITiate:IMMediate` command.

Usage: Event

---

*TST?

Self-test query

Initiates self-tests of the instrument and returns an error code.

Return values:

<ErrorCode>   **integer > 0 (in decimal format)**
                     An error occurred.
                     (For details, see the Service Manual supplied with the instru-
                     ment).

                     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

10.2 General commands

:LOCK? <LockRequestId>

Sends a lock request ID which uniquely identifies the controller to the instrument.

Parameters:

<LockRequestId>   Number

0

test query to prove whether the instrument is locked

Controller ID

request lock from the controller with the specified Controller ID

Return values:

<Value>   Number

0

request refused; the instrument is already locked to other <Lock Request Id>, i.e. to another controller

1

request granted

Example: `:LOCK? 12345`
`Response: 1`
`:UNL 12345`

Usage: Query only

Manual operation: See "Exclusive Access" on page 60

:UNLock <UnlockId>

Unlocks an instrument locked to a controller with Controller ID = `<Unlock Id>`.

Setting parameters:

<UnlockId>   Number

Unlock ID which uniquely identifies the controller to the instrument. The value must match the Controller ID `<Lock Request Id>` set with the command `:LOCK?`.

0

Clear lock regardless of locking state

Usage: Setting only

Manual operation: See "Exclusive Access" on page 60

10.3 Preset commands

The preset commands are not bundled into one subsystem. Therefore, they are listed separately in this section. These specific commands are described in the associated subsystems.

The following presetting actions are available:

- Activating the default state of all internal instrument functions (`*RST` on page 351). Functions that concern the integration of the instrument into a measurement setup are not changed, e.g. TCP/IP address or reference oscillator source settings.
- Activating the original state of delivery (factory reset, `:SYSTem:FPReset` on page 354). Only functions that are protected by a password remain unchanged and the passwords themselves.

:SOURce<hw>:PRESet
:SYSTem:PRESet

Triggers an instrument reset. It has the same effect as:

- The `*RST` command
- The "SGMA-GUI > Instrument Name > Preset" function.
  However, the command does not close open GUI dialogs like the function does.

Example:	`SYST:PRES`
	All instrument settings (also the settings that are not currently active) are reset to their default values.
Usage:	Setting only

:SYSTem:FPReset

Triggers an instrument reset to the original state of delivery.

Example:	`SYST:FPR`
	all instrument settings (also those that are not currently active) are reset to the factory values.
Usage:	Event
Manual operation:	See "Execute Factory Preset" on page 295

10.4 CALibration subsystem

:CALibration<hw>:BBIN[:MEASure]?

Starts adjustment of the analog I/Q input. The I/Q input is adjusted with respect to DC offset and gain.

Return values:

<Measure>	0 | 1 | OFF | ON
	*RST: 0
Example:	CAL:BBIN:MEAS?
	starts the adjustment of the analog I/Q input.
	Response: 0
	adjustment has been performed successfully.
Usage:	Query only

:CALibration:ALL[:MEASure]?

Starts all internal adjustments for which no external measuring equipment is required.

Return values:

<All>	1 | ON | 0 | OFF
Usage:	Query only
Manual operation:	See "Adjust All" on page 272

:CALibration:FREQuency[:MEASure]?

Performs all adjustments which affect the frequency.

Return values:

<Synthesis>	1 | ON | 0 | OFF
Usage:	Query only
Manual operation:	See "Synthesis" on page 272

:CALibration:IQMModulator:BBANd[:STATe] <Modulator>

Parameters:

<Modulator>	OFF | ON | 1 | 0
Manual operation:	See "Baseband" on page 273

:CALibration:IQModulator:FULL?

Starts the adjustment of the I/Q modulator for the entire frequency range. The I/Q modulator is adjusted with respect to carrier leakage, I/Q imbalance and quadrature.

Return values:

<Modulator>   1 | ON | 0 | OFF

Usage: Query only

Manual operation: See "I/Q Modulator" on page 273

:CALibration:IQModulator:LOCal?

Starts the adjustment of the I/Q modulator for the current frequency. The I/Q modulator is adjusted with respect to carrier leakage, I/Q imbalance and quadrature.

This adjustment is only possible when `:OUTPut[:STATe] ON` and `[:SOURce]:IQ:STATe ON`.

Usage: Query only

Manual operation: See "Adjust I/Q Modulator at Current Frequency" on page 272

:CALibration:IQModulator:IQModulator[:STATe] <Modulator>

Acitvates/deactivates a separat internal adjustment procedure for the I/Q modulator.

Parameters:

<Modulator>   OFF | ON | 1 | 0

Manual operation: See "I/Q Modulator" on page 273

:CALibration:LEVel[:MEASure]?

Starts all adjustments which affect the level.

Return values:

<Level>   1 | ON | 0 | OFF

Usage: Query only

Manual operation: See "Level" on page 272

:CALibration:FREQuency:TEMPerature?
:CALibration:LEVel:TEMPerature?
:CALibration:IQModulator:TEMPerature?

Queries the delta temperature since the last performed adjustment.

Return values:

<Temperature>   string

Usage: Query only

:CALibration:ROSCillator:DATA:MODE <Mode>

Defines whether the factory provided or a custom defined calibration value is used to adjust the reference oscillator.

Parameters:

<Mode>	FACTory | CUSTomer
	*RST: FACTory

Example:	:CALibration1:ROSCillator:DATA:MODE CUSTomer
	:CALibration1:ROSCillator:DATA 35600

Manual operation:	See "Active Adjustment Data" on page 301

:CALibration:ROSCillator[:DATA] <Data>

Sets the calibration value for the custom defined external adjustment.

Parameters:

<Data>	integer
	Range: 0 to INT_MAX
	*RST: 0

Manual operation:	See "Calibration Value" on page 301

10.5 CLOCk subsystem

:CLOCk:INPut:FREQuency?

Queries the measured frequency of the external clock signal. An external clock reference must be supplied at the [USER1/2] input.

Return values:

<Frequency>	float
	Range: 0 to max
	Increment: 0.001
	*RST: 0

Example:	CLOC:INP:FREQ?
	queries the measured frequency of the external clock reference.

Usage:	Query only

Manual operation:	See "Measured External Clock" on page 134

:CLOCk:INPut:SLOPe <Slope>

The command sets the active slope of an externally applied clock signal at the [USER 1/2] connector.

Parameters:

<Slope>   NEGative | POSitive

                   *RST: POSitive

Example: CLOC:INP:SLOP NEG

                   The active slope of the external clock signal is the falling slope.

:CLOCk:OUTPut:MODE <Mode>

The command sets the output of bit or symbol clock pulses at the [USER 1/2] connector at the rear panel.

Parameters:

<Mode>   SYMBol | BIT

                   *RST: SYMBol

Example: CLOC:OUTP:MODE SYMB

                   The internal symbol clock is output.

:CLOCk:SYNC[:STATe]?

Requires instruments working in secondary synchronization mode.

Queries the status of the external clock source. The status indicates, if the external clock source of the secondary instrument is synchronized or not synchronized yet.

Return values:

<State>   0 | 1 | OFF | ON

                   *RST: n.a. (no preset. default: 0)

Example: :CLOCk:SYNC:STATe?
                   // Response: "1"
                   // The clock source of the secondary instrument
                   is synchronized.

Usage: Query only

Manual operation: See "Synchronisation State" on page 134

10.6 CONNector subsystem

:CONNector:REFLo:OUTPut <Output>

Determines the signal provided at the output connector [REF/LO OUT] (rear of the instrument).

Parameters:

<Output>   REF | LO | OFF

                        *RST: REF

Manual operation: See "REF/LO Output" on page 221

:CONNector:USER<ch>:OMODe <Omode>

Sets the operation mode of the user connector.

Parameters:

<Omode>   MKR1 | MKR2 | TRIGger | CIN | COUT | SIN | SOUT | NEXT |
                        LOW | MLATency | MARRived | HIGH | SVALid | SNValid |
                        PVOut | PETRigger | PEMSource | TOUT

                        MKR1/2
                        Marker 1/2

                        TRIGger
                        Trigger

                        TOUT
                        Trigger out

                        CIN
                        Clock in

                        COUT
                        Clock out

                        SIN
                        Sync in

                        SOUT
                        Sync out

                        NEXT
                        Next trigger

                        SVALid|SNValid
                        Signal valid /not valid

                        PVOut
                        Pulse generator video out

                        PETRigger
                        Pulse generator external trigger

                        PEMSource
                        External pulse modulator source

Manual operation: See "Mode" on page 259

:CONNector:USER\<ch>:THReshold \<Threshold>

Sets the threshold for the user connector.

Parameters:

\<Threshold>   float

                             Range: 0 to 2
                             Increment: 0.1
                             *RST: 1

Manual operation: See "Threshold" on page 262

:CONNector:USER\<ch>:CLOCk:IMPedance \<Impedance>
:CONNector:USER\<ch>:TRIGger:IMPedance \<Impedance>

Selects the input impedance for the external trigger/clock inputs, when `:CONNector:USER<ch>:OMODe` is set to `TRIGger` or `CIN/COUT`.

Parameters:

\<Impedance>   G50 | G10K

                             G10K
                             Provided only for backward compatibility with other R&S signal generators.
                             The R&S SGT accepts this values and maps it automatically to G1K.

                             *RST: G10K

Manual operation: See "Impedance" on page 262

:CONNector:USER\<ch>:CLOCk:SLOPe \<Slope>
:CONNector:USER\<ch>:TRIGger:SLOPe \<Slope>

Sets the polarity of the active slope of an applied instrument trigger/clock.

Parameters:

\<Slope>   NEGative | POSitive

                             *RST: POSitive

Manual operation: See "Trigger Slope" on page 262

10.7 DIAGnostic subsystem

:DIAGnostic:POINt:CATalog?

Queries the test points available in the instrument.

Usage: Query only

:DIAGnostic[:MEASure]:POINt? <Name>

Triggers voltage or temperature measurement at the specified test point and returns the measured value.

Use the command `:DIAGnostic:POINt:CATalog?` to retrieve a list of the available test points.

For description of the test points, see the service manual.

Query parameters:

<Name>	string

Return values:

<Value>	number
	Default unit: V or °C

Usage: Query only

10.8 FORMat Subsystem

The `FORMat` subsystem contains the commands which determine the format of the data that the R&S SGT returns to the controller. This affects all query commands which return a list of numerical data or block data. Reference is made to this in the descriptions of the commands.

: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 The instrument expects (with setting commands) and sends (with queries) the least significant byte of each IEEE754 floating-point number first and the most significant byte last.
	SWAPped The instrument expects (with setting commands) and sends (with queries) the most significant byte of each IEEE754 floating-point number first and the least significant byte last.
	*RST: NORMal

Example: `FORM:BORD SWAP`

The data is transferred with the most significant bit first.

:FORMat[:DATA] <Data>

Determines the data format which the R&S SGT uses to return data. When data is transferred from the control computer to the instrument, the instrument detects the data format automatically. In this case, the value set here is irrelevant.

Parameters:

<Data>　　　　　　　　ASCii | PACKed

　　　　　　　　　　　ASCii
　　　　　　　　　　　Numerical data is transferred as plain text separated by commas.

　　　　　　　　　　　PACKed
　　　　　　　　　　　Numerical data is transferred 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
　　　　　　　　　　　The data is transferred as ASCII data.

:FORMat:SREGister <Format>

Determines the numerical format which is returned when the status registers are queried.

Parameters:

<Format>　　　　　　　ASCii | BINary | HEXadecimal | OCTal

　　　　　　　　　　　ASCii
　　　　　　　　　　　The register content is returned as a decimal number.

　　　　　　　　　　　BINary
　　　　　　　　　　　The register content is returned as a binary number. #B is placed in front of the number.

　　　　　　　　　　　HEXadecimal
　　　　　　　　　　　The register content is returned as a hexadecimal number. #H is placed in front of the number.

　　　　　　　　　　　OCTal
　　　　　　　　　　　The register content is returned as an octal number. #Q is placed in front of the number.

　　　　　　　　　　　*RST:　　　　ASCii

Example:　　　　　FORM:SREG HEX
　　　　　　　　　　　The register content is returned as a hexadecimal number.

10.9 MMEMory subsystem

The MMEMory subsystem (**M**ass **Mem**ory) contains the commands for managing files and directories as well as for loading and storing complete instrument settings in files.

The files are stored on the internal flash memory of the instrument or on external USB memory devices.

The default directory is determined using the command `MMEMory:CDIR`.

Use the command `:SYSTem:MMEMory:PATH:USER?` to query the path of the directory for user-defined data.

The `/opt` directory is a protected and therefore a not accessible system directory. The files on this directory contain data that must not be changed. Therefore, this directory should not be accessed, since reconstruction of the system partition will lead to data loss.

10.9.1 File naming conventions

To enable files in different file systems to be used, the following file naming conventions should be observed.

The file name can be of any length and is case-sensitive, meaning it is distinguished between uppercase and lowercase letters.

The file and the optional file extension are separated by a dot. All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the file name). If possible, special characters should not be used. The use of the slashes "\" and "/" should be avoided since they are used in file paths. A number of names are reserved for the operating system, e.g. `CLOCK$`, `CON`, `AUX`, `COM1...COM4`, `LPT1...LPT3`, `NUL` and `PRN`.

In the R&S SGT all files in which lists and settings are stored are given a characteristic extension. The extension is separated from the actual file name by a dot (see Chapter 10.9.2, "Extensions for user files", on page 364 for an overview of the file types).

The two characters "*" and "?" function as "wildcards", meaning 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 file name. "*.*" therefore stands for all files in a directory.

When used in conjunction with the commands, the parameter `<file_name>` is specified as a string parameter with quotation marks. It can contain either the complete path including the drive, only the path and the file name, or only the file name. The file name must include the file extension. The same applies for the parameters `<directory_name>` and `<path>`.

Depending on how much information is provided, either the values specified in the parameter or the values specified with the command `MMEM:CDIR` (default directory) are used for the path and the drive settings in the commands.

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 subsequently used in the `:MMEMory:STORe:STATe` on page 372 command. Also, subsequently to loading a file with instrument settings with command `:MMEMory:LOAD:STATe` on page 371, these settings have to be activated with the common command `*RCL <number>`.

10.9.2 Extensions for user files

Table 10-1: Automatically assigned file extensions in the instrument

Function	Contents	File suffix
R&S SGMA-GUI Save As/Open	Software settings	`*.savrcl`

10.9.3 Examples

In these examples, the current instrument setting is stored in the file `test.savrcltxt` in the directory `/var/user/..`

Storing and Loading Current Settings

1. Store the current setting in an intermediate memory with the number 4. This setting can be called using command `*RCL` and the associated number of the memory, for example `*RCL 4`.
   `*SAV 4`

2. To store the settings in a file in a specific directory, specify the complete path.
   `MMEM:STOR:STAT 4,"/var/user/test.savrcltxt"`

3. To store the settings in a file in the default drive, set the default drive and specify only the file name.
   `MMEM:CDIR '/var/user/'*SAV 4`
   `MMEM:STOR:STAT 4,"test.savrcltxt"`

4. Load the file `test.savrcltxt` in the `user` directory.
   `MMEM:LOAD:STAT 4,'/var/user/test.savrcltxt'`

5. Activate the instrument setting of the file `test.savrcltxt`.
   `*RCL 4`

Working with Files and Directories

1. Read out all files in the specified directory.
   `MMEM:CAT? 'usbuser'`

   Response: `127145265,175325184,"test,DIR,0","temp,DIR,0",`
   `"readme.txt,ASC,1324","state.savrcltxt,STAT,5327",`
   `"waveform.wv,BIN,2342"`

the directory `usbuser` contains the subdirectories `test` and `temp` as well as the files `readme.txt`, `state.savrcltxt` and `waveform.wv` which have different file types.

Tip: To query only the subdirectories of the current or specified directory, perform:
`MMEM:DCAT? 'usbuser'`

Response: `'test', 'temp'`

To query only the number of subdirectories in the current or specified directory, perform:

`MMEM:DCAT:LENG? 'usbuser'`

Response: `2`

2. To query the number of files in the current or specified directory, perform:
`MMEM:CAT:LENG? 'usbuser'`

Response: `3`

3. Create a new subdirectory for mass memory storage in the specified directory.
`MMEM:MDIR 'usbnew'`

4. Copy the file `state` to a new file.
`MMEM:COPY '/var/user/state.savrcltxt','usbnew'`

5. Rename the file `state`.
`MMEM:MOVE 'state.savrcltxt','state_new.savrcltxt'`

6. Remove the `test` directory.
`MMEM:RDIR 'usbtest'`

10.9.4 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

: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 omit-
ted, 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

: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

: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` indi-
                          cate 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:DATA:UNPRotected <Msus>, <Data>

The **setting** command sends the I/Q data and the marker data to the file defined with
the `<Msus>` parameter. The required tags are created automatically so that the file
content follows the waveform file format.

The **query** reads out the I/Q data part or the marker information of the specified file.

Waveform files can also be created with the command `[:SOURce<hw>]:BB:`
`ARBitrary:WAVeform:DATA`. In this case, the *complete content* of the waveform file
must be specified, i.e. not only the I/Q or marker data but all required tags.

Parameters:

<Msus>   <Identifier>:<file name>

                          Mass Storage Unit Specifier
                          A string that specifies whether I/Q data (`NVWFM`) or marker data
                          (`NVMKR`) is transferred and the file name the data is stored in.
                          If the file with the specified name does not exist, a file is created.
                          Any existing content in the file is *overwritten*.
                          Complete file path and file extension may also be specified. If
                          omitted, files are stored in the default directory and the exten-
                          sion `*.wv` is assigned to the file name.

Setting parameters:

<Data>   block data

                          I/Q data or marker binary data, where the number of marker ele-
                          ments has to be equal to the number of I/Q samples
                          Binary block data follows the syntax:
                          `#<Digits><Length><I0Q0..IxQx…IN-1QN-1>` or
                          `#<Digits><Length><M0M1…Mx…MN-1>`

                          #
                          Indicates the start of the data block

<Digits>
Decimal value
Gives the number of decimal digits used for the `<Length>`
value

<Length>
Decimal value
Number of bytes that follow in the `<Binary data>` part

I0Q0..IxQx…IN-1QN-1
Binary data in ASCII format
`IxQx…` represents binary data (16-bit signed integer in 2's complement notation) containing the I and Q component alternately and starting with the I component. Each I and Q component consists of 2 bytes in MSB format (most significant byte first).
The values of the 2 bytes in an I component and a Q component are in the range: -32767 to +32767.

M0M1…Mx…MN-1
Binary data in ASCII format
`Mx` represents one marker byte, where only the 4 least significant bits are used. These 4 bits are assigned to the 4 possible markers of the instrument, 1 bit per marker: Bit_0 = Marker 1, ... Bit_3 = Marker 4.
One 4-bit marker element is required for every I/Q sample.

Example:

```
:MMEM:DATA:UNPR "NVWFM:/var/user/wave.wv",#220<I0Q0..IxQx>
// the binary data <I0Q0..IxQx> is added to a file named wave.wv
// and saved in the selected directory
// <I0Q0..IxQx> contains of 20 bytes, i.e. 5 I/Q samples,
// 2 bytes for each I and Q component
// <I0Q0..IxQx> is a placeholder;
// the actual ASCII values are not printable

:MMEMory:DATA:UNPRotected? "NVWFM:/var/user/wave.wv"
:MMEMory:DATA:UNPRotected "NVMKR:/var/user/wave.wv",#15<M0M1…M5>
// the specified marker data is added to a file named wave.wv
// in the specified directory
// used are printable values;
// used are only the 4 least significant bits of a byte
:MMEMory:DATA:UNPRotected? "NVMKR:/var/user/wave.wv"
// note that, the query returns binary values
SOURce1:BB:ARBitrary:WAVeform:CLOCk "/var/user/wave.wv",1.1E6
SOURce1:BB:ARBitrary:WAVeform:CLOCk? "/var/user/wave.wv"
```

: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

: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

: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

: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

: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

: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

10.10 Fast speed commands

This section describes special commands that allow a fast frequency and level setting.

:FFASt <Freq>

Special command to set the RF output frequency with minimum latency. No unit (e.g. Hz) allowed.

Bypasses the status system so command `*OPC?` cannot be appended.

Parameters:

<Freq>	float
Example:	`FFASt 12750000000`

:PFASt <Pow>

Special command to set the RF output level with minimum latency at the RF output connector. This value does not consider a specified offset. No unit (e.g. dBm) allowed.

Bypasses the status system so command `*OPC?` cannot be appended.

Parameters:

<Pow>   float

Example: `:PFASt -20`

10.11 OUTPut subsystem

:OUTPut:AFIXed:RANGe:LOWer?

Queries the minimum level which can be set without the attenuator being adjusted (Attenuator FIXed).

Return values:

<Lower>   float

Usage: Query only

Manual operation: See "Level Range" on page 228

:OUTPut:AFIXed:RANGe:UPPer?

Queries the maximum level which can be set without the attenuator being adjusted (Attenuator FIXed).

Return values:

<Upper>   float

Usage: Query only

Manual operation: See "Level Range" on page 228

:OUTPut:AMODe <AMode>

Switches the mode of the attenuator at the RF output.

Parameters:

<AMode>   AUTO | FIXed | APASsive

AUTO

The attenuator is switched automatically. The level settings are made in the full range.

APASsive

The attenuator is switched automatically. The level settings are made only for the passive reference circuits. The high-level ranges are not available.

FIXed

The level settings are made without switching the attenuator. When this operating mode is switched on, the attenuator is fixed to its current position and the resulting variation range is defined.

    *RST: AUTO

Manual operation: See "Mode" on page 227

:OUTPut[:STATe] <State>

Activates the RF output signal ([RF on/off]).

Parameters:

<State>   1 | ON | 0 | OFF

Manual operation: See "RF On/Off" on page 68

:OUTPut[:STATe]:PON <Pon>

Selects the state of the RF output when the instrument is switched on.

Parameters:

<Pon>   OFF | UNCHanged

OFF

Deactivates the output when the instrument is switched on ([RF off]).

UNCHanged

Restores the initial state of the RF output before the last turn off.

    *RST: UNCHanged

Manual operation: See "Power-On State" on page 229

10.12 SCONfiguration subsystem

:SCONfiguration:MODE <Configuration>

Switches between standard mode and ARB mode for envelope tracking.

Parameters:

<Configuration>   STANdard | AFETracking

STANdard

Standard mode used for signal generation.

AFETracking

ARB foe Envelope Tracking: enables the usage of an extra baseband for enabling the envelope tracking ARB generation.

*RST: STANdard

Manual operation: See "System Configuration" on page 86

10.13 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 SGT.

ⓘ The local state is set with the INIT command. Switching off the local state enhances the measurement performance. Measurements results can be retrieved in local state on or off.

Sensor parameters are set with the SENSe commands.

To start the measurement and retrieve the result, use the :READ<ch>[:POWer]? command.

Suffix	Value range	Description
SENSe<ch>	[1] to 4	Indicates the sensor Use the :SLISt commands to change the sensor mapping
READ<ch>	[1] to 4	Sensor assignment
INIate<hw>	[1] to 4	Sensor assignment
ELEMent<ch>	[1] to 25	Sensor-mapping list

Programming examples

Example: Detecting and assigning a power sensor

```
SLISt:LIST?
// Response: "NRP33SN-V-900007-USB Legacy","NRP-Z211-900001-USB Legacy"
// Lists all automatically detected sensors.

SLISt:SCAN:STATe 1
// Searches for sensors connected in the LAN or via the USBTMC protocol.

SLISt:SCAN:LSENsor 'NRQ6',101624 // sensor name, serial number
SLISt:SCAN:LSENsor 11.123.1.123, 101624 // IP address, serial number
// Adds sensors to the list, that are connected to LAN.



SLISt:SCAN:USENsor 'NRQ6',101624 //sensor name, serial number
SLISt:SCAN:USENsor #H15b,101624  //device ID (hexadecimal), serial number
SLISt:SCAN:USENsor 347,101624    //device ID (decimal), serial number
// Adds a sensor to the list, that is connected to the USB interface.



SLISt:LIST?
// Response: "NRP33SN-V-900007-USB Legacy","NRP-Z211-900001-USB Legacy",
// "NRP33SN-V-900005-USBTMC","NRP33SN-V-900011-LAN"
// Lists all automatically detected sensors.

SLISt:ELEMent3:MAPPing SENS1
// Maps the third sensor from the list to the first sensor channel.

SLISt:SENSor:MAP "NRPS18S-100654-USB Legacy", SENS3
// Maps the sensor to channel 3.



SLISt:CLEar[ALL]
// Remove all sensors from the list.
SLISt:CLEar:LAN
// Remove all sensors from the list, that are connected over LAN.
SLISt:CLEar:USB
// Remove all sensors from the list, that are connected over USB.
```

Example: Performing a simple power measurement

Prerequisite: The sensor is connected to the instrument and mapped to the first sensor channel.

```
INITiate1:CONTinuous ON
// Switches the continous power measurement on.


READ1?
// Triggers the measurement and displays the results.
```

Example: Performing a power measurement with a fixed filter

Prerequisite: The sensor is connected to the instrument and mapped to the first sensor channel.

```
SENSe1:SOURce RF
// Sensor measures the power of the RF signal.


SENSe1:FILTer:TYPE NSRatio
// Selects fixed noise filter mode.


SENSe1:FILTer:NSRatio 0.02 DB
// Sets the maximum noise component in the result to 0.02 DB.


SENSe1:FILTer:NSRatio:MTIMe 10
//Limits the settling time to 10 seconds.


SENSe1:APERture:DEFault:STATe 0
// Deactivates the default aperture time of the sensor.


SENSe1:APERture:TIMe 10e-6
// Sets the aperture time to 10 us.


SENSe1:UNIT DBM
// Selects unit dBm for the measured value.


INITiate:CONTinuous ON
// Switches the continous power measurement on.


READ?
// Triggers the measurement and displays the results.
```

:SLISt[:LIST]?

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 376.

Usage: Query only

Manual operation: See "Sensor Mapping List" on page 254

:SLISt:SCAN[:STATe] <State>

Starts the search for R&S NRP power sensors, connected in the LAN or via the USBTMC protocol.

Parameters:

<State>   1 | ON | 0 | OFF

*RST: 0

Example: See Example"Detecting and assigning a power sensor" on page 376.

Manual operation: See "Scan" on page 254

: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 376.
Usage:	Setting only
Manual operation:	See "Add LAN Sensor settings" on page 254

: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 376.
Usage:	Setting only
Manual operation:	See "Add USB Sensor settings" on page 255

: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 376.
Usage:	Event
Manual operation:	See "Clear" on page 254

: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 376.
Usage:	Event
Manual operation:	See "Clear" on page 254

:SLISt:CLEar[:ALL]

Removes all R&S NRP power sensors from the list.

Example:	See Example"Detecting and assigning a power sensor" on page 376.
Usage:	Event
Manual operation:	See "Clear" on page 254

: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 376.
Manual operation:	See "Sensor Mapping List" on page 254

: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 376.
Usage:	Setting only
Manual operation:	See "Sensor Mapping List" on page 254

:INITiate<hw>[:POWer]:CONTinuous <Continuous>

Switches the local state of the continuous power measurement by R&S NRP power sensors on and off. Switching off local state enhances the measurement performance during remote control.

The remote measurement is triggered with `:READ<ch>[:POWer]?`). This command also returns the measurement results. The local state is not affected, measurement results can be retrieved with local state on or off.

Parameters:

<Continuous>	1 | ON | 0 | OFF
	*RST: 0

Example:	`INIT1:CONT ON`
	Switches on the local state of continuous power measurement.

Manual operation:	See "State" on page 249

: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 249

: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 com-
                           mand READ.

                           :READ2?

                           Response: 7.34

                           7.34 dBm are measured by sensor 2.

Manual operation: See "Level (Peak) / Level (Average)" on page 249

: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 382.

Parameters:

<UseDefAp>   1 | ON | 0 | OFF

                           *RST: 1

Example: See Example"Performing a power measurement with a fixed fil-
                           ter" on page 377.

Manual operation: See "Default Aperture Time" on page 252

: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 fil-
                           ter" on page 377.

Manual operation: See "Aperture Time" on page 252

: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 252

:SENSe<ch>[:POWer]:CORRection:SPDevice:STATe <State>

Activates the use of the S-parameter correction data.

Note: If you use power sensors with attenuator, the instrument automatically activates the use of S-parameter data.

Parameters:

<State>	1 | ON | 0 | OFF
	*RST: 0

Example: `:SENSe1:POWer:CORRection:SPDevice:STATe 1`
Activates the use of the S-parameters correction data.

Manual operation: See "S-Parameter" on page 252

: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 252

:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority <Priority>

Selects average or peak power for permanent display.

Parameters:

<Priority>	AVERage | PEAK
	*RST: AVERage

Example: `:SENS1:DISP:PERM:STAT ON`
Turns on the permanent view.
`:SENS1:DISP:PERM:PRI AVER`
Sets the average power for display.

Manual operation: See "Display" on page 250

:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe <State>

Activates the permanent display of the measured power level results. The instrument also indicates the sensor type, the connection, the measurement source and the offset if set.

Parameters:

<State>   1 | ON | 0 | OFF

                           *RST: 0

Example: :SENS1:POW:DISP:PERM:STAT ON

                           Turns on the permanent view.

Manual operation: See "Permanent" on page 250

: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 251

: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 measure-
ment time (see also "About the measuring principle, averaging filter, filter length, and
achieving stable results" on page 245).

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 251

: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 377.

Manual operation: See "Noise Content" on page 251

: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 377.

Manual operation: See "Timeout" on page 252

: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 251

: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 377.

Manual operation: See "Filter" on page 251

:SENSe<ch>[:POWer]:FREQuency <Frequency>

Sets the RF frequency of the signal, if signal source `:SENSe<ch>[:POWer]:SOURce USER` is selected.

Parameters:

<Frequency>   float

*RST: 1 GHz

Example: `:SENS1:SOUR USER`
Selects user-defined source.
`:SENS1:FREQ 2.44GHz`
Sets the RF frequency of the source which is 2.44 GHz.

Manual operation: See "Frequency" on page 250

:SENSe<ch>[:POWer]:LOGGing:STATe <State>

Activates the recording of the power values, measured by a connected R&S NRP power sensor.

Parameters:

<State>   1 | ON | 0 | OFF

                          *RST: 0

Example: :SENS:LOGG:STAT ON

                          Activates recording of the power measurement of the first sensor.

Manual operation: See "Enable Logging" on page 252

: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 250

:SENSe<ch>[:POWer]:OFFSet:STATe <State>

Activates the addition of the level offset to the measured value. The level offset value is set with command :SENSe<ch>[:POWer]:OFFSet.

Parameters:

<State>   1 | ON | 0 | OFF

                          *RST: 0

Example: :SENS1:POW:OFFS 0.4dB

                          Sets a level offset of 0.4 dB

                          :SENS1:POW:OFFS:STAT ON

                          A level offset of 0.4 dB is added to the measured value.

Manual operation: See "Level Offset State,Level Offset" on page 250

: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 249

: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 377.

Manual operation:	See "Source" on page 250

:SENSe<ch>[:POWer]:STATus[:DEVice]?

Queries if a sensor is connected to the instrument.

Return values:

<Status>	1 | ON | 0 | OFF
	*RST: 0

Example:	:SENS1:STAT?
	Response: 1
	A sensor is connected.

Usage:	Query only

Manual operation:	See "State" on page 249

:SENSe<ch>[:POWer]:SVERsion?

Queries the software version of the connected R&S NRP power sensor.

Return values:

<SVersion>	string

Example:	:SENS1:POW:SVER?
	Queries the software version of the power sensor.

Usage:	Query only

:SENSe<ch>[:POWer]:TYPE?

Queries the sensor type. The type is automatically detected.

Return values:

<Type>   string

Example: :SENS1:TYPE?
                         Queries the type of sensor.
                         Response: NRP-Z21
                         The R&S NRP-Z21 sensor is used.

Usage: Query only

Manual operation: See "Sensor type and serial number" on page 249

: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 249

10.14 SOURce subsystem

The SOURce subsystem contains the commands for configuring the digital and analog signals.

SOURce<hw>

The R&S SGT is a one path instrument, therefore the keyword SOURce<hw> is optional and can be omitted.

Exception are some commands used with option R&S SGT-K540, envelope tracking. For details, see Chapter 10.14.4, "SOURce:BB:ARB subsystem", on page 401.

10.14.1 SOURce general commands

[:SOURce]:FREQuency[:CW|FIXed] <Cw>

Sets the RF frequency at the RF output connector of the selected instrument.

Note: Enabled frequency offset affects the result of this query. The query returns the frequency, including frequency offset.

Parameters:

<Cw>   float
                          *RST: 1 GHz

Example: See [:SOURce]:FREQuency:OFFSet on page 390.

Manual operation: See "Freq/Freq (Offs)" on page 67
                          See "Frequency" on page 218

[:SOURce]:FREQuency:OFFSet <Offset>

Sets a frequency offset, for example include the frequency shift of downstream instrument.

Note: Enabled frequency offset affects the result of the query :SOURce:FREQuency:CW?

The query returns the frequency, including frequency offset.

Parameters:

<Offset>   float

> Range: -3e9 to 3e9
> Increment: 1E-3
> *RST: 0

Example: SOURce:FREQuency:OFFSet 0

SOURce:FREQuency:CW 2143000000

SOURce:FREQuency:OFFSet 20000000

SOURce:FREQuency:CW?

// 2163000000

Manual operation: See "Offset" on page 218

[:SOURce]:OPMode <OpMode>

Sets the operation mode.

Parameters:

<OpMode>   NORMal | BBBYpass

NORMal
normal operation

BBBYpass
Baseband bypass mode

> *RST: NORMal

Manual operation: See "Operation Mode" on page 217

[:SOURce]:LOSCillator:SOURce <Source>

Selects the source of the local oscillator signal.

Parameters:

<Source>   INTernal | EXTernal

INT: use built in oscillator; EXT: use signal at [LO/ REF IN] con-
nector

> *RST: INTernal

Manual operation: See "Source" on page 220

[:SOURce]:PATH:COUNt?

Queries the number of installed RF paths.

Return values:

<Count>   integer

> Range: 1 to INT_MAX
> *RST: 1

Example: `PATH:COUN?`
Queries the number of RF paths.
`Response: 1`
The instrument is equipped with one RF path.

Usage: Query only

10.14.2 SOURce:AWGN subsystem

The `SOURce:AWGN` subsystem contains the commands for setting the noise generator.

These commands are available in instrument equipped with the option R&S SGT-K62 (Additive White Gaussian Noise).

[:SOURce<hw>]:AWGN:BRATe <BRate>

Sets the bit rate which is used for calculation of bit energy to noise power ratio from carrier/noise ratio for Digital Standard signals.

Valid units are bps, kbps and mabps as well as b/s, kb/s and mab/s.

Parameters:

<BRate>   float

Range: 400 bps to 250E6 bps
Increment: 0.001
*RST: 100000

Example: `SOURce1:AWGN:BRATe?`
queries the bit rate which is used for calculation of the Eb/N0 value from the C/N value.

Manual operation: See "Bit Rate" on page 147

[:SOURce<hw>]:AWGN:BWIDth <BWidth>

Sets the system bandwidth. The noise signal at the level which corresponds to the specified carrier/noise ratio is generated in the bandwidth specified here.

This command is available for modes Additive Noise and Noise Only (`SOUR:AWGN:MODE ADD|ONLY`).

Parameters:

<BWidth>	float	
	Range:	1000 to depends on the installed options
	Increment:	100
	*RST:	3.84E6

Example:	`SOURce:AWGN:MODE ADD`
	`SOURce:AWGN:BWIDth 10 MHz`
	Sets a system bandwidth of 10 MHz.

Manual operation: See "System Bandwidth" on page 144

[:SOURce<hw>]:AWGN:BWIDth:NOISe?

This command is available for modes In Additive Noise and Noise Only (`SOUR:AWGN:MODE ADD|ONLY`) modes, queries the real noise bandwidth.

Return values:

<Noise>	float	
	Range:	0 to 200E6
	Increment:	100
	*RST:	0

Example:	`AWGN:BWID:NOIS?`
	queries the noise bandwidth.

Usage: Query only

Manual operation: See "Noise Bandwidth" on page 146

[:SOURce<hw>]:AWGN:BWIDth:RATio <Ratio>

In Additive Noise and Noise Only (`SOUR:AWGN:MODE ADD|ONLY`) modes, sets the ratio of minimum real noise bandwidth to system bandwidth.

The overall bandwidth is calculated as follows and may not exceed the total bandwidth specified in the data sheet:

Overall Bandwidth = System BW x Min Noise/System BW Ratio

Parameters:

<Ratio>	float	
	Range:	1 to Max
	Increment:	0.1
	*RST:	1

Example:	`AWGN:BWID:RAT 2`
	sets a minimum noise/system bandwidth ratio of 2.
Manual operation:	See "Minimum Noise/System Bandwidth Ratio" on page 145

[:SOURce<hw>]:AWGN:CNRatio <CnRatio>

In Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) mode, sets the carrier/interferer ratio. The value range depends on the selected AWGN mode.

Parameters:

<CnRatio>	float
	Range: -50 to 40 Increment: 0.01 *RST: 0 Default unit: dB
Example:	`AWGN:CNR 10`
	sets a carrier/noise ratio of 10 dB.
Manual operation:	See "Carrier/Noise Ratio / Signal/Noise Ratio" on page 147

[:SOURce<hw>]:AWGN:DISP:MODE <Mode>

Selects the display mode to Bseband or RF.

Parameters:

<Mode>	RF | BB
	*RST: RF
Example:	`AWGN:DISP:MODE RF`
	Sets the display mode to RF
Manual operation:	See "Display Mode" on page 146

[:SOURce<hw>]:AWGN:DISP:ORESults <OResults>

(requires option R&S SGT-K18, Digital Baseband Connectivity)

In additive Noise and Noise Only (`SOUR:AWGN:MODE ADD|ONLY`) modes and for Display Mode set to Baseband (`AWGN:DISP:MODE BB`), selects the display of output results for the analog (DACIF) or the digital (BBOUT) signal path.

Parameters:

<OResults>	ANALog | DIGital
	*RST: ANALog
Example:	`SOURce:AWGN:MODE ONLY`

	activates the generation of a pure noise for path A.
	`SOURce:AWGN:DISP:MODE BB`
	sets the display mode
	`SOURce:AWGN:DISP:ORESults DIGital`
	displays the output results of the digital signal of path A.

[:SOURce\<hw\>]:AWGN:ENRatio \<EnRatio\>

In Additive Noise mode, sets the ratio of bit energy to noise power density.

For **Digital Standard** signals, the bit rate used for calculation of E_b/N_0 value from C/N value is defined with command `SOUR:AWGN:BRAT`.

Parameters:

\<EnRatio\>	float
	Range: -50 to depends on hardware
	Increment: 0.01
	*RST: 15.84
	Default unit: dB

Example: `AWGN:ENR 10`

sets a ratio of bit energy to noise power density of 10 dB

Manual operation: See "E_b/N_0" on page 148

[:SOURce\<hw\>]:AWGN:FREQuency:RESult?

In CW inerferer mode, queries the actual frequency of the sine.

The actual frequency may differ from the desired frequency, since the resolution is limited to 0.7 Hz.

Return values:

\<Result\>	float
	Range: -40E6 to 40E6
	Increment: 0.01
	*RST: 0

Example: `AWGN:FREQ:RES?`

queries the actual frequency of the interfering sine

Usage: Query only

Manual operation: See "Resulting CW Frequency Offset" on page 145

[:SOURce\<hw\>]:AWGN:FREQuency:TARGet \<Target\>

Sets the desired frequency of the sine in `AWGN:MODE CW` mode.

The resulting frequency may differ from the desired frequency because of the limited frequency resolution of 0.7 Hz.

Parameters:

\<Target\>	float
	Range: -40E6 to 40E6
	Increment: 0.01
	*RST: 0

Example: `AWGN:FREQ:TARG 2kHz`

sets a frequency of 2 kHz for the interfering sine.

Manual operation: See "Target CW Frequency Offset" on page 145

[:SOURce<hw>]:AWGN:MODE <Mode>

Selects the mode for generating the interfering signal.

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: `SOURce:AWGN:MODE ONLY`
                         `SOURce:AWGN:STATe ON`
                         selects the generation of a pure noise and activates it

Manual operation: See "Mode" on page 144

[:SOURce<hw>]:AWGN:POWer:CARRier <Carrier>

available for Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) modes

Sets/queries the carrier or signal power depending on the selected reference mode.

- `SOUR:AWGN:POW:RMOD CARR`
  Sets the carrier power. The power of the noise signal is derived from the entered C/N value.

- `SOUR:AWGN:POW:RMOD NOIS`
  queries the carrier power which is derived from the entered C/N value. The noise power is set with command `SOUR:AWGN:POW:NOISe`.

Parameters:

<Carrier>   float

                         Increment: 0.01
                         *RST: 0
                         Default unit: dBm

Example: `AWGN:POW:CARR?`
                         queries the carrier power

Manual operation: See "Carrier Power / Signal Power" on page 148

[:SOURce<hw>]:AWGN:POWer:MODE <Mode>

In Additive Noise (`SOUR:AWGN:MODE ADD`) mode, selects the mode for setting the noise power.

Parameters:

<Mode>   CN | SN | EN

CN|SN
The noise power is set on the basis of the value entered for the carrier/noise or signal/noise ratio
(`SOURce:AWGN:CNRatio|SNRatio`).

EN
The noise power is set on the basis of the value entered for the ratio of bit energy to noise power density (`AWGN:ENR`).

*RST: CN

Example: `SOUR:AWGN:POW:MODE CN`
the noise power is set on the basis of the value entered for the carrier/noise ratio (`AWGN:CNR`).

Manual operation: See "Set Noise Power Via" on page 147

[:SOURce<hw>]:AWGN:POWer:NOISe <Noise>

Sets or queries the noise power in the system bandwidth depending on the selected mode:

● `SOUR:AWGN:MODE ADD|CW`

● "Noise Only" mode
  The command sets the noise power.

Parameters:

<Noise>   float

Increment: 0.01
Default unit: dBm

Example: `SOURce:AWGN:POWer:NOISe?`
queries the noise power in the system bandwidth.
Response: `10`
the noise power in the system bandwidth is 10 dBm.

Manual operation: See "Noise Power (System Bandwidth) / Interferer Power"
on page 148

[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal?

In Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) modes, queries the noise power in the total bandwidth.

Tip: Use the command `[:SOURce<hw>]:AWGN:DISP:ORESults` to define the analog or digital signal path before.

Return values:

<Total>	float
	Range: -145 to 20
	Increment: 0.01
	*RST: -30

Example: `SOURce:AWGN:POWer:NOISe:TOTal?`
queries the noise power in the total bandwidth.
Response: `15`
the noise power in the total bandwidth is 15 dBm.

Usage: Query only

Manual operation: See "Noise Power (Total Bandwidth)" on page 149

[:SOURce<hw>]:AWGN:POWer:RMODe <RMode>

In Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) modes and Display Mode set to RF (`AWGN:DISP:MODE RF`), selects the mode for setting the interfering signal.

Parameters:

<RMode>	CARRier | NOISe

                   CARRier
The carrier power is kept constant when the C/N value or Eb/N0 value is changed. The noise power is adjusted.

                   NOISe
The noise power is kept constant when the C/N value or Eb/N0 value is changed. The carrier power is adjusted.

                   *RST: CARRier

Example: `SOURce:AWGN:MODE ADD`
selects Additive Noise mode.
`SOURce:AWGN:DISP:MODE RF`
sets the display mode to RF
`SOURce:AWGN:POWer:RMODe NOISe`
selects Reference Mode Noise. The noise power is kept constant when the C/N value or Eb/N0 value is changed. The carrier power is adjusted.

Manual operation: See "Reference Mode" on page 147

[:SOURce<hw>]:AWGN:POWer:SUM?

In Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) modes, queries the overall power of the noise signal plus useful signal.

Return values:

<Sum>	float
	Range: -145 to 20
	Increment: 0.01
	*RST: 0

Example:	SOURce:AWGN:POWer:SUM?
	queries the overall power of the noise signal plus useful signal.
Usage:	Query only
Manual operation:	See "Carrier + Noise Power / Signal + Noise Power (System Bandwidth) / Carrier + Interferer Power / Signal + Interferer Power" on page 150

[:SOURce<hw>]:AWGN:POWer:SUM:PEP?

In Additive Noise and CW Interferer (SOUR:AWGN:MODE ADD|CW) modes, 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:	SOURce:AWGN:POWer:SUM:PEP?
	queries the peak envelope power of the overall signal.
Usage:	Query only
Manual operation:	See "Carrier + Noise PEP / Signal + Noise PEP (Total Bandwidth) / Carrier + Interferer PEP / Signal + Interferer PEP" on page 150

[:SOURce<hw>]:AWGN:STATe <State>

Activates or deactivates the white noise (AWGN = Averaged White Gaussian Noise).

Use the command [:SOURce<hw>]:AWGN:MODE to define the mode the AWGN generator is working in.

Parameters:

<State>	0	1	OFF	ON
	*RST: 0

Example:	SOURce:AWGN:STATe ON
Manual operation:	See "State" on page 144

10.14.3 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 "Baseband" block output.

[:SOURce]:BB:FOFFset <Foffset>

Sets the frequency offset for the baseband signal. The offset affects the signal on the baseband block output. It shifts the useful baseband signal in the center frequency.

Parameters:

<Foffset>   float

Example: `BB:FOFF 2MHZ`
                          sets a frequency offset of 2 MHz.

Manual operation: See "Frequency Offset" on page 135

[:SOURce]:BB:POFFset <Phoffset>

Sets the relative phase offset of the baseband signal.

The phase offset affects the signal of the "Baseband Block" output.

Parameters:

<Phoffset>   float

Example: `BB:POFF 0.5DEG`
                          sets a relative phase offset of 0.5 DEG for the baseband signal

Manual operation: See "Phase Offset" on page 135

[:SOURce<hw>]:BB:PGAin <PGain>

The command sets the relative path gain for the selected baseband signal compared to the baseband signals of the other baseband sources (external baseband). The gain affects the signal on the "baseband block" output.

Parameters:

<PGain>   float

                          Range: -50 to 50
                          Increment: 1E-3
                          *RST: 0

[:SOURce]:BB:INFO:PSEQuencer?

Returns the baseband pulse sequencer information.

Return values:

<InfoXmlString>   string

Usage: Query only

10.14.4 SOURce:BB:ARB subsystem

The ARB subsystem contains the commands for setting the ARB Generator. Settings for clock and trigger interfaces and for external outputs are entered in the `SOURce:INPut` and `SOURce:OUTput` subsystems.

For option R&S SGT-K540, envelope tracking, the ARB for envelope tracking can be enabled when `:SCONfiguration:MODE` is set to `AFETracking`. Then the numeric suffix to `SOURce` distinguishes between signal generation for "Baseband 1" and the second ARB generated for the envelope tracking, "Baseband 2":

- `SOURce[1]` = Baseband 1
  The keyword `SOURce` is optional and can be omitted
- `SOURce2` = Baseband 2
  The keyword `SOURce` is mandatory, i.e. the command must contain the keyword with suffix 2.

The ARB waveform for the envelope tracking (`SOURce2`) uses the same trigger, marker and clock settings as the first ARB waveform (`SOURce1`). Therefore those commands are not defined for `SOURce2`.

10.14.4.1 Common commands

[:SOURce<hw>]:BB:ARBitrary:PRESet

Sets all ARB generator parameters to their default values.

Example: `SOURce1:BB:ARB:PRESet`

Usage: Event

Manual operation: See "Set To Default" on page 91

[:SOURce<hw>]:BB:ARBitrary:STATe <State>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

You have to selecta an waveform first.

Parameters:

<State>   0 | 1 | OFF | ON

                            *RST: 0

Example: `SOURce1:BB:ARBitrary:WAV:SELect 'wave1'`
                            loads waveform file from the default directory.
                            `SOURce1:BB:ARBitrary:TRIGger:SEQ RETR`
                            sets trigger mode Retrigger.
                            `SOURce1:BB:ARBitrary:STATe ON`
                            switches on the ARB generator. The selected waveform is output straight away. A trigger event causes restart.

Manual operation: See "State" on page 90

[:SOURce<hw>]:BB:ARBitrary:PRAMp[:STATe] <ArbPramState>

If activated, the burst gate marker signal included in the ARB waveform file is used as marker signal for the pulse modulator.

Parameters:

<ArbPramState>   0 | 1 | OFF | ON

                            *RST: 0

Example: `SOURce1:BB:ARBitrary:WAVeform:SELect "/var/user/Pulse_PMod_Burst"`
                            `SOURce1:BB:ARBitrary:PRAMp:STATe 1`
                            `SOURce1:BB:ARBitrary:STATe 1`

Options: R&S SGT-K22

10.14.4.2 Clock commands

The `CLOCk` subsystem contains the commands for setting the clock.

For option R&S SGT-K540, the ARB waveform for the envelope tracking (`SOURce2`) uses the same clock settings as the first ARB waveform (`SOURce1`). Therefore these commands are not defined for `SOURce2`.

[:SOURce\<hw\>]:BB:ARBitrary:CLOCk \<Clock\>

The command sets the clock rate in samples. Loading a waveform waveform (`ARB:WAV:SEL <name>`) sets the clock rate that is defined in the waveform tag 'clock'. The command subsequently changes the clock rate; see data sheet for value range.

In the case of an external clock source (selection `ARB:CLOCk:SOURce EXTernal`) the clock for the external source must be entered with this command.

Parameters:

\<Clock\>	float
	Increment: 0.001
	*RST: 1E6

Example:	`BB:ARB:CLOC:SOUR INT`
	selects the internal clock source for generating waveforms.
	`BB:ARB:CLOC 0.5 MHz`
	sets the clock rate to 0.5 MHz.

Manual operation:	See "Clock Frequency" on page 92

[:SOURce\<hw\>]:BB:ARBitrary:CLOCk:MODE \<Mode\>

The command enters the type of externally supplied clock (`:BB:ARB:CLOCk:SOURce EXTernal`). When MSAMple is used, a multiple of the sample clock is supplied via the CLOCK connector and the sample clock is derived internally from this. The multiplier is entered with the command `:BB:ARB:CLOCk:MULTiplier`.

Parameters:

\<Mode\>	SAMPle | MSAMple
	*RST: SAMPle

Example:	`BB:ARB:CLOC:MODE SAMP`
	selects clock type "Sample", i.e. the supplied clock is a sample clock.

Manual operation:	See "Clock Mode" on page 134

[:SOURce\<hw\>]:BB:ARBitrary:CLOCk:MULTiplier \<Multiplier\>

The command specifies the multiplier for clock type "Multiple Samples" (`:BB:ARB:CLOCk:MODE MSAM`) in the case of an external clock source.

Parameters:

\<Multiplier\>	integer
	Range: 1 to 64
	*RST: 4

Example: `BB:ARB:CLOC:SOUR EXT`
                     selects the external clock source. The clock is supplied via the
                     CLOCK connector.
                     `BB:ARB:CLOC:MODE MSAM`
                     selects clock type Multiple Samples, i.e. the supplied clock has a
                     rate which is a multiple of the sample rate.
                     `BB:ARB:CLOC:MULT 12`
                     The multiplier for the external clock rate is 12.

Manual operation: See "Sample Clock Multiplier" on page 134

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce <Source>

Sets the source for the digital modulation clock.

Parameters:
<Source>   INTernal|EXTernal

                     INTernal
                     The internal clock reference is used.

                     EXTernal
                     The external clock reference is supplied to the connector.

                     *RST: INTernal

Example: `BB:ARB:CLOC:SOUR EXT`
                     Selects an external clock reference. The clock is supplied via the
                     connector.
                     `BB:ARB:CLOC:MODE SAMP`
                     Enters clock type sample.

Manual operation: See "Clock Source" on page 134

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SYNChronization:MODE <Mode>

Selects the synchronization mode.

This parameter is used to enable generation of very precise synchronous signal of sev-
eral connected R&S SGT.

Note: If several instruments are connected, the connecting cables from the primary
instrument to the secondary instrument one and between each two consecutive secon-
dary instruments must have the same length and type. Avoid unnecessary cable length
and branching points.

Parameters:
<Mode>   NONE | PRIMary | SECondary | DIIN

                     NONE
                     The instrument is working in stand-alone mode.

                     PRIMary
                     The instrument provides all connected instrument with its syn-
                     chronisation (including the trigger signal) and reference clock
                     signal.

SECondary

The instrument receives the synchronisation and reference clock signal from another instrument working in primary mode.

DIIN

The instrument receives the synchronisation and reference clock signal from the "DIG I/Q" connector.

*RST: NONE

Manual operation: See "Sync Mode" on page 133

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SYNChronization:EXECute

Performs automatically adjustment of the instrument's settings required for the synchronization mode, set with the command `[:SOURce<hw>]:BB:ARBitrary:CLOCk:SYNChronization:MODE`.

Example: `BB:ARB:CLOC:SYNC:MODE PRIM`
the instrument is configured to work as a primary instrument.
`BB:ARB:CLOC:SYNC:EXEC`
all synchronization's settings are adjusted accordingly.

Usage: Event

10.14.4.3 Trigger commands

The `TRIGger` subsystem contains the commands for setting the trigger.

For option R&S SGT-K540, the ARB waveform for the envelope tracking (`SOURce2`) uses the same trigger settings as the first ARB waveform (`SOURce1`). Therefore these commands are not defined for `SOURce2`.

[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute

The command stops waveform output for trigger modes Armed_Auto and Armed_Retrigger. A subsequent internal or external trigger event restart waveform output.

Example:	`BB:ARB:TRIG:SOUR INT`
	sets internal triggering.
	`BB:ARB:TRIG:SEQ ARET`
	sets Armed_Retrigger mode, i.e. every trigger event causes waveform output to restart.
	`BB:ARB:TRIG:EXEC`
	executes a trigger, waveform output is started.
	`BB:ARB:TRIG:ARM:EXEC`
	waveform output is stopped.
	`BB:ARB:TRIG:EXEC`
	executes a trigger, waveform output is started again.
Usage:	Event
Manual operation:	See "Arm" on page 123

[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute

The command executes a trigger. The internal trigger source must be selected using the command `ARB:TRIGger:SOURce INTernal` and a trigger mode other than `AUTO` must be selected using the command `:ARB:SEQuence`.

Example:	`BB:ARB:TRIG:SOUR INT`
	sets internal triggering.
	`BB:ARB:SEQ RETR`
	sets Retrigger mode, i.e. every trigger event causes signal output to restart.
	`BB:ARB:TRIG:EXEC`
	executes a trigger.
Usage:	Event
Manual operation:	See "Execute Trigger" on page 123

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut
     <Output>

(enabled for "Trigger Source" External)

Enables/disables output of the signal synchronous to the external trigger event.

Parameters:
<Output>	0	1	OFF	ON

ON

The signal calculation starts simultaneously with the external trigger event but because of the instrument's processing time the first samples are cut off and no signal is outputted. After elapsing of the internal processing time, the output signal is synchronous to the trigger event.

OFF

The signal output begins after elapsing of the processing time and starts with sample 0, i.e. the complete signal is outputted. This mode is recommended for triggering of short signal sequences with signal duration comparable with the processing time of the instrument.

*RST: ON

Example:	`BB:ARB:TRIG:SOUR EXT`
	sets external triggering.
	`BB:ARB:TRIG:EXT:SYNC:OUTP ON`
	enables synchronous output to external trigger
Manual operation:	See "Sync. Output to External Trigger" on page 123

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MAXimum?
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MINimum?

The command queries the minimum marker delay for setting `:BB:ARB:TRIGger:OUTPut:DELay:FIXed ON`.

Return values:

<Minimum>	float
	Range: 0 to 16777215
	Increment: 1E-3
	*RST: 0
Example:	`BB:ARB:TRIG:OUTP:DEL:FIX ON`
	restricts the marker signal delay setting range to the dynamic range.
	`BB:ARB:TRIG:OUTP:DEL:MIN`
	queries the minimum of the dynamic range.
	`Response: 0`
	the minimum for the marker delay setting is 0 samples.
Usage:	Query only
Manual operation:	See "Current Range without Recalculation" on page 132

[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe?

The command queries the status of waveform output or all trigger modes with ARB on.

Return values:

<RMode>	STOP	RUN

RUN

The waveform is output. A trigger event occurred in the triggered mode.

STOP

The waveform is not output. A trigger event did not occur in the triggered modes, or waveform output was stopped by the command `:BB:ARB:TRIG:ARM:EXECute` (armed trigger modes only).

Example: `BB:ARB:TRIG:SOUR EXT`
sets external triggering
`BB:ARB:TRIG:MODE ARET`
selects the Armed_Retrigger mode.
`BB:ARB:TRIG:RMOD?`
queries the current status of waveform output.
`Response: RUN`
the waveform is output, an external trigger was executed.

Usage: Query only

Manual operation: See "Running/Stopped" on page 122

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth <SLength>

The command defines the length of the signal sequence to be output in the Single trigger mode. The unit is defined with command `SOUR:BB:ARB:TRIG:SLUNit`. It is possible to output deliberately just part of the waveform, an exact sequence of the waveform, or a defined number of repetitions of the waveform.

Parameters:

<SLength>   integer

Range: 1 to dynamic
*RST: 1
Default unit: sample

Example: `BB:ARB:SEQ SING`
sets trigger mode Single.
`BB:ARB:TRIG:SLUN SAMP`
sets unit Samples for the entry of sequence length.
`BB:ARB:TRIG:SLEN 200`
sets a sequence length of 200 samples. The first 200 samples of the current waveform will be output after the next trigger event.

Manual operation: See "Signal Duration" on page 122

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit <SLUnit>

The command defines the unit for the entry of the length of the signal sequence (`SOUR:BB:ARB:TRIG:SLEN`) to be output in the "Single" trigger mode (`SOUR:BB:ARB:SEQ SING`).

Parameters:

<SLUnit>   SEQuence | SAMPle

                      *RST: SEQuence

Example: `BB:ARB:SEQ SING`
                      sets trigger mode Single.
                      `BB:ARB:TRIG:SLUN SEQ`
                      sets unit Sequence length for the entry of sequence length.
                      `BB:ARB:TRIG:SLEN 2`
                      sets a sequence length of 2 waveforms. The current waveforms will be output twice after the next trigger event.

Manual operation: See "Signal Duration Unit" on page 122

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe <SMode>

The command selects the extended trigger mode for multi segment waveforms.

Parameters:

<SMode>   SAME | NEXT | NSEam | SEQuencer

                      NSEam = Next Segment Seamless

                      *RST: NEXT

Example: `SOUR:BB:ARB:SEQ AUTO`
                      selects trigger mode AUTO.
                      `SOUR:BB:ARB:TRIG:SMOD SAME`
                      the same segment of the waveform is output repeatedly.

Manual operation: See "Next Segment Mode" on page 126

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce <Source>

Selects the trigger source.

Parameters:

<Source>   INTernal|EXTernal

                      INTernal
                      manual trigger or `*TRG`.
                      EXTernal
                      trigger signal on the USER 1/2 connector.

                      *RST: INTernal

Example: `SOURce1:BB:ARBitrary:TRIGger:SOURce EXTernal`
                      sets external triggering via the USER 1 connector.

Manual operation: See "Trigger Source" on page 123

[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT <TrigDelUnit>

Determines the units the trigger delay is expressed in.

Parameters:

\<TrigDelUnit\>	SAMPle | TIME
	*RST: SAMPle

Manual operation: See "External Delay Unit" on page 124

[:SOURce\<hw\>]:BB:ARBitrary:TRIGger[:EXTernal\<1\|2\>]:DELay \<Delay\>

The command specifies the trigger delay (expressed as a number of samples) for external triggering.

Parameters:

\<Delay\>   float

Range: 0 to depends on other values
Increment: 0.01
*RST: 0
Default unit: sample

Example: `BB:ARB:TRIG:SOUR EXT`

selects an external trigger

`BB:ARB:TRIG:DEL 200`

sets a delay of 200 samples for the trigger.

Manual operation: See "Trigger Delay" on page 124

[:SOURce\<hw\>]:BB:ARBitrary:TRIGger[:EXTernal\<1\|2\>]:TDELay \<ExtTimeDelay\>

Specifies the trigger delay for external triggering. The value affects all external trigger signals.

Parameters:

\<ExtTimeDelay\>   float

Range: 0 to 688
Increment: 1E-9
*RST: 0
Default unit: s

Manual operation: See "Trigger Delay" on page 124

[:SOURce\<hw\>]:BB:ARBitrary:TRIGger[:EXTernal\<1\|2\>]: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

Usage: Query only

Manual operation: See "Actual Trigger Delay" on page 124

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:INHibit <Inhibit>

Specifies the number of samples by which a restart is to be inhibited following a trigger event. This command applies only in the case of external triggering.

Parameters:

<Inhibit>   integer

                             Range: 0 to 67108863
                             *RST: 0
                             Default unit: sample

Example: `BB:ARB:TRIG:SOUR EXT`
                             selects an external trigger
                             `BB:ARB:TRIG:INH 200`
                             sets a restart inhibit for 200 samples following a trigger event.

Manual operation: See "Trigger Inhibit" on page 124

[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence <Sequence>

The command selects the trigger mode.

Parameters:

<Sequence>   AUTO | RETRigger | AAUTo | ARETrigger | SINGle

                             AUTO
                             The waveform is output continuously.

                             RETRigger
                             The waveform is output continuously. A trigger event (internal or external) causes a restart.

                             AAUTo
                             The waveform is output only when a trigger event occurs. After the trigger event the waveform is output continuously. Waveform output is stopped with command
                             `SOUR:BB:ARB:TRIG:ARM:EXEC` and started again when a trigger event occurs.

                             ARETrigger
                             The waveform is output only when a trigger event occurs. The device automatically toggles to RETRIG mode. Every subsequent trigger event causes a restart. Waveform output is stopped with command `SOUR:BB:ARB:TRIG:ARM:EXEC` and started again when a trigger event occurs.

                             SINGle
                             The waveform is output only when a trigger event occurs. After the trigger event the waveform is output once to the set sequence length (`SOUR:BB:ARB:TRIG:SLEN`). Every subsequent trigger event causes a restart.
                             *RST: AUTO

Example: `BB:ARB:SEQ AAUT`

sets the "Armed_auto" trigger mode; the device waits for the first
trigger (e.g. with `*TRG`) and then generates the signal continu-
ously.

Manual operation: See "Trigger Mode" on page 121

10.14.4.4 Marker commands

The `TRIGger:OUTPut` subsystem contains the commands for setting the marker.

For option R&S SGT-K540, the ARB waveform for the envelope tracking (`SOURce2`)
uses the same marker settings as the first ARB waveform (`SOURce1`). Therefore these
commands are not defined for `SOURce2`.

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE <Mode>

The command defines the signal for the selected marker output.

Parameters:

<Mode>   UNCHanged | RESTart | PULSe | PATTern | RATio

UNCHanged
A marker signal as defined in the waveform file (tag 'marker
mode x') is generated.

RESTart
A marker signal is generated at every waveform start.

PULSe
A pulsed marker signal is generated. The pulse frequency (=
sample rate/divider) is defined with the
`SOUR:BB:ARB:TRIG:OUTP:PULS:DIV` command and can be
queried with the `SOUR:BB:ARB:TRIG:OUTP:PULS:FREQ?`
command.

PATTern
A marker signal is generated with the aid of a user-definable bit
pattern. The bit pattern is entered with the aid of com-
mand `:BB:ARB:TRIGger:OUTPut:PATTern`. The bit pattern
is a maximum of 32 bits long.

RATio

A regular marker signal corresponding to the Time Off / Time On specifications in the commands `:ARB:TRIGger:OUTPut:OFFTime` and `:ARB:TRIGger:OUTPut:ONTime` is generated.

*RST: UNCHanged

Manual operation: See "Marker Mode" on page 131

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime <OffTime>
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime <OnTime>

The command sets the number of samples in a period (ON time + OFF time) during which the marker signal in setting `:ARB:TRIGger:OUTPut:MODE RATio` on the marker outputs is ON.

Parameters:

<OnTime>   integer

                          Range: 1 to 14913079
                          *RST: 1

Example: `BB:ARB:TRIG:OUTP2:ONT 20`

                          sets an ON time of 20 samples for marker 2

Manual operation: See "Marker Mode" on page 131

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern <Pattern>,
    <BitCount>

The command defines the bit pattern used to generate the marker signal.

Parameters:

<Pattern>   numeric

                          0 is marker off, 1 is marker on.
                          *RST: #H2

<BitCount>   integer

                          Range: 1 to 64
                          *RST: 2

Example: `BB:ARB:TRIG:OUTP:MODE PATT`

                          `BB:ARB:TRIG:OUTP:PATT #H39FE0000,32`

Manual operation: See "Marker Mode" on page 131

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

The command sets the divider for the pulsed marker signal in the setting `SOURce:BB:ARB:TRIGger:OUTPut:MODE PULSe`. The pulse frequency is derived by dividing the symbol rate by the divider.

Parameters:

<Divider>	integer
	Range: 2 to 1024
	*RST: 2

Manual operation: See "Marker Mode" on page 131

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?

The command queries the pulse frequency of the pulsed marker signal in the setting `SOURce:BB:ARB:TRIGger:OUTPut:MODE PULSe`. The pulse frequency is derived by dividing the symbol rate by the divider. The divider is defined with command `:BB:ARB:TRIG:OUTP:PULS:DIV`.

Return values:

<Frequency>	float
	Increment: 0.001

Example:	`BB:ARB:TRIG:OUTP2:PULS:DIV 4`
	sets the divider for the marker signal on the output to the value 4.
	`BB:ARB:TRIG:OUTP2:MODE PULS`
	enables the pulsed marker signal.
	`BB:ARB:TRIG:OUTP2:PULS:FREQ?`
	queries the pulse frequency of the marker signal.
	`Response: 33 000`
	the resulting pulse frequency is 33 kHz.

Usage: Query only

Manual operation: See "Marker Mode" on page 131

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut:DELay:FIXed <Fixed>

The command restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal. If a delay is entered in setting ON but is outside this range, the maximum possible delay is set and an error message is output.

The setting always affects every marker.

Parameters:

<Fixed>	0	1	OFF	ON
	*RST: 0

Example:	`BB:ARB:TRIG:OUTP:DEL:FIX ON`
	restricts the marker signal delay setting range to the dynamic range.

Manual operation: See "Fix marker delay to current range" on page 133

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay <Delay>

Sets 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: Samples

Manual operation: See "Marker x Delay" on page 132

10.14.4.5 Test signal commands

[:SOURce<hw>]:BB:ARBitrary:SIGNal:TYPE <ArbSignalType>

Selects the type of test signal.

Parameters:

<ArbSignalType>   SINE | RECT | CIQ
                           *RST: SINE

Example: SORce1:BB:ARBitrary:SIGNal:TYPE SINE

[: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: BB:ARB:TSIG:SINE:CRE

                           generates a test sine signal and uses it as output straight away.

Usage: Event

Manual operation: See "Generate Signal RAM" on page 118

[: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: `BB:ARB:TSIG:SINE:CRE:NAM 'sine_test'`
                        generates a test sine signal and saves it into the wavefile
                        `sine_test`.

Usage: Setting only

Manual operation: See "Generate Signal File" on page 118

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I <I>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q <TSig>

Sets the value for the I/Q component of the test signal

Parameters:

<TSig>   float

                        Range: -1 to 1
                        Increment: 0.001
                        *RST: 0
                        Default unit: FS

Example: `BB:ARB:TSIG:CIQ:Q 0.5`
                        sets the value for the Q component of the test signal.

Manual operation: See "Q Value" on page 120

[: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: `BB:ARB:TSIG:RECT:AMPL 0.5`
                        sets the amplitude of the test signal

Manual operation: See "Amplitude" on page 119

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency <Frequency>

Sets the frequency of the test signal.

Parameters:

<Frequency>   float

                     Range: 100 to depends on hardware
                     Increment: 0.01
                     *RST: 1000

Example: SOURce:BB:ARBitrary:TSIGnal:RECTangle:FREQuency
                     100 kHz
                     sets the frequency of the test signal of 100 kHz.

Manual operation: See "Frequency" on page 119

[: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: BB:ARB:TSIG:RECT:OFFS 0.5
                     sets the DC component

Manual operation: See "Offset DC" on page 119

[: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: BB:ARB:TSIG:RECT:SAMP 400
                     sets 400 samples per period

Manual operation: See "Samples per Period" on page 119

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency <Frequency>

Sets the frequency of the simple sinusoidal test signal. This signal is used as output via
the I channel. A sine wave of the same frequency but optionally phase-shifted is gener-
ated on the Q path (ARB:TSIGnal:SINE:POFFset).

Parameters:

<Frequency>   float

                       Range: 100 to depends on hardware
                       Increment: 0.01
                       *RST: 1000
                       Default unit: Hz

Example: BB:ARB:TSIG:SINE:FREQ 100 kHz

                       sets a sine signal of 100 kHz.

Manual operation: See "Frequency" on page 117

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:PHASe <Phase>

The command 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: BB:ARB:TSIG:SINE:PHAS 90

                       sets a phase offset of 90 degrees.

Manual operation: See "Phase Offset Q" on page 118

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles <Samples>

The command sets the sample rate for the sine signal in samples per period.

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
                       Default unit: 100 samples per period

Example: BB:ARB:TSIG:SINE:SAMP 100

                       sets a sample rate of 100 samples per period.

Manual operation: See "Samples per Period" on page 117

10.14.4.6 SOURce:BB:ARB:MCAR subsystem

The MCARrrier subsystem contains the commands for setting the Multi Carrier Waveform Generator.

CARRier<ch>

The numerical suffix under `CARRier` distinguish between the carriers. The value range is 0 .. 31.

[: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: `BB:ARB:MCAR:CARR:COUN 10`

sets 10 carriers for the multi carrier waveform.

Manual operation: See "Number of Carriers" on page 107

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE <Mode>

The command sets the carrier frequency mode.

Parameters:

<Mode>   EQUidistant | ARBitrary

EQUidistant
Sets an equidistant carrrier spacing. The carrier frequency in the carrier table is not configurable.

ARBitrary
Enables you to specify the carrier frequency in the carrier table. Carrier spacing is irrelevant.

*RST: EQUidistant

Example: `BB:ARB:MCAR:CARR:MODE EQU`

sets an equidistant carrier spacing. The carrier frequency can not be set.

Manual operation: See "Mode" on page 107

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing <Spacing>

The command sets the frequency spacing between adjacent carriers of the multi carrier waveform. The carriers are generated symmetrically around the RF carrier. The maximum carrier spacing is limited to **Carrier spacing = Total baseband bandwidth / (Number of carriers - 1).**

The total baseband bandwidth is 60, 120 or 160 MHz depending on the installed options. .

Note: In order to avoid wrap-around problems, the effective "Carrier Spacing" might be slightly modified. The "Carrier Spacing" is rounded in that way that the carrier closest to the center RF frequency shows no phase jump assuming 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);

Parameters:

<Spacing>	float
	Range: 0.0 to 120E6
	Increment: 0.01
	*RST: 0
	Default unit: Hz

Example:	`BB:ARB:MCAR:CARR:SPAC 10 MHz`
	sets a carrier spacing of 10 MHz.

Manual operation:	See "Carrier Spacing" on page 107

[: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
	*RST: 0

Example:	`BB:ARB:MCAR:CARR2:CONF?`
	queries the multi carrier conflict state.
	Response: `0` no conflict has occurred.

Usage:	Query only

Manual operation:	See "!!!" on page 115

[: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 115

[: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: `BB:ARB:MCAR:CARR15:FILE "/var/user/IQ_wcdma"`
selects file `IQ_wcdma`. The data of the file is modulated onto
carrier 15.

Manual operation: See "File" on page 115

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency <Frequency>

Sets or indicates the carrier frequency, depending on the selected carrier frequency
mode.

The carrier frequency can be set in "Arbitrary Carrier frequency" mode. For "Equidistant Carrier Spacing", the carrier spacing is determined automatically.

Parameters:

<Frequency>   float

Value range depends on the max bandwidth, see data sheet

Range: -40E6 to 40E6
*RST: 0

Example: `BB:ARB:MCAR:CARR:MODE ARB`
Activates ARB multi-carrier mode.
`BB:ARB:MCAR:CARR:FREQ 5.0`
Sets 5.0 MHz carrier frequency.

Manual operation: See "Carrier Freq Offs." on page 115

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe <Phase>

The command sets the start phase of the selected carrier.

The phase settings are only valid if optimization of the crest factor is disabled
(`:SOURce:BB:ARB:MCARrier:CFACtor:MODE OFF`).

Parameters:

<Phase>   float

Range: 0 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `BB:ARB:MCAR:CARR15:PHAS 90 DEG`
sets a start phase of 90° for carrier 15.

Manual operation: See "Phase" on page 115

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer <Power>

The command sets the gain of the selected carrier.

Parameters:

<Power>   float

                      Range: -80 to 0
                      Increment: 0.01
                      *RST: 0
                      Default unit: dB

Example: `BB:ARB:MCAR:CARR15:POW -50 dB`

                      sets the power of carrier 15 to -50 dB.

Manual operation: See "Gain" on page 115

[: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 110

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe <State>

Enables/disables the selected carrier.

Parameters:

<State>   0 | 1 | OFF | ON

                      *RST: 0

Example: `SOURce1:BB:ARBitrary:MCARrier:CARRier15:STATe`
                      `ON`

Manual operation: See "State" on page 115

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CFACtor:MODE <Mode>

The command sets the mode for optimizing the crest factor by calculating the carrier phases.

Parameters:

<Mode>   OFF | MIN | MAX

                      OFF
                      There is no automatic setting for minimizing or maximizing the crest factor. The Phase setting (command `BB:ARB:MCAR:CARR:PHAS`) is in use.

                      MIN
                      The crest factor is minimized by internally calculating optimized carrier phases. The Phase setting (command `BB:ARB:MCAR:CARR:PHAS`) is invalid.

MAX

The crest factor is maximized by internally calculating optimized carrier phases. The Phase setting (command `BB:ARB:MCAR:CARR:PHAS`) is invalid.

*RST: OFF

Example: `BB:ARB:MCAR:CFAC:MODE OFF`

switches off automatic crest factor optimization. The setting `SOUR:BB:ARB:MCAR:CARR:PHAS` has an effect.

Manual operation: See "Crest Factor Mode" on page 108

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor <CFactor>

Sets the value of the desired crest factor, if baseband clipping is enabled (`BB:ARB:MCAR:CLIP:STAT ON`).

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: `BB:ARB:MCAR:CLIP:STAT ON`

enables clipping.

`BB:ARB:MCAR:CLIP:CFAC 37 dB`

sets the target crest factor.

Manual operation: See "Target Crest Factor" on page 108

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff <Cutoff>

Sets the cut off frequency of the final lowpass filter, if baseband clipping is enabled (`BB:ARB:MCAR:CLIP:STAT ON`).

When the cut off frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multicarrier signal, but may also increase the resulting crest factor.

Parameters:

<Cutoff>   float

           Range: 0 to 120E6
           Increment: 0.01
           *RST: 50E6
           Default unit: MHz

Example: BB:ARB:MCAR:CLIP:STAT ON
Enables clipping
BB:ARB:MCAR:CLIP:CUT 50 MHz
Sets the cut off frequency of the filter.

Manual operation: See "Filter Cut Off Frequency" on page 109

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] <State>

Switches baseband clipping on and off.

Clipping reduces the peak power of the resulting multi carrier signal according to the value set with the command BB:ARB:MCAR:CLIP:CFAC.

The resulting clipped peak power is defined by sum of the the RMS level of the unclipped multi carrier signal and the input parameter Target Crest Factor. Note that clipping reduces also the RMS level. Hence the resulting crest factor of the clipped signal is slightly above the Target Crest Factor. In order to get the unclipped parts of the clipped multicarrier signal matched with the unclipped multicarrier signal, the RF output power should be reduced by the difference between resulting crest factor and Target Crest Factor.

Parameters:

<State>   0 | 1 | OFF | ON
*RST: 0

Example: BB:ARB:MCAR:CLIP:STAT ON
enables clipping
BB:ARB:MCAR:CLIP:CFAC 37 dB
sets the target crest factor.

Manual operation: See "Clipping" on page 108

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad

Creates and loads a multi carrier waveform using the current entries of the carrier table.

This multi carrier waveform is saved with the file name specified with command SOUR:BB:ARB:MCAR:OFIL. The file extension is *.wv.

Example: MMEM:CDIR '/var/user/waveform'
sets the default directory.
BB:ARB:MCAR:OFIL 'mcar1_2'
defines the file name mcar1_2.wv for the multi carrier waveform.
BB:ARB:MCAR:CLO
creates multi carrier waveform mcar1_2.wv.
The new multi carrier waveform is loaded.

Usage: Event

Manual operation: See "Create and Load" on page 111

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk?

The command 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 111

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate

Creates a multi carrier waveform using the current settings of the carrier table. The multi carrier waveform is saved into the file defined with command `SOUR:BB:ARB:MCAR:OFIL`. The file extension is `*.wv`.

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:MCAR:OFIL 'multi_wv1'`
defines the file name `multi_wv1.wv` for the multi carrier waveform.
`BB:ARB:MCAR:CRE`
creates multi carrier waveform `multi_wv1.wv`.

Usage: Event

Manual operation: See "Create" on page 111

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP <Step>

The command sets the step width by which the start delays of the carriers in the defined carrier range will be 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, i.e. the first carrier has a start delay of 5us, the second a start delay of 6 us, etc.
Manual operation:	See "Delay Step" on page 114

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay[:STARt] <Start>

The command sets the start delay for the individual carriers in the defined carrier range. If the command `:BB:ARB:MCAR:EDIT:CARR:DEL:STEP` is used to define a step width, the delay entered here applies only to the starting carrier. The delays of the remaining carriers are stepped up or down by the delay value specified in the `:BB:ARB:MCAR:EDIT:CARR:DEL:STEP` command.

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 114

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute

The command adopts the settings for the carrier range which has been defined using the `:BB:ARB:MCAR:EDIT:CARR:...` commands.

Example:	`BB:ARB:MCAR:EDIT:CARR:STAR 4`
	the carrier range starts at carrier 2.
	`BB:ARB:MCAR:EDIT:CARR:STOP 20`
	the carrier range stops at carrier 20.
	`BB:ARB:MCAR:EDIT:CARR:STAT ON`
	sets all the carriers in the carrier range (2 to 20) to ON.
	`BB:ARB:MCAR:EDIT:CARR:EXEC`
	transfers the assistant settings for carrier 2 to 20 into the carrier table.
Usage:	Event
Manual operation:	See "Apply Assistant Settings" on page 114

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE <File>

Selects input file

Parameters:

<File>   string

Example: BB:ARB:MCAR:EDIT:CARR:FILE "/var/user/IQ_wcdma'

Manual operation: See "Input Waveform File" on page 114

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP <Step>

The command sets the step width by which the start phases of the carriers in the defined carrier range will be incremented.

The phase settings are only valid if optimization of the crest factor is disabled (:SOURce:BB:ARB:MCARrier:CFACtor:MODE OFF).

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, i.e. the first carrier has a start phase of 90°, the second a start phase of 91°, etc.

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe[:STARt] <Start>

The command sets the start phase for the individual carriers in the defined carrier range. If the command :BB:ARB:MCAR:EDIT:CARR:PHAS:STEP is used to define a step width, the phase entered here applies only to the starting carrier. The phases of the remaining carriers are stepped up or down by the phase value specified in the :BB:ARB:MCAR:EDIT:CARR:PHAS:STEP command.

The phase settings are only valid if optimization of the crest factor is disabled (:SOURce:BB:ARB:MCARrier:CFACtor:MODE OFF).

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 113

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP <Step>

The command sets the step width by which the starting power of the carriers in the defined carrier range will be 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, i.e. the first carrier has -80dB, the second -79dB, etc.

Manual operation: See "Gain Step" on page 113
                                See "Phase Step" on page 114

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer[:STARt] <Start>

The command sets the power for the individual carriers in the defined carrier range. If the command `:BB:ARB:MCAR:EDIT:CARR:POW:STEP` is used to define a step width, the power entered here applies only to the starting carrier. The power of the remaining carriers is stepped up or down by the power specified in the `:BB:ARB:MCAR:EDIT:CARR:POW:STEP` command.

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 113

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt <Start>
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP <Stop>

The command selects the last carrier in the carrier range to which the settings with the `:BB:ARB:MCAR:EDIT:CARR:..` commands 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 Stop" on page 113

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe <State>

The command 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 113

[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe <OFile>

This command defines the output file name for the multi carrier waveform. This file name is used when a waveform is calculated (command `SOUR:BB:ARB:MCAR:CLOad` or `SOUR:BB:ARB:MCAR:CREate`). The file extension is `*.wv`.

Parameters:

<OFile>   string

Example: `MMEM:CDIR "/var/user/waveform"`
sets the default directory.
`BB:ARB:MCAR:OFIL 'mcar1_2'`
defines the file name `mcar1_2.wv` for the multi carrier waveform file

Manual operation: See "Output File" on page 110

[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet

Sets all ARB multi carrier parameters to their default values.

Example: `SOURce1:BB:ARB:MCARrier:PRESet`

Usage: Event

Manual operation: See "Set to Default" on page 105

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?

The command queries the resulting file size. The file size is returned in samples.

Return values:

<Samples>   integer

                     Range: 0 to INT_MAX
                     *RST: 0

Example:	`BB:ARB:MCAR:SAMP?`
	queries the file size of the currently calculated multi carrier waveform.
Usage:	Query only
Manual operation:	See "File Size" on page 111

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog?

Queries the available settings files in the specified default directory. The settings files are used to set the ARB multi carrier submenu. Only files with the file extension `*.arb_multcarr` will be listed.

Return values:

<Catalog>	string
Example:	`MMEM:CDIR '/var/user/waveform'`
	sets the default directory
	`BB:ARB:MCAR:SETT:CAT?`
	reads out all the settings files in the default directory.
	`Response: mcar1, mcar2`
	the directory contains the configuration files
	`mcar1.arb_multcarr` and `mcar2.arb_multcarr`.
Usage:	Query only
Manual operation:	See "Save/Recall Frame" on page 106

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD <Filename>

Loads the settings file. If a settings file with the specified name does not yet exist, it is created. The file extension may be omitted. Only files with the file extension `*.arb_multcarr` will be loaded or created.

Setting parameters:

<Filename>	string
Example:	`BB:ARB:MCAR:SETT:LOAD '/var/user/new'`
	creates settings file `new.arb_multcarr`.
Usage:	Setting only
Manual operation:	See "Save/Recall Frame" on page 106

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe <Filename>

The command stores the current settings of submenu "Multi Carrier" in a file in the specified directory. The file extension may be omitted, the files are stored with the file extension `*.arb_multcarr`.

Setting parameters:

<Filename>	string

Example: `BB:ARB:MCAR:SETT:STOR '/var/user/mcarr2'`
stores settings file `mcarr2.arb_multcarr` in the default directory.

Usage: Setting only

Manual operation: See "Save/Recall Frame" on page 106

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe:FAST <Fast>

Determines whether the instrument performs an absolute or a differential storing of the settings.

Enable this function to accelerate the saving process by saving only the settings with values different to the default ones.

Note: This function is not affected by the "Preset" function.

Parameters:

<Fast>   0 | 1 | OFF | ON
                  *RST: 1

Manual operation: See "Save/Recall Frame" on page 106

[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME <Time>

Sets the user-defined signal period. This setting is only possible for Signal Period Mode User (`BB:ARB:MCAR:TIME:MODE USER`).

Parameters:

<Time>   float

                 Range: 0 to 1E9
                 Increment: 1E-9
                 *RST: 0
                 Default unit: s

Example: `BB:ARB:MCAR:TIME:MODE USER`
selects Signal Period Mode User.
`BB:ARB:MCAR:TIME 10 s`
sets a signal period of 10 seconds

Manual operation: See "Signal Period" on page 109

[: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>   LONG | SHORt | LCM | USER

LONG

The resulting signal period is defined by the longest I/Q file in the carrier table. Shorter I/Q files are periodically repeated.

SHORt

The resulting signal period is defined by the shortest I/Q file in the carrier table. Only the first part of longer I/Q files is used.

USER

The signal period can be set with command `[:SOURce<hw>]: BB:ARBitrary:MCARrier:TIME`. Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

LCM

The output file duration is the least common multiple of all input file durations.

*RST: LONG

Example: `SPOURce1:BB:ARBitrary:MCARrier:TIME:MODE LONG`
selects signal period mode long

Manual operation: See "Signal Period Mode" on page 109

10.14.4.7   SOURce:BB:ARB:WAV subsystem

The WAVeform subsystem contains the commands for working with waveform files.

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog?

Reads out the files in the default directory. The default directory is set using command `MMEM:CDIRectory`. When the names of the waveform files are returned they are separated by commas. Only files with the file extension `*.wv` will be listed.

Return values:
<Catalog>   string

Example:	`MMEM:CDIR '/var/user/waveform'`
	sets the default directory.
	`BB:ARB:WAV:CAT?`
	reads out all the files in the default directory.
	`Response: sin1, wave`
	the directory contains the waveform files `sin1.wv` and `wave.wv`.
Usage:	Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog:LENGth?

Reads out the files in the default directory and returns the number of waveform files in this directory. The default directory is set using command `MMEM:CDIRectory`. Only files with the file extension `*.wv` will be listed.

Return values:

<Length>	integer
	Number of waveform files in default directory
	Range: 0 to INT_MAX
	*RST: 0

Example:	`MMEM:CDIR '/var/user/waveform'`
	sets the default directory.
	`BB:ARB:WAV:CAT?`
	reads out all the files in the default directory.
	`Response: sin1, wave`
	the directory contains the waveform files `sin1.wv` and `wave.wv`.
	`BB:ARB:WAV:CAT:LEN?`
	`Response: 2`
Usage:	Query only

[: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 with the command `:MMEMory:DATA:UNPRotected` on page 368.

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

Example: see :MMEMory:DATA:UNPRotected on page 368

[: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 is transmitted as a binary data block.

The **query** command retrieves the content of the specified tag of the currently selected waveform file or the waveform file specified with the <filename>.

By default, the waveform files are saved in the default directory of the instrument (/var/instrument/Lists).

To access waveform files located in another directory, the complete file path and file name are required.

Parameters:
<Filename>   string

Specifies the name of the waveform file the binary data will be copied to.
The file extension (.wv) may be omitted.

Setting parameters:
<Data>   block data

Contents of the waveform file as a definite length binary block.

Query parameters:
<Tag>   'comment' | 'copyright' | 'date' | 'lacpfilter' | 'marker name' | 'poweroffset'

Indentifier of the tag which shall be retrieved from the waveform file.

Example: **Setting**
BB:ARB:WAV:DATA "/var/sgt/temp/test1", <bin data block>
writes the block data to file 'test1.wv' in the /var/instrument/Lists directory.

Example: **Query**
BB:ARB:WAV:DATA? '/var/user/wave1.wv','comment'
queries the content of the 'comment' tag of file wave1.wv in directory /var/user
Response: " #222Sinusoidal test signal"

[: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 will be deleted.

Setting parameters:

\<Filename>	string

Example: `BB:ARB:WAV:DEL '/var/user/wave1.wv'`
deletes waveform file `wave1.wv`.

Usage: Setting only

[:SOURce\<hw>]:BB:ARBitrary:WAVeform:FREE?

Queries the free disk space on the default path of the instrument's harddisk.

Return values:

\<Free>	integer

                 Range: 0 to INT_MAX
                 *RST: 1

Example: `MMEM:CDIR '/var/user/waveform'`
Sets the default directory.
`BB:ARB:WAV:FREE?`
Queries the free disk space in directory.

Usage: Query only

[:SOURce\<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel?

Queries the filling level of the streaming buffer.

Return values:

\<BLevel>	integer

                 Range: 0 to 100
                 *RST: 0

Example: `SOURce1:BB:ARBitrary:WAVeform:HDDStreaming:STATe 1`
Enables HDD streaming.
`SOURce1:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel?`
Queries the streaming buffer level.
Response: `94%`

Usage: Query only

[:SOURce\<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:STATe \<State>

Enables/disables the streaming of modulation data directly from the hard drive (HDD).

HDD streaming is recommended for processing of large files that require more ARB memory than the currently installed one.

Parameters:

\<State>	0	1	OFF	ON

                 *RST: 0

Example: See `[:SOURce<hw>]:BB:ARBitrary:WAVeform:`
                       `HDDStreaming:BLEVel?` on page 436

[:SOURce<hw>]:BB:ARBitrary:WAVeform:POINts?

The command queries the number of samples in the waveform file selected using command `:ARB:WAV:SEL`. Only the file name has to be entered. Only files with the file extension `*.wv` will be read out.

Return values:
<Points>   <waveform filename>

                      Range: 0 to 1000
                      *RST: 1

Example: `BB:ARB:WAV:POINt?`
                       queries the number of I/Q values pairs in the waveform file.
                       `Response: 401`
                       the waveform file contains 401 I/Q values pairs.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect <Filename>

Selects the waveform file. If the file is not on the default path, the path must be specified.

The file extension may be omitted. Only files with the file extension `*.wv` will be created or loaded.

Parameters:
<Filename>   string

Example: `BB:ARB:WAV:SEL '/var/user/wave1.wv'`
                       selects waveform file and loads it.

Manual operation: See "Load Waveform" on page 91

[:SOURce<hw>]:BB:ARBitrary:WAVeform:TAG?

The command queries the content of the specified tag of the selected Waveform file.

Return values:
<Tag>   string

Example: `BB:ARB:WAV:SEL '/var/user/wave1.wv'`
                       selects waveform file and loads it
                       `BB:ARB:WAV:TAG? 'comment'`
                       queries the content of the `comment` tag
                       Response: "Sine wave for test purposes"

Usage: Query only

10.14.4.8 SOURce:BB:ARB:WSEG subsystem

The `WSEGment` subsystem contains the commands for setting the Multi Segment Waveform Generator.

[:SOURce<hw>]:BB:ARBitrary:WSEGment?

This command queries the currently output segment of the multi segment waveform.

Return values:

<WSegment>	integer
	Range: 0 to 1023
	*RST: 0

Example: `BB:ARB:WSEG?`
queries the currently output segment.
`Response 2`
segment 2 is currently output.

Usage: Query only

Manual operation: See "Current Segment" on page 125

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad <FilenameInput>

Creates a and loads a multi segment waveform using the current entries of the speci-fied configuration file.

This multi segment waveform is saved with the file name specified in the configuration file. The file extension is `*.wv`.

Setting parameters:

<FilenameInput>	string

Example: `MMEM:CDIR '/var/user/'`
sets the default directory.
`BB:ARB:WSEG:CONF:SEL 'multi_sin'`
creates the configuration file `multi_sin.inf_mswv` in the default directory.
`BB:ARB:WSEG:CONF:SEGM:APP 'sinus1'`
includes waveform `sinus1.wv` as segment 1 in the configura-tion file. The waveform must be available in the default directory.
`BB:ARB:WSEG:CONF:SEGM:APP 'sinus2'`
includes waveform `sinus2.wv` as segment 2 in the configura-tion file. The waveform must be available in the default directory.
`BB:ARB:WSEG:CONF:OFIL 'mseg1_2'`
defines the file name `mseg1_2.wv` for the multi segment wave-form.
`BB:ARB:WSEG:CLO '/var/user/multi_sin.inf_mswv'`
creates multi segment waveform `mseg1_2.wv` using the set-tings of the configuration file `multi_sin.inf_mswv`.
The new multi segment waveform is loaded.

Usage: Setting only

Manual operation: See "Create and Load" on page 96

[: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 Max (depends on instrument type)
Increment:	0.001
*RST:	1E8

Example: `SOUR:BB:ARB:WSEG:CONF:SEL "MSegFile"`
selects a multi segment file.
`SOUR:BB:ARB:WSEG:CONF:BLAN:APP 1000,100000000`
adds a blank segment with 1000 samples and 100 MHz clock rate to the selected multi segment file

Usage: Setting only

Manual operation: See "Clock Rate" on page 99
See "Samples" on page 99
See "Append Blank" on page 99

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?

Queries the available configuration files in the specified default directory. The configuration files are used to create multi segment waveform files.

Return values:

<Catalog>   string

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:CAT?`
reads out all the configuration files in the default directory.
`Response: mulit1, multi2`
the directory contains the configuration files `multi1.inf_mswv` and `multi2.inf_mswv`.

Usage: Query only

Manual operation: See "Load List" on page 96

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk <Clock>

This command defines the clock rate used for multi segment waveform output in case of Clock Mode "User" (`:BB:ARB:WSEG:CONF:CLOCk:MODE USER`).

Parameters:

<Clock>   float

                Increment: 1E-3
                *RST: max SampleRate

Example: `BB:ARB:WSEG:CONF:CLOC:MODE USER`
selects Clock Mode User.
`BB:ARB:WSEG:CONF:CLOC 50MHz`
defines a clock rate of 50 MHz.

Manual operation: See "User Clock Rate" on page 101

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE <Mode>

Selects the clock rate mode for the multi segment waveform.

Parameters:

<Mode>   UNCHanged | HIGHest | USER

UNCHanged
The segments are output with the clock rate defined in the wave-
form file.

HIGHest
The segments are output at the highest available clock rate.

USER
The segments are output with the clock rate defined with com-
mand [:SOURce<hw>]:BB:ARBitrary:WSEGment:
CONFigure:CLOCk

*RST: UNCHanged

Example: BB:ARB:WSEG:CONF:CLOC:MODE UNCH
selects clock mode unchanged. The segments are output with
the clock rate defined in the waveform file.

Manual operation: See "Clock" on page 100

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent <Comment>

This command enters a comment for the configuration file. The configuration file must
be specified with command :BB:ARB:WSEG:CONF:SEL.

Parameters:
<Comment>   string

Example: BB:ARB:WSEG:CONF:COMM <3gpp_up>
enters comment "3gpp_up".

Manual operation: See "Comment" on page 97

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete <Filename>

Deletes the configuration file. The configuration files are used to create multi segment
waveform files.

Setting parameters:
<Filename>   string

Example: MMEM:CDIR '/var/user/waveform'
sets the default directory.
BB:ARB:WSEG:CONF:DEL 'multi1'
deletes configuration file multi1.inf_mswv.

Usage: Setting only

Manual operation: See "Delete" on page 99

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE] <Mode>

This command selects the level mode for the multi segment waveform.

Parameters:

<Mode>   UNCHanged | ERMS

                          UNCHanged
                          The segments are output exactly as defined in the files.

                          ERMS
                          The segments are output so that all segments have the same
                          rms value.

                          *RST: UNCHanged

Example: BB:ARB:WSEG:CONF:LEV:MODE UNCH
                          selects level mode unchanged. The segments are output as
                          defined in the waveform file.

Manual operation: See "Level" on page 100

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment
       <Mode>

Enables/disables the generation of an additional marker restart signal in the output
waveform file.

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

                          OFF
                          No additional marker is generated.

                          MRK1|MRK2|MRK3|MRK4
                          Generates a restart marker signal at the beginning of each seg-
                          ment for the corresponding marker.
                          The segment begin is defined by the low-high slope of the
                          marker. This applies for switching between two segments as well
                          as in case of segment replay.

                          *RST: OFF

Example: BB:ARB:WSEG:CONF:SEL 'ConfComm'
                          BB:ARB:WSEG:CONF:MARK:ESEG MRK3

Manual operation: See "Segment Restart" on page 102

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment
       <Mode>

Enables/disables the generation of an additional marker restart signal in the output
waveform file.

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

OFF
No additional marker is generated.

MRK1|MRK2|MRK3|MRK4
Generates a restart marker signal at the beginning of the first segment for the corresponding marker.
Use this setting to generate a restart marker for the complete sequence.

*RST:　　　OFF

Example:　　　　　`BB:ARB:WSEG:CONF:SEL 'ConfComm'`
　　　　　　　　　　　`BB:ARB:WSEG:CONF:MARK:FSEG MRK3`

Manual operation:　　See "Sequence Restart" on page 101

[: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

IGNore
The marker information carried in the individual segment waveform files is not considered.

TAKE
The output waveform file contains the marker information as configured in the individual waveform files.

*RST:　　　TAKE

Example:　　　　　`BB:ARB:WSEG:CONF:SEL 'ConfComm'`
　　　　　　　　　　　`BB:ARB:WSEG:CONF:MARK:MODE TAKE`

Manual operation:　　See "Segment Marker" on page 101

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe <OFile>

Defines the file name for the multi segment waveform. The file extension is `*.wv`.

Parameters:

<OFile>　　　　　　　　string

Example: `MMEM:CDIR '/var/user/waveform'`
                        sets the default directory.
                        `BB:ARB:WSEG:CONF:SEL 'multi1'`
                        creates the configuration file `multi1.inf_mswv` in default
                        directory.
                        `BB:ARB:WSEG:CONF:OFIL 'mseg1_2'`
                        defines the file name `mseg1_2.wv` for the multi segment wave-
                        form file created using configuration file `multi1.inf_mswv`.

Manual operation: See "Save List" on page 96
                        See "Output file" on page 97

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend
    <Waveform>

Appends the specified waveform to the configuration file.

Setting parameters:
<Waveform>   string

Example: `MMEM:CDIR '/var/user/waveform'`
                        sets the default directory
                        `BB:ARB:WSEG:CONF:SEL 'new'`
                        creates the configuration file `new.inf_mswv` in the default
                        directory.
                        `BB:ARB:WSEG:CONF:SEGM:APP 'arb1'`
                        appends waveform `arb1.wv` to configuration file `new`. Wave-
                        form `arb1` will be the first segment of a multi segment waveform
                        created with configuration file `new`.

Usage: Setting only

Manual operation: See "Append" on page 99

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?

Queries the segments of the currently selected configuration file.

Return values:
<Catalog>   string

Example: `MMEM:CDIR '/var/user/waveform'`
                        sets the default directory.
                        `BB:ARB:WSEG:CONF:SEL 'multi_sin'`
                        selects the configuration file `multi_sin.inf_mswv`.
                        `BB:ARB:WSEG:CONF:SEGM:CAT?`
                        queries the segments of the selected configuration file.
                        `Response: arb4, arb2`
                        The configuration file includes the segments `arb4.wv` and
                        `arb2.wv`.

Usage: Query only

Manual operation:　　　See "Append" on page 99

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect <Filename>

Selects the configuration file in the default directory.

A path can also be specified, in which case the files in the specified directory are selected. If a configuration file with the specified name does not yet exist, it is created. The file extension may be omitted. Only files with the file extension `*.inf_mswv` will be selected or created.

Parameters:

<Filename>　　　　　　　string

Example:　　　　　　`MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:SEL 'new'`
create configuration file `new.inf_mswv` in the default directory.

Manual operation:　　　See "New List" on page 96
See "Load List" on page 96

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate <FilenameInput>

Creates a multi segment waveform using the current settings of the specified configuration file. The multi segment waveform is saved into the file defined in the configuration file. The file extension is `*.wv`.

Setting parameters:

<FilenameInput>　　　　string

Example:　　　　　　`MMEM:CDIR '/var/user/'`
sets the default directory
`BB:ARB:WSEG:CONF:SEL 'new'`
creates the configuration file `new.inf_mswv` in the default directory.
`BB:ARB:WSEG:CONF:SEGM:APP 'arb1.wv'`
'includes waveform `arb1.wv` as segment 1 in the configuration file. The waveform must be available in the default directory.
`BB:ARB:WSEG:CONF:OFIL 'multi_wv1'`
defines the file name `multi_wv1.wv` for the multi segment waveform.
`BB:ARB:WSEG:CRE '/var/user/new.inf_mswv'`
creates multi segment waveform `multi_wv1.wv` using the settings of the configuration file `new.inf_mswv`.

Usage:　　　　　　　Setting only

Manual operation:　　　See "Save List" on page 96
See "Create" on page 96

[: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

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME?

This command queries the name of the waveform of the currently output segment of the multi segment waveform.

Return values:

<Name>   string

Example: BB:ARB:WSEG:NAME?
                         queries the currently output segment.

Usage: Query only

Manual operation: See "Current Segment" on page 125

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT <Next>

Selects the segment to be output.

Parameters:

<Next>   float

                         Range: 0 to 1023
                         *RST: 0

Example: MMEM:CDIR '/var/user/waveform'
                         sets the default directory.
                         BB:ARB:WSEG:NEXT 2
                         selects segment 2 to be output.
                         BB:ARB:TRIG:SMOD NEXT
                         selects extended trigger mode next, i.e. the segment specified
                         with command :BB:ARB:WSEG:NEXT will be output.
                         BB:ARB:SEQ AUTO
                         selects trigger mode Auto.
                         BB:ARB:WAV:SEL 'multi_wv1'
                         loads multi segment waveform multi_wv1.wv. Generation of
                         segment 2 starts.
                         BB:ARB:WSEG:NEXT 3
                         switched at once to output of segment 3.

Manual operation: See "Next Segment" on page 126

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute

Triggers manually switchover to the subsequent segment in the mutli segment file. A manual trigger can be executed only when an internal next segment source (`BB:ARB:WSEG:NEXT:SOUR INT`) has been selected.

To perform a switchover to any segment within the multi segment file, select the next segment with the command `BB:ARB:WSEG:NEXT`.

This command is disabled, if a sequencing play list is enabled.

Example:	`BB:ARB:WSEG:NEXT:SOUR INT`
	selects internal next segment source.
	`BB:ARB:WSEG:NEXT 2`
	selects segment 2 to be output.
	`BB:ARB:WSEG:NEXT:EXEC`
	executes a switchover to the next segment.
Usage:	Event
Manual operation:	See "Execute Next Segment" on page 130

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:SOURce <Source>

Selects the next segment source, i.e. determines whether the next segment is switched upon receiving of an external trigger signal or upon executing of software trigger .

Parameters:

<Source>	INTernal | NEXT
	INTernal
	Switch over to any segment is triggered manually by means of the command `BB:ARB:WSEG:NEXT:EXEC`.
	NEXT
	The trigger event for switching to the next segment is input on the NEXT connector.
	*RST:　　INTernal
Example:	`BB:ARB:WSEG:NEXT:SOUR INT`
	selects internal next segment source.

[: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 65535
<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:	`BB:ARB:WSEG:SEQ:SEL '/var/user/play_list_1'` selects the sequencing list `play_list_1.wvs`.
	`BB:ARB:WSEG:SEQ:APP ON,3,15,BLANK` appends the segment number 3 as a new segment to the sequencing list; this segment is activated and will be repeated 15 times and followed by a blank segment.
Usage:	Setting only
Manual operation:	See "Append" on page 103

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect <Filename>

Selects the sequencing list (files with extension `*.wvs`)

Parameters:

<Filename>	string
Example:	`BB:ARB:WSEG:SEQ:SEL '/var/user/play_list_1'` selects the sequencing list `play_list_1.wvs`.
Manual operation:	See "Append" on page 103
	See "New/Load Sequencing List" on page 104
	See "Sequencing List" on page 130

[: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`

10.14.5 SOURce:BB:ARBitrary:CFR subsystem

Option R&S SGT-K548 is required for the use of the following SCPIs.

Example: Preparing for CFR

```
// Load an ARB waveform file, e.g., the file "test.wv".
SOURce1:BB:ARBitrary:LOAD "test"
// Activate ARB.
SOURce1:BB:ARBitrary:STATe 1
```

Example: Applying clipping and filtering algorithm

```
// Set for filter and clipping CFR algorithm.
SOURce1:BB:ARBitrary:CFR:ALGorithm CLFiltering
SOURce1:BB:ARBitrary:CFR:DCFDelta -3
SOURce1:BB:ARBitrary:CFR:ITERations 5


// Configure simple filtering.
SOURce1:BB:ARBitrary:CFR:FILTer SIMPle
SOURce1:BB:ARBitrary:CFR:CSPacing 20E6
SOURce1:BB:ARBitrary:CFR:SBANdwidth 18E6

// Configure enhanced filtering.
SOURce1:BB:ARBitrary:CFR:FILTer ENHanced
SOURce1:BB:ARBitrary:CFR:PFReq 9E6
SOURce1:BB:ARBitrary:CFR:SFReq 11E6
SOURce1:BB:ARBitrary:CFR:FORDer 100
```

Example: Applying peak cancellation algorithm

```
// Set for peak cancellation CFR algorithm.
SOURce1:BB:ARBitrary:CFR:ALGorithm PCANcellation
SOURce1:BB:ARBitrary:CFR:DCFDelta -3
// Set a cancellation pulse bandwidth of 800 kHz.
SOURce1:BB:ARBitrary:CFR:CPBandwidth 800000
// Set a transition bandwidth of 10 kHz.
SOURce1:BB:ARBitrary:CFR:TBANdwidth 10000
```

Example: Activating and monitoring CFR characteristics

```
SOURce1:BB:ARBitrary:CFR:STATe 1
SOURce1:BB:ARBitrary:CFR:MEASure:STATe?
// Response: "1"
// Query the original crest factor.
SOURce1:BB:ARBitrary:CFR:OCFactor?
// Response: "6"
// Query the resulting crest factor.
SOURce1:BB:ARBitrary:CFR:RCFactor?
// Response: "3"
// Create the waveform file "cfr.wv" with reduced crest factor.
SOURce1:BB:ARBitrary:CFR:CREate "cfr"
```

[:SOURce<hw>]:BB:ARBitrary:CFR[:STATe] <ArbCfrState>

Enables the crest factor reduction calculation.

Parameters:

<ArbCfrState>   1 | ON | 0 | OFF

                       *RST: 0

Manual operation: See "State" on page 138

[:SOURce<hw>]:BB:ARBitrary:CFR:ALGorithm <ArbCfrAlgorithm>

Defines the algorithm for crest factor reduction.

Parameters:

<ArbCfrAlgorithm>   CLFiltering | PCANcellation

                       CLFiltering
                       Clipping and filtering algorithm. This algorithm performs a hard
                       clipping of the baseband signal. It is followed by a low pass filter-
                       ing of the result in an iterative manner until the target crest factor
                       is reached. You can define the settings of the filter that is used
                       for the calculation.

                       PCANcellation
                       Peak cancelation algorithm. This algorithm subtracts Blackman
                       windowed sinc pulses from the signal wherever the amplitude is
                       above a defined threshold.

                       *RST: CLFiltering

Example: See Example"Applying clipping and filtering algorithm"
                       on page 449.

Example: See Example"Applying peak cancellation algorithm"
                       on page 449.

Manual operation: See "Algorithm" on page 138

[:SOURce<hw>]:BB:ARBitrary:CFR:CPBandwidth <ArbCfrCancPulBw>

Sets the cancellation pulse bandwidth for peak cancellation CFR algorithm.

Parameters:

<ArbCfrCancPulBw> float

Range: 0 to 250E6
Increment: 0.1

Example: See Example"Applying peak cancellation algorithm" on page 449.

Manual operation: See "Cancellation Pulse Bandwidth" on page 141

[:SOURce<hw>]:BB:ARBitrary:CFR:CSPacing <ArbCfrChanSpac>

Sets the channel spacing, if `[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer` is set to `SIMPle`.

Parameters:

<ArbCfrChanSpac>   float

Range: 0 to depends on the sample rate of the loaded file
Increment: 0.1
*RST: 250E6

Manual operation: See "Channel Spacing" on page 140

[:SOURce<hw>]:BB:ARBitrary:CFR:DCFDelta <ArbCfrDCFDelta>

Sets the value difference by which you want to change your crest factor.

Parameters:

<ArbCfrDCFDelta>   float

Range: -20 to 0
Increment: 0.1
*RST: -3

Manual operation: See "Desired Crest Factor Delta" on page 138

[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer <ArbCfrFilterMod>

Selects which filter mode is used for the filtering.

Parameters:

<ArbCfrFilterMod>   SIMPle | ENHanced

*RST: SIMPle

Manual operation: See "Filter Mode" on page 139

[:SOURce<hw>]:BB:ARBitrary:CFR:FORDer <ArbCfrMaxFilOrd>

Sets the maximum filter order, if `[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer` is set to `ENHanced`.

Parameters:

<ArbCfrMaxFilOrd>   integer

                          Range: 0 to 300
                          *RST: 100

Example: See Example"Applying clipping and filtering algorithm"
                          on page 449.

Manual operation: See "Maximum Filter Order" on page 141

[:SOURce<hw>]:BB:ARBitrary:CFR:ITERations <ArbCfrMaxIter>

Sets the number of iterations that are used for calculating the resulting crest factor. The iteration process is stopped when the desired crest factor delta is achieved by 0.1 dB.

Parameters:

<ArbCfrMaxIter>   integer

                          Range: 1 to 10
                          *RST: 5

Manual operation: See "Max Iterations" on page 138

[:SOURce<hw>]:BB:ARBitrary:CFR:MEASure[:STATe]?

Queries the state of the crest factor reduction calculation.

Return values:

<MeasureState>   1 | ON | 0 | OFF

                          ON: the original and resulting crest factors are already calcula-
                          ted.
                          *RST: 0

Example: See Example"Activating and monitoring CFR characteristics"
                          on page 449.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:CFR:OCFactor?

Queries the original crest factor of the waveform after the calculation of the resulting crest factor is completed. The original crest factor is calculated as an average over the whole waveform, including any idle periods that might be present in TDD waveforms.

Return values:

<ArbCfrOCrestFac>   float

Range:	1 to 100
Increment:	0.01
*RST:	6

Usage: Query only

Manual operation: See "Original Crest Factor" on page 139

[:SOURce<hw>]:BB:ARBitrary:CFR:PFReq <ArbCfrPassBFreq>

Sets the passband frequency, if `[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer` is set to `ENHanced`. Frequency components lower than the passband frequency are passed through unfiltered.

Parameters:

<ArbCfrPassBFreq>   float

Range:	0 to depends on the sample rate of the loaded file
Increment:	0.1
*RST:	250E6

Example: See Example"Applying clipping and filtering algorithm" on page 449.

Manual operation: See "Passband Frequency" on page 140

[:SOURce<hw>]:BB:ARBitrary:CFR:RCFactor?

Queries the resulting crest factor of the waveform after the calculations are completed. The resulting crest factor is calculated as an average over the whole waveform, including any idle periods that might be present in TDD waveforms.

Return values:

<ArbCfrResCreFac>   float

Range:	1 to 100
Increment:	0.1
*RST:	6

Example: See Example"Activating and monitoring CFR characteristics" on page 449.

Usage: Query only

Manual operation: See "Resulting Crest Factor" on page 139

[:SOURce<hw>]:BB:ARBitrary:CFR:SBANdwidth <ArbCfrSignalBw>

Sets the signal bandwidth, if `[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer` is set to `SIMPle`.

The value of the signal bandwidth should not be higher than the channel spacing (`[:SOURce<hw>]:BB:ARBitrary:CFR:CSPacing`).

Parameters:

<ArbCfrSignalBw>   float

Range: 0 to depends on the sample rate of the loaded file
Increment: 0.1
*RST: 250E6

Manual operation: See "Signal Bandwidth" on page 140

[:SOURce<hw>]:BB:ARBitrary:CFR:SFReq <ArbCfrStopBFreq>

Sets the stopband frequency of the filter, if `[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer` is set to `ENHanced`. Frequency components higher than the stopband frequency are filtered out by the lowpass filter.

Parameters:

<ArbCfrStopBFreq>   float

Range: 0 to depends on the sample rate of the loaded file
Increment: 0.1
*RST: 250E6

Example: See Example"Applying clipping and filtering algorithm"
on page 449.

Manual operation: See "Stopband Frequency" on page 140

[:SOURce<hw>]:BB:ARBitrary:CFR:TBANdwidth <DDArbCfrTranBw>

Sets the transition bandwidth of the cancellation pulse for peak cancellation CFR algorithm.

Parameters:

<DDArbCfrTranBw>   float

Range: 0 to 250E6
Increment: 0.1

Example: See Example"Applying peak cancellation algorithm"
on page 449.

Manual operation: See "Transition Bandwidth" on page 141

[:SOURce<hw>]:BB:ARBitrary:CFR:WAVeform:CREate <CreateWvFile>

With enabled signal generation, triggers the instrument to save the current settings in a waveform file. Waveform files can be further processed.

The filename and the directory it is saved in are user-definable; the predefined file extension for waveform files is `*.wv`.

Setting parameters:

<CreateWvFile>   string

Example: See Example"Activating and monitoring CFR characteristics"
                       on page 449.

Usage: Setting only

Manual operation: See "Generate Waveform" on page 138

10.14.6 SOURce:BBIN subsystem

The `SOURce:BBIN` subsystem contains the commands for setting the external digital
baseband signals.

[:SOURce<hw>]:BBIN:ALEVel:EXECute

This command starts measuring the input signal. The measurement estimates the
crest factor and the peak power.

Example: `BBIN:ALEV:EXEC`
                       starts measuring the input signal.

Usage: Event

Manual operation: See "Auto Level Set" on page 267

[:SOURce\<hw\>]:BBIN:CDEVice?

Digital Input only.

Indicates the ID of an externally connected R&S Instrument or R&S Device.

Return values:

\<CDevice\>   string

Example: BBIN:CDEV
                            queries the connected device ID.

Usage: Query only

Manual operation: See "Connected Device" on page 265

[:SOURce\<hw\>]:BBIN:POWer:CFACtor \<CFactor\>
[:SOURce\<hw\>]:BBIN:CFACtor \<CFactor\>

This command enters the crest factor of the external baseband signal.

Parameters:

\<CFactor\>   float

                            Range: 0 to 30
                            Increment: 0.01
                            *RST: 0
                            Default unit: dB

Example: BBIN:CFAC 10
                            enters a crest factor of 10 dB for the external baseband signal.

Manual operation: See "Crest Factor" on page 267

[:SOURce\<hw\>]:BBIN:DIGital:ASETting:STATe \<State\>

Activates automatic adjustment of the baseband input signal.

The R&S SGT receives peak level, level and crest factor values directly from the connected transmitter and recognizes changes automatically.

Parameters:

\<State\>   0 | 1 | OFF | ON

                            *RST: 0

Example: BBIN:DIG:ASET:STAT ON
                            switches on automatic adjustment of the baseband input signal.

Manual operation: See "DIG IQ Auto Setting" on page 267

[:SOURce\<hw\>]:BBIN:FOFFset \<FOffset\>

Enters the frequency offset for the external baseband signal.

The complex I/Q bandwidth of the shifted useful signal must not exceed the total available baseband bandwidth (see data sheet).

Parameters:

<FOffset>   float

                   Range: -40E6 to 40E6
                   Increment: 0.01
                   *RST: 0
                   Default unit: Hz

Example: BBIN:FOFF 2 MHz
                   sets a frequency offset of 2 MHz.

Manual operation: See "Frequency Offset" on page 268

[:SOURce<hw>]:BBIN:GIMBalance <GImbalance>

This command enters a gain to the Q component of the external baseband signal.

Parameters:

<GImbalance>   float

                   Range: -3 to 3
                   Increment: 0.001
                   *RST: 0
                   Default unit: dB

Example: BBIN:GIMB -1.0dB
                   amplifies the Q component of the external input signal with -1.0
                   dB.

[:SOURce<hw>]:BBIN:IQSWap[:STATe] <State>

This command swaps the I and Q channel if set to ON.

Parameters:

<State>   0 | 1 | OFF | ON
                   *RST: 0

Example: BBIN:IQSW ON
                   swaps the I and Q channel of the external baseband signal.

Manual operation: See "I/Q-Swap" on page 265

[:SOURce<hw>]:BBIN:MODE <Mode>

This command selects the external input signal mode for the "Baseband In" block.

Parameters:

<Mode>   ANALog | DIGital

                   ANALog
                   The external analog baseband signal is supplied via the inputs **I**
                   and **Q**.

DIGItal

The external digital baseband signal is fed into the signal path via the "Digital Input" connector. The internal signal processing is based on a sample rate of 100 MHz. Input signals with a sample rate less than 100 MHz are upsampled. The sample rate can be estimated or defined by the user in the appropriate entry fields.

*RST: ANALog

Example: `BBIN:SOUR ANAL`

selects an external analog signal as the input signal. The signal must be applied at the inputs I and Q.

[:SOURce\<hw\>]:BBIN:MPERiod \<MPeriod\>

Sets the recording duration for measuring the baseband input signal by Auto Level Set.

Parameters:

\<MPeriod\>   integer

Range: 1 to 32
*RST: 2
Default unit: s

Example: `BBIN:MPER 4s`

sets the recording duration for Auto Level Set to 4 seconds.

Manual operation: See "Measurement Period" on page 267

[:SOURce\<hw\>]:BBIN:OFFSet:I \<I\>
[:SOURce\<hw\>]:BBIN:OFFSet:Q \<Q\>

This command enters a DC offset to the I / Q component of the external baseband signal.

Parameters:

\<Q\>   float

Range: -10 to 10
Increment: 0.001
*RST: 0
Default unit: %FS

Example: `BBIN:OFFS:Q -0.1PCT`

sets -0.1 %FS DC offset to the Q component of the external input signal.

[:SOURce\<hw\>]:BBIN:OLOad:HOLD:RESet

This command executes a reset of the Overload Hold State and LED.

Example: `BBIN:MODE DIG`
                   selects the digital baseband input mode.
                   `BBIN:OLO:HOLD:RES`
                   resets the overload hold state.

Usage: Event

[:SOURce<hw>]:BBIN:OLOad:HOLD:STATe?

This command queries an overload since the last reset for evaluating the measurement. The Overload Hold state can be reset via the "Reset" command, or is reset automatically by starting a new measurement ("Auto Level Set") or by setting new values (Crest Factor, Peak Level, Level).

Return values:
<State>   0 | 1 | OFF | ON
                   *RST: 0

Example: `BBIN:MODE DIG`
                   selects the digital baseband input mode.
                   `BBIN:OLO:HOLD:STAT?`
                   queries the overload state.
                   `Response: 0`
                   the AC/DC converter has not been overloaded.

Usage: Query only

Manual operation: See "Overflow Hold" on page 268
                      See "Reset" on page 268

[:SOURce<hw>]:BBIN:OLOad:STATe?

This command queries the current overload state of the A/D converter.

Return values:
<State>   0 | 1 | OFF | ON
                   *RST: 0

Example: `BBIN:MODE DIG`
                   selects the digital baseband input mode.
                   `BBIN:OLO:STAT?`
                   queries the overload state.
                   `Response: 0`
                   The AC/DC converter is not overloaded.

Usage: Query only

Manual operation: See "Overflow" on page 268

[:SOURce<hw>]:BBIN:ODELay <Delay>

Seds the output delay of the external baseband signal.

Parameters:

<Delay>   float

                           Range: 0 to 1
                           Increment: 1E-9
                           *RST: 0

[:SOURce<hw>]:BBIN:PGAin <PGain>

This command enters the relative gain for the external baseband signal compared with the signals of the other baseband sources. The actual gain of the different baseband signals depends not only on the path gain setting but also on the signal characteristics such as the crest factor and on the number of used sources. used and on the total RF output power. The gain affects the signal on the "Baseband" In block output.

Parameters:

<PGain>   float

                           Range: -50 to 50
                           Increment: 1E-3
                           *RST: 0
                           Default unit: dB

Example: BBIN:PGA 3dB
                          sets the relative gain of 3 dB for the external baseband signal.

[:SOURce<hw>]:BBIN:POWer:PEAK <Peak>

This command enters the 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: BBIN:POW:PEAK -2
                          enters the peak level of -2 dBfs.

Manual operation: See "Peak Level" on page 267

[:SOURce<hw>]:BBIN:POWer:RMS?

This command queries the rms level of the external digital baseband signal.

Return values:

<Rms>   float

                           Range: -100 to 10
                           Increment: 0.01
                           *RST: 0

Example:	BBIN:POW:RMS
	queries the estimated rms level.
Usage:	Query only
Manual operation:	See "Level" on page 267

[:SOURce<hw>]:BBIN:SKEW <Skew>

This command determines the delay between Q and I channel. Positive values represent a delay for Q versus I.

Parameters:

<Skew>	float
	Range: -1E-9 to 1E-9
	Increment: 1E-12
	*RST: 0
	Default unit: s
Example:	BBIN:SKEW -23PS
	enters a delay between Q and I channel of 23 picoseconds.

[:SOURce<hw>]:BBIN:SRATe[:ACTual] <Actual>

Sets the sample rate of the external digital baseband signal.

Parameters:

<Actual>	float
	Range: 25E6 to 250E6
	Increment: 5E6
	*RST: 100E6
Example:	:SOURce:BBIN:SRATe:ACTual 50E6
Manual operation:	See "Sample Rate Value" on page 266

[:SOURce<hw>]:BBIN:SRATe:SOURce <Source>

Queries the source for estimating the sample rate of the digital input signal or defining it by the user.

Parameters:

<Source>	USER	DIN
	*RST: USER
Example:	BBIN:SRAT:SOUR?
Manual operation:	See "Sample Rate Source" on page 266

[:SOURce<hw>]:BBIN:STATe <State>

This command switches the feeding of an external analog signal into the signal path on/off.

Parameters:

<State>   0 | 1 | OFF | ON

                        *RST: 0

Example: BBIN:SOUR ANAL

                        selects an external analog signal as the input signal. The signal must be applied at the inputs I and Q.

                        BBIN:STAT ON

                        switches on the Baseband In block. The external analog signal is A/D-converted and fed into the digital signal.

Manual operation: See "State" on page 265

10.14.7 SOURce:BB:IMPairment subsystem

This subsystem contains the commands for the digital I/Q impairments.

The suffix <ch> in the IQOutput<ch> commands has the following values:

- <ch>= 0: I/Q Analog Outputs

- <ch>= 1: I/Q Modulator Digital Impairments

[:SOURce<hw>]:BB:IMPairment:DELay <Delay>

Sets the time delay of both I and Q vectors relative to the selected trigger and marker or relative to the other instrument(s) working in the primary/secondary instrument mode.

A positive value means that the I and Q vectors delay relative to the marker/trigger or to the other instrument and vice versa.

Parameters:

<Delay>	float
	Range: -500E-9 to 500E-9
	Increment: 1E-12
	*RST: 0

Example: `BB:IMP:DEL 32.0E-9`

Sets the I/Q delay

Manual operation: See "IQ Delay" on page 160

[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude] <IqRatio>

This command sets the ratio of I modulation to Q modulation (amplification "imbalance"). The input may be either in dB or %. The resolution is 0.001 dB, an input in percent is rounded to the closest valid value in dB. A query returns the value in dB.

Parameters:

<IqRatio>	float
	Range: -1 to 1
	Increment: 1E-4
	*RST: 0

Example: `BB:IMP:IQR 3 PCT`

sets the imbalance to 3 percent.

`BB:IMP:IQR?`

queries the imbalance.

`Response: 0.259000`

the value is returned in dB

Manual operation: See "Gain Imbalance" on page 159

[:SOURce<hw>]:BB:IMPairment:LEAKage:I <I>

This command sets the carrier leakage amplitude for the I-signal component.

Parameters:

<I>	float
	Range: -10 to 10
	Increment: 0.01
	*RST: 0
	Default unit: PCT

Example: `BB:IMP:LEAK:I 3 PCT`

sets the leakage for the I-component to 3 percent.

Manual operation: See "I/Q Offset" on page 159

[:SOURce<hw>]:BB:IMPairment:LEAKage:Q <Q>

This command sets the carrier leakage amplitude for the Q-signal component.

Parameters:

<Q>   float

                           Range: -10 to 10
                           Increment: 0.01
                           *RST: 0
                           Default unit: PCT

Example: BB:IMP:LEAK:Q 3 PCT

                           sets the leakage for the Q-component to 3 percent.

Manual operation: See "I/Q Offset" on page 159

[:SOURce<hw>]:BB:IMPairment:QUADrature[:ANGLe] <Angle>

This command sets the quadrature offset for the digital I/Q signal.

Parameters:

<Angle>   float

                           Range: -10 to 10
                           Increment: 0.01
                           *RST: 0
                           Default unit: DEG

Example: BB:IMP:QUAD:ANGL −5DEG

                           sets the quadrature offset to -5 degrees.

Manual operation: See "Quadrature Offset" on page 159

[:SOURce<hw>]:BB:IMPairment:SKEW <Skew>

Sets the time offset between the I and Q vectors.

In an I/Q modulator without I/Q skew, the I and Q vectors are aligned to the marker. With an I/Q skew, both vectors are shifted relative to the marker so that the offset of each of the vectors to the marker will be the half of the I/Q skew value.

A positive I/Q skew means that the Q vector delays relative to the I vector and vice versa.

Parameters:

<Skew>   float

                           Range: -500E-9 to 500E-9
                           Increment: 1E-12
                           *RST: 0

Example: BB:IMP:SKEW 410.0E-9

                           sets the I/Q skew.

Manual operation: See "Skew" on page 159

[:SOURce<hw>]:BB:IMPairment:STATe <State>

The command activates (ON) and deactivates (OFF) the three impairment or correction values LEAKage, QUADrature and IQRatio for the digital baseband signal prior to input into the I/Q modulator.

Parameters:

<State>	0 | 1 | OFF | ON
	*RST: 0
Example:	BB:IMP:STAT OFF
	deactivates digital impairment.
Manual operation:	See "State" on page 157
	See "State" on page 159

[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE <Mode>

This command sets the optimization mode.

Parameters:

<Mode>	FAST | QHIGh
	FAST
	Optimization is reached by compensation for I/Q skew.
	QHIGh
	Optimization is reached by compensation for I/Q skew and frequency response correction.
	*RST: FAST
Example:	BB:IMP:OPT:MODE FAST
	sets the optimization mode Fast.
Manual operation:	See "Optimization Mode" on page 155

[:SOURce]:BB:IMPairment:POFFset <PhaseOffset>

Adds a phase offset to the digital impairments in the I/Q modulator. The phase of the digital impairments is shifted relatively to the I/Q samples.

Parameters:

<PhaseOffset>	float
	Range: -999.99 to 999.99
	Increment: 0.01
	*RST: 0
Manual operation:	See "Phase Offset" on page 160

[:SOURce]:BB:IMPairment:IQOutput<ch>:STATe <State>

Activates the impairment or correction values LEAKage, QUADrature and IQRatio for the corresponding stream.

Parameters:

<State>   0 | 1 | OFF | ON

                           *RST: 0

Manual operation: See "State" on page 159

[:SOURce]:BB:IMPairment:IQOutput<ch>:DELay <Delay>

Defines the time delay of both I and Q vectors between the marker signal at the marker outputs relative to the signal generation start.

A positive value means that the I and Q vectors delay relative to the marker/trigger or to the other instrument and vice versa.

Parameters:

<Delay>   float

                           Range: -500E-9 to 500E-9
                           Increment: 1E-12
                           *RST: 0

Manual operation: See "IQ Delay" on page 160

[:SOURce]:BB:IMPairment:IQOutput<ch>:IQRatio[:MAGNitude] <IqRatio>

Sets the ratio of I modulation to Q modulation (amplification imbalance) of the corresponding digital I/Q channel. The input may be either in dB or %. The resolution is 0.001 dB, an input in percent is rounded to the closest valid value in dB. A query returns the value in dB.

Parameters:

<IqRatio>   float

                           Range: -1 to 1
                           Increment: 0.0001
                           *RST: 0

Manual operation: See "Gain Imbalance" on page 159

[:SOURce]:BB:IMPairment:IQOutput<ch>:POFFset <PhaseOffset>

Adds a phase offset between Q vector and I vector in the corresponding stream. The phase is shifted relatively to the I/Q samples.

Parameters:

<PhaseOffset>   float

                           Range: -999.99 to 999.99
                           Increment: 0.01
                           *RST: 0

Manual operation: See "Phase Offset" on page 160

[:SOURce]:BB:IMPairment:IQOutput<ch>:QUADrature[:ANGLe] <Angle>

Sets the quadrature offset. 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

Manual operation:　　See "Quadrature Offset" on page 159

[:SOURce]:BB:IMPairment:IQOutput<ch>:SKEW <Skew>

Sets a delay between the Q vector and the I vector of the corresponding stream.

Parameters:

<Skew>　　　　　　　　float

　　　　　　　　　　　Range:　　　-500E-9　to　500E-9
　　　　　　　　　　　Increment:　1E-12
　　　　　　　　　　　*RST:　　　　0

Manual operation:　　See "Skew" on page 159

[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:I <I>
[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:Q <Q>

Determines the leakage amplitude of the I or Q-signal component of the corresponding stream.

Parameters:

<Q>　　　　　　　　　　float

　　　　　　　　　　　Range:　　　-10　to　10
　　　　　　　　　　　Increment:　0.01
　　　　　　　　　　　*RST:　　　　0

Manual operation:　　See "I/Q Offset" on page 159

10.14.8　SOURce:BB:PROGress subsystem general commands

In the R&S SGT, 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 467
Usage:	Query only

10.14.9 SOURce:BB:POWer subsystem

This subsystem contains the commands for retrieving the level values of the digital baseband signal.

[:SOURce<hw>]:BB:CFACtor?

This command 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:	`BB:CFAC`
	queries the crest factor of the baseband signal.
Usage:	Query only

[:SOURce<hw>]:BB:POWer:PEAK?

This command queries the peak power 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 power of the baseband signal.

Usage: Query only

[:SOURce<hw>]:BB:POWer:RMS?

This command queries the power 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 power of the baseband signal.

Usage: Query only

10.14.10 SOURce:CORRection subsystem

The output level is corrected in the CORRection subsystem. Correction is performed by user-defined table values being added to the output level for the respective RF frequency. In the R&S SGT, this subsystem is used to select, transfer and activate user correction tables.

Each list is stored as a file. The name of the user correction file can be freely selected. The file extension *.uco is assigned automatically and cannot be changed.

The files can be stored in a freely selectable directory and opened from there. The default directory is set using command :MMEMory:CDIRectory on page 366. In the case of files which are stored in the default directory, only the file name has to be specified in commands. Otherwise, the complete absolute path has to be specified with every command. The extension can be omitted in any case.

In the following command examples, the files are stored in the default directory.

[:SOURce]:CORRection:CSET:CATalog?

Requests a list of user correction tables. The individual lists are separated by commas.

The lists are stored with the fixed file extensions `*.uco` in a directory of the user's choice. The directory applicable to the commands is defined with the command `MMEMory:CDIR`.

Return values:

<Catalog>	string

Example: `MMEM:CDIR '/var/user/ucor'`
selects the directory for the user correction files.
`CORR:CSET:CAT?`
queries which correction tables are available.
Response:`UCOR1,UCOR2,UCOR3`
the correction tables `UCOR1, UCOR2 and UCOR3` are available.

Usage: Query only

[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency <Frequency>

Transfers the frequency data to the table selected with `:CORRection:CSET:SELect`.

The numerical suffix at SOURce must not be used for this command.

Parameters:

<Frequency>	Frequency#1[, Frequency#2, ...]
	Range: 300 kHz to RFmax (depending on model)

Example: `CORR:CSET '/var/user/ucor1'`
selects the table `ucor1`.
`CORR:CSET:DATA:FREQ 100MHz,102MHz,103MHz,...`
enters the frequency value in the table `ucor1`.

Manual operation:　　See "Edit User Cor. Data" on page 232

[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency:POINts?

Queries the number of frequency values in the selected table.

The numerical suffix at SOURce must not be used for this command.

Return values:

<Points>　　　　　　　integer

　　　　　　　　　　　Range:　　　0 to 10000
　　　　　　　　　　　*RST:　　　　0

Example:　　　　　`CORR:CSET '/var/user/'`
　　　　　　　　　　selects the table ucor1.
　　　　　　　　　　`CORR:CSET:DATA:FREQ:POIN?`
　　　　　　　　　　queries the number of frequency values in the table ucor1.
　　　　　　　　　　Response: `440`
　　　　　　　　　　the table ucor1 contains 440 frequency values.

Usage:　　　　　　Query only

[:SOURce<hw>]:CORRection:CSET:DATA:POWer <Power>

Transfers the level data to the table selected with `[:SOURce<hw>]:CORRection:CSET[:SELect]`.

`*RST` does not affect data lists. The numerical suffix at SOURce must not be used for this command.

Parameters:

<Power>　　　　　　　Power#1[, Power#2, ...]

Example:　　　　　`CORR:CSET '/var/user/ucor1'`
　　　　　　　　　　selects the table `ucor1`.
　　　　　　　　　　`CORR:CSET:DATA:POW 1dB, 0.8dB, 0.75dB,...`
　　　　　　　　　　enters the level values in the table `ucor1`.

Manual operation:　　See "Edit User Cor. Data" on page 232

[:SOURce<hw>]:CORRection:CSET:DATA:POWer:POINts?

Queries the number of level values in the selected table.

The numerical suffix at SOURce must not be used for this command.

Return values:

<Points>　　　　　　　integer

　　　　　　　　　　　Range:　　　0 to 10000
　　　　　　　　　　　*RST:　　　　0

Example:	`CORR:CSET '/var/user/ucor1'`
	selects the table ucor1.
	`CORR:CSET:DATA:POW:POIN?`
	queries the number of level values in the table ucor1.
	Response: `440`
	the table ucor1 contains 440 level values.
Usage:	Query only

[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe

The command fills the selected user correction list 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:	`CORR:CSET:DATA:SENS:POW:SONC`
	fills the user correction list with level values acquired by the power sensor connector to the [SENSOR] connector.
Usage:	Event
Manual operation:	See "Fill User Correction Data with Sensor" on page 237

[:SOURce]:CORRection:CSET:DELete <Filename>

Deletes the specified table.

The lists are stored with the fixed file extensions `*.uco` in a directory of the user's choice. The directory applicable to the commands is defined with the command `MMEMory:CDIR`. A path can also be specified in command `SOUR:CORR:CSET:CAT?`, in which case the file in the specified directory is deleted.

Setting parameters:

<Filename>	<table name>

Example:	`MMEM:CDIR '/var/user/ucor'`
	selects the directory for the user correction files.
	`CORR:CSET:DEL 'UCOR1'`
	deletes the table `ucor1`.
Usage:	Setting only
Manual operation:	See "User Cor. Data - User Correction" on page 232

[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog?

Requests a list of available ASCII files for export/import of user correction data. The individual files are separated by commas.

The ASCII files are stored with the fixed file extensions `*.txt` or `*.csv` in a directory of the user's choice. The directory applicable to the commands is defined with the command `MMEMory:CDIR`.

Return values:

<Catalog>   string

Example: `MMEM:CDIR '/var/user/import'`
                            selects the directory for the ASCII files with frequency and level
                            value pairs.
                            `CORR:DEXC:AFIL:EXT TXT`
                            selects that ASCII files with extension `*.txt` are listed.
                            `CORR:DEXC:AFIL:CAT?`
                            queries the available files with extension `*.txt`.
                            Response: `'ucor1,ucor2'`
                            the ASCII files `ucor1.txt` and `ucor2.txt` are available.

Usage: Query only

[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension <Extension>

Selects the file extension of the ASCII file to be imported or exported. Selection TXT
(text file) or CSV (Excel file) is available.

Parameters:

<Extension>   TXT | CSV

                            *RST: TXT

Example: `MMEM:CDIR '/var/user/import'`
                            selects the directory for the ASCII files with frequency and level
                            value pairs.
                            `CORR:DEXC:AFIL:EXT TXT`
                            selects that ASCII files with extension *.txt are listed.
                            `CORR:DEXC:AFIL:CAT?`
                            queries the available files with extension *.txt.
                            Response: `'list1,list2'`
                            the ASCII files `ucor1.txt` and `ucor2.txt` are available.

Manual operation: See "Extension" on page 234

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect <Filename>

Selects the ASCII file to be imported or exported.

The ASCII files are stored with the fixed file extensions `*.txt` or `*.csv` in a directory
of the user's choice. The directory applicable to the commands is defined with the com-
mand `MMEMory:CDIR`. A path can also be specified in command
`SOUR:CORR:DEXC:AFIL:SEL`, in which case the files are stored or loaded in the
specified directory.

Parameters:

<Filename>   <ascii file name>

Example: `CORR:DEXC:MODE IMP`
                     selects that ASCII files with frequency and level value pairs are
                     imported and transferred into user correction lists.
                     `CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`
                     selects that ASCII file `ucor.csv` is imported.
                     `CORR:DEXC:SEL '/var/user/import_ucor_imp'`
                     selects that the ASCII file `ucor.csv` is imported into user cor-
                     rection list `ucor_imp`.

Manual operation: See "Select ASCII Source/Destination" on page 235

[: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: `CORR:DEXC:MODE EXP`
                     selects that the user correction list is exported into an ASCII file.
                     `CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`
                     selects ASCII file ucor.csv as destination for the user correction
                     list data.
                     `CORR:DEXC:AFIL:SEP:COL TAB`
                     the pairs of frequency and level values are separated by a tabu-
                     lator.
                     `CORR:DEXC:AFIL:SEP:DEC DOT`
                     selects the decimal separator dot.
                     `CORR:DEXC:SEL '/var/user/import_ucor_imp'`
                     selects that the user correction list ucor_imp is imported into
                     ASCII file ucor.csv.

Manual operation: See "Column Separator" on page 235

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal <Decimal>

Selects the decimal separator used in the ASCII data between '.' (decimal point) and ','
(comma) with floating-point numerals.

Parameters:
<Decimal>   DOT | COMMa
                     *RST: DOT

Example: `CORR:DEXC:MODE EXP`

selects that the user correction list is exported into an ASCII file.

`CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`

selects ASCII file ucor.csv as destination for the user correction list data.

`CORR:DEXC:AFIL:SEP:COL TAB`

the pairs of frequency and level values are separated by a tabulator.

`CORR:DEXC:AFIL:SEP:DEC DOT`

selects the decimal separator dot.

`CORR:DEXC:SEL '/var/user/import_ucor_imp'`

selects that the user correction list `ucor_imp` is imported into ASCII file `ucor.csv`.

Manual operation: See "Decimal Point" on page 234

[:SOURce<hw>]:CORRection:DEXChange:EXECute

Starts the export or import of the selected file. When import is selected, the ASCII file is imported as user correction list. When export is selected, the user correction list is exported into the selected ASCII file.

Example: `CORR:DEXC:MODE IMP`

selects that ASCII files with frequency and level value pairs are imported and transferred into user correction lists.

`CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`

selects that ASCII file ucor.csv is imported.

`CORR:DEXC:SEL '/var/user/import_ucor_imp'`

selects that the ASCII file `ucor.csv` is imported into user correction list `ucor_imp`.

`CORR:DEXC:EXEC`

starts the import of the ASCII file data into the user correction file.

Usage: Event

Manual operation: See "Import/Export" on page 235

[:SOURce<hw>]:CORRection:DEXChange:MODE <Mode>

Selects if user correction lists should be imported or exported. Depending on the selection her, the file select command define either the source or the destination for user correction lists and ASCII files.

Parameters:

<Mode>   IMPort | EXPort

*RST: IMPort

Example:	`CORR:DEXC:MODE IMP`
	selects that ASCII files with frequency and level value pairs are imported and transferred into user correction lists.
	`CORR:DEXC:AFIL:SEL '/var/user/ucor.csv'`
	selects that ASCII file ucor.csv is imported.
	`CORR:DEXC:SEL '/var/user/ucor_imp'`
	selects that the ASCII file `ucor.csv` is imported into user correction list `ucor_imp`.

Manual operation:	See "Mode - User Correction" on page 234

[:SOURce\<hw>]:CORRection:DEXChange:SELect \<Filename>

Selects the user correction list to be imported or exported.

The user correction files are stored with the fixed file extensions `*.uco` in a directory of the user's choice. The directory applicable to the commands is defined with the command `MMEMory:CDIR`. A path can also be specified in command `SOUR:CORR:DEXC:SEL`, in which case the files are stored or loaded in the specified directory.

Parameters:	
\<Filename>	string

Example:	`CORR:DEXC:MODE IMP`
	selects that ASCII files with frequency and level value pairs are imported and transferred into user correction lists.
	`CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`
	selects that ASCII file ucor.csv is imported.
	`CORR:DEXC:SEL '/var/user/import_ucor_imp'`
	selects that the ASCII file `ucor.csv` is imported into user correction list `ucor_imp`.

Manual operation:	See "Select Destination/Source" on page 235

[:SOURce\<hw>]:CORRection:CSET[:SELect] \<Filename>

Selects or creates a file for the user correction data.

If the file does not exist, the instrument automatically creates a new file with the name you assigned. Note the predefined file extensions under Chapter 10.9.2, "Extensions for user files", on page 364.

To determine the file location (directory/path) you can either enter it with the command directly, or use the command `MMEMory:CDIR`.

To activate level correction use the command `[:SOURce<hw>]:CORRection[:STATe]`.

Parameters:	
\<Filename>	\<table name>

Example:	CORR:CSET '/var/user/ucor1'
	selects the table ucor1.
	CORR ON
	activates level correction. Correction is performed using the table ucor1.
Manual operation:	See "User Cor. Data - User Correction" on page 232
	See "Edit User Cor. Data" on page 232

[:SOURce<hw>]:CORRection[:STATe] <State>

Activates/deactivates level correction. Level correction is performed using the table which has been selected with the command [:SOURce<hw>]:CORRection:CSET[: SELect].

Parameters:

<State>	0 | 1 | OFF | ON
	*RST: 0

Example:	SOUR:CORR:CSET '/var/user/ucor1'
	selects the table ucor1.
	SOUR:CORR ON
	activates user correction.
Manual operation:	See "State" on page 231

[: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:	CORR:VAL?
	queries the value currently used for level correction.
	Response: −3
	the correction value is - 3 dB.
Usage:	Query only
Manual operation:	See "User Correction" on page 231

[: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

Manual operation: See "Fill User Correction Data with Sensor" on page 237

10.14.11 SOURce:IQ subsystem

This subsystem contains the commands for checking the I/Q modulation.

[:SOURce]:IQ:CREStfactor <CrestFactor>

Sets the crest factor of the IQ modulation signal.

Parameters:

<CrestFactor>   float

                          Range: 0 to 80
                          Increment: 0.01
                          *RST: 0

Manual operation: See "Crest Factor" on page 156

[:SOURce]:IQ:IMPairment:IQRatio[:MAGNitude] <IqRatio>

Sets the ratio of I modulation to Q modulation (amplification "imbalance"). The input
may be either in dB or %. The resolution is 0.001 dB, an input in percent is rounded to
the closest valid value in dB. A query returns the value in dB.

Parameters:

<IqRatio>   float

                          Range: -1 to 1
                          Increment: 1E-3
                          *RST: 0

Manual operation: See "Gain Imbalance" on page 157

[:SOURce]:IQ:IMPairment:LEAKage:I <I>

Sets the carrier leakage amplitude for the I-signal component.

Parameters:

<I>	float
	Range: -10 to 10
	Increment: 0.01
	*RST: 0

Manual operation: See "I/Q Offset" on page 157

[:SOURce]:IQ:IMPairment:LEAKage:Q <Q>

Sets the carrier leakage amplitude for the Q-signal component.

Parameters:

<Q>	float
	Range: -10 to 10
	Increment: 0.01
	*RST: 0

Manual operation: See "I/Q Offset" on page 157

[:SOURce]:IQ:IMPairment:QUADrature[:ANGLe] <Angle>

Sets the quadrature offset for the digital I/Q signal.

Parameters:

<Angle>	float
	Range: -10 to 10
	Increment: 0.01
	*RST: 0

Manual operation: See "Quadrature Offset" on page 158

[:SOURce]:IQ:IMPairment[:STATe] <State>

Activates/ deactivates the three impairment or correction values LEAKage, QUADrature and IQRatio for the baseband signal prior to input into the I/Q modulator.

Parameters:

<State>	1	ON	0	OFF
	*RST: 0

[:SOURce]:IQ:IMPairment:SWAP[:STATe] <State>

When set to ON, this command swaps the I and Q channel for an external modulation signal.

Parameters:

<State>   1 | ON | 0 | OFF

                                 *RST: 0

Manual operation: See "I/Q Swap" on page 154

[:SOURce]:IQ:STATe <State>

Switches the I/Q modulation on and off.

Parameters:

<State>   1 | ON | 0 | OFF

                                 *RST: 0

Manual operation: See "I/Q Mod State" on page 68
                                       See "State" on page 154

[:SOURce]:IQ:SOURce <Source>

Sets the input signal for the I/Q modulator.

Parameters:

<Source>   ANALog | BASeband

                                 *RST: BASeband

Manual operation: See "IQ Source" on page 154

[:SOURce<hw>]:IQ:SWAP[:STATe] <State>

When set to ON, this command 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 154

[:SOURce]:IQ:WBSTate <State>

Selects optimized settings for wideband modulation signals.

Parameters:

<State>   1 | ON | 0 | OFF

                                 *RST: 0

Manual operation: See "I/Q Wideband" on page 155

10.14.12 SOURce:IQ:OUTPut subsystem

Example: Enabling and configuring the analog output

```
SCONfiguration:OUTPut:MAPPing:IQOutput1:STReam1:STATe 1

SOURce1:IQ:OUTPut:ANALog:PRESet
SOURce1:IQ:OUTPut:ANALog:TYPE DIFF
SOURce1:IQ:OUTPut:ANALog:MODE VAR
SOURce1:IQ:OUTPut:LEVel 2
SOURce1:IQ:OUTPut:ANALog:BIAS:COUPling:STATe 1
SOURce1:IQ:OUTPut:ANALog:BIAS:I 1
SOURce1:IQ:OUTPut:ANALog:BIAS:Q?
// 1
SOURce1:IQ:OUTPut:ANALog:OFFSet:I 2
SOURce1:IQ:OUTPut:ANALog:OFFSet:Q 2.5
SOURce1:IQ:OUTPut:ANALog:STATe 1
```

[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe <State>

Activates the specified analog I/Q output.

Parameters:

<State>	1 | ON | 0 | OFF
	*RST: 0

Example:	`SOURce:IQ:OUTPut:ANALog:STATe ON`
	Activates the output of the analog I/Q signal on the [I/Q Out 1] connectors.
Manual operation:	See "State" on page 161

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet

Sets the default settings (`*RST` values specified for the commands).

Not affected are:

- The state set with the command `[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe`.
- If `SCONfiguration:EXTernal:PBEHaviour 1`, the I/Q ouptput type set with the command `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE`.

Example:	See Example"Enabling and configuring the analog output" on page 481.
Usage:	Event
Manual operation:	See "Set to Default" on page 162

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog?

Queries the files with I/Q output settings in the default directory. Listed are files with the file extension `*.iqout`.

Return values:

<Catalog>	string
Usage:	Query only
Manual operation:	See "Save/Recall" on page 162

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:STORe <Filename>

Stores the current settings into the selected file; the file extension (`*.iqout`) is assigned automatically.

Setting parameters:

<Filename>	"<filename>"
	Filename or complete file path
Usage:	Setting only
Manual operation:	See "Save/Recall" on page 162

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.iqout`.

Setting parameters:

<Filename>	"<filename>"
	Filename or complete file path
Usage:	Setting only
Manual operation:	See "Save/Recall" on page 162

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:DELete <Filename>

Deletes the selected file from the default or specified directory. Deleted are files with the file extension `*.iqout`.

Setting parameters:

<Filename>	"<filename>"
	Filename or complete file path
Usage:	Setting only
Manual operation:	See "Save/Recall" on page 162

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE <Type>

Sets the type of the analog signal.

Parameters:

<Type>	SINGle | DIFFerential | DAC
	*RST: SINGle
Example:	`SOURce1:IQ:OUTPup:ANALog:TYPE DIFFerential`
Manual operation:	See "I/Q Output Type" on page 162

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:COUPling[:STATe] <State>

Couples the bias setting of the I and Q signal components.

Parameters:

<State>	1 | ON | 0 | OFF
	*RST: 0
Example:	See Example"Enabling and configuring the analog output" on page 481.
Manual operation:	See "Couple I/Q Bias" on page 163

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:I <I>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:Q <Q>

Specifies the amplifier bias V_{bias} of the respective I or Q component.

The value range is adjusted so that the maximum overall output voltage does not exceed 4V, see "Maximum overall output voltage" on page 161.

Parameters:

<Q>	float	
	Range:	-3.6V to 3.6V
	Increment:	1E-4
	*RST:	0
	Default unit: V	

Example: See Example"Enabling and configuring the analog output"
                            on page 481.

Manual operation: See "Bias (EMF)" on page 163

[:SOURce<hw>]:IQ:OUTPut:LEVel <Level>

Sets the off-load voltage Vp of the analog I/Q signal output.

The value range is adjusted so that the maximum overall output voltage does not
exceed 4V, see "Maximum overall output voltage" on page 161.

Parameters:

<Level>   float

                           Range: 0.02V to 4V
                           Increment: 1E-4
                           *RST: 1
                           Default unit: V

Example: See Example"Enabling and configuring the analog output"
                           on page 481.

Manual operation: See "I/Q Level Vp EMF" on page 163

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:MODE <Mode>

Determines the mode for setting the output parameters.

Parameters:

<Mode>   FIXed | VARiable

                           FIXed
                           Locks the I/Q output settings

                           VARiable
                           Unlocks the settings

                           *RST: FIXed

Example: See Example"Enabling and configuring the analog output"
                           on page 481.

Manual operation: See "Mode" on page 163

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:I <I>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:Q <Q>

Sets an offset V_{offset} between the inverting and non-inverting input of the differential
analog I/Q output signal.

The value range is adjusted so that the maximum overall output voltage does not
exceed 4V, see "Maximum overall output voltage" on page 161.

Parameters:

<Q>   float

                                 Range: -0.3V to 0.3V
                                 Increment: 1E-4
                                 *RST: 0
                                 Default unit: V

Example: See Example"Enabling and configuring the analog output"
                                 on page 481.

Manual operation: See "Offset (EMF)" on page 164

10.14.13 SOURce:IQ:OUTPut:ENVelope commands

The following remote control commands require software option R&S SGT-K540.

Example: Generating an RF envelope signal and defining the shaping function

```
// define the RF level and frequency
SOURce1:FREQuency:CW 2143000000
SOURce1:POWer:LEVel:IMMediate:AMPLitude -15
SOURce1:POWer:LEVel:IMMediate:OFFSet 0.5
SOURce1:CORRection:VALue?
// Response: 1

// enable RF envelope generation and define the settings
SOURce1:IQ:OUTPut:ANALog:ENVelope:STATe 1
SOURce1:IQ:OUTPut:ANALog:ENVelope:ADAPtion AUTO
SOURce1:IQ:OUTPut:ANALog:TYPE DIFF
SOURce1:IQ:OUTPut:ANALog:ENVelope:ETRak USER
SOURce1:IQ:OUTPut:ANALog:ENVelope:VREF VCC
SOURce1:IQ:OUTPut:ANALog:ENVelope:POWer:OFFSet?
// Response: 1.5

SOURce1:IQ:OUTPut:ANALog:ENVelope:VPP:MAX 4
SOURce1:IQ:OUTPut:ANALog:ENVelope:GAIN 0
SOURce1:IQ:OUTPut:ANALog:ENVelope:EMF:STATe 1
SOURce1:IQ:OUTPut:ANALog:ENVelope:RIN 50
SOURce1:IQ:OUTPut:ANALog:ENVelope:TERMination GROund
SOURce1:IQ:OUTPut:ANALog:ENVelope:BINPut 1
SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:OFFSet 2

SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:MIN 0.5
SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:MAX 2.5

SOURce1:IQ:OUTPut:ANALog:ENVelope:BIAS 0
SOURce1:IQ:OUTPut:ANALog:ENVelope:OFFSet -2
SOURce1:IQ:OUTPut:ANALog:ENVelope:VOUT:MAX?
// Response: 0.5
SOURce1:IQ:OUTPut:ANALog:ENVelope:VOUT:MIN?
// Response: -1.5
```

```
SOURce1:IQ:OUTPut:ANALog:ENVelope:PIN:MIN -30
SOURce1:IQ:OUTPut:ANALog:ENVelope:PIN:MAX 0

SOURce1:IQ:OUTPut:ANALog:ENVelope:DELay 0.00000000001
SOURce1:IQ:OUTPut:ANALog:ENVelope:FDPD OFF

// enable envelope shaping
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:MODE DETR
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:DETRoughing:FUNCtion F3
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:DETRoughing:COUPling OFF
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:DETRoughing:FACtor 0.225
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:DETRoughing:PEXPonent 1

// quering the oprating point level, current PEP and levels
// SOURce1:IQ:OUTPut:ANALog:ENVelope:ADAPtion?
// Response: Auto
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue:LEVel?
// Response: 0.927
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue:PEP?
// Response: 1.922
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue? 1,NORM,VOLT
// Response: 2.5
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue? 0,NORM,VOLT
// Response: 0.563
// SOURce1:IQ:OUTPut:ANALog:ENVelope:PIN:MAX?
// Response: 0
// SOURce1:IQ:OUTPut:ANALog:ENVelope:PIN:MIN?
// response: -30
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue? 0,DBM,POW
// Response: 2.5
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue? -30,DBM,POW
// Response: 0.563

SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:MODE TABL
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:PV:FILE:CATalog?
// Response: myLUT_pv
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:PV:FILE:SELect "/var/user/myLUT_pv.iq_lutpv"
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:INTerp LIN
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:SCALe POWer

// change the envelope shaping mode
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:MODE POLY
// query files with polynomial functions in the default user directory
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients:CATalog?
// Response: env_poly_evm,myPoly
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients:LOAD "myPoly"
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients?
// Response: 0.135,0.82
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients 0.135,0.83
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients:STORe "/var/user/myPoly.iq_poly"
```

```
// enable the outputs
SOURce1:IQ:OUTPut:ANALog:STATe 1
OUTPut1:STATe 1

// store the settings
MMEMory:CDIRectory "/var/user/setups"
SOURce1:IQ:OUTPut:ANALog:SETTings:CATalog?
// Response: etrak_v1-2
SOURce1:IQ:OUTPut:ANALog:SETTings:STORe "my_ET"

SOURce1:IQ:OUTPut:ANALog:PREset
// change the envelope voltage adaptation mode
SOURce1:IQ:OUTPut:ANALog:ENVelope:ADAPtion MAN


SOURce1:IQ:OUTPut:LEVel 4


SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:GAIN:PRE -3
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:GAIN:POST 2.5

// change the envelope shaping mode
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:MODE TABL
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:FILE:CATalog?
// Response: myLUT_vv
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:FILE:SELect "/var/user/myLUT_vv.iq_lut"

// set the shaping values in raw format
// SOURce1:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:DATA  0,0, 0.1,0.2, 1,1
// SOURce1:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:CATalog?
// Response: myLUT_vv
// set the shaping values and store them into a file
// SOURce1:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:NEW "LUT_vv_raw", 0,0, 0.1,0.2, 1,1.5
// SOURce1:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:CATalog?
// Response: myLUT_vv, LUT_vv_raw
```

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:STATe <State>

Enables the output of a control signal that follows the RF envelope.

Parameters:

<State>   1 | ON | 0 | OFF

                            *RST: 0

Example: See Example"Generating an RF envelope signal and defining
                           the shaping function" on page 485

Manual operation: See "RF Envelope" on page 178

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:ADAPtion <AdaptionMode>

Defines the envelope voltage adaption mode.

Parameters:

\<AdaptionMode\>	AUTO | MANual | POWer
	`AUTO` = Auto Normalized, `POWer` = Auto Power, `MANual` = Manual
	*RST: AUTO

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Manual operation:	See "Envelope Voltage Adaptation" on page 178

[:SOURce\<hw\>]:IQ:OUTPut[:ANALog]:ENVelope:ETRak \<ETrakIfcType\>

Selects one of the predefined interface types or allows user-defined settings.

See Table 6-3.

Parameters:

\<ETrakIfcType\>	USER | ET1V2 | ET1V5 | ET2V0
	*RST: USER

Example:	`SOURce1:IQ:OUTPut:ANALog:ENVelope:ETRak ET2V0`
Manual operation:	See "eTrak® Interface Type" on page 178

[:SOURce\<hw\>]:IQ:OUTPut[:ANALog]:ENVelope:VREF \<VoltageReferenc\>

Defines whether the envelope voltage V_{out} is set directly or it is estimated from the selected supply voltage V_{cc}.

Parameters:

\<VoltageReferenc\>	VCC | VOUT
	*RST: VCC

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Manual operation:	See "Envelope Voltage Reference" on page 179

[:SOURce\<hw\>]:IQ:OUTPut[:ANALog]:ENVelope:DELay \<Delay\>

Enables a time delay of the generated envelope signal relative to the corresponding RF signal.

Parameters:

\<Delay\>	float
	Range: -500E-9 to 500E-9
	Increment: 1E-12
	*RST: 0

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485

Manual operation: See "Envelope to RF Delay" on page 185

[:SOURce\<hw\>]:IQ:OUTPut[:ANALog]:ENVelope:FDPD \<CalcFromDpdStat\>

Enables calculation of the envelope from predistorted signal.

Parameters:

\<CalcFromDpdStat\>   1 | ON | 0 | OFF

   *RST: 0

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485

Options: R&S SGT-K540/K541

Manual operation: See "Calculate Envelope from Predistorted Signal" on page 185

[:SOURce\<hw\>]:IQ:OUTPut[:ANALog]:ENVelope:VOUT:MIN \<VoutMin\>
[:SOURce\<hw\>]:IQ:OUTPut[:ANALog]:ENVelope:VOUT:MAX \<VoutMax\>

Queries the minimum and maximum values of the estimated envelope output voltage V_{out}.

Parameters:

\<VoutMax\>   float

   Range: 0.04 to 8
   Increment: 1E-3
   *RST: 1

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485

Manual operation: See "V_{out}Min/Max" on page 179

[:SOURce\<hw\>]:IQ:OUTPut[:ANALog]:ENVelope:BIAS \<Bias\>

Sets a bias.

Parameters:

\<Bias\>   float

   Range: -3.6V to 3.6V
   Increment: 1E-4
   *RST: 0
   Default unit: V

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485.

Manual operation: See "Bias" on page 179

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:OFFSet <Offset>

Sets an offset between the envelope and the inverted envelope signal.

Parameters:

<Offset>   float

Range:	-8V to 8V
Increment:	1E-4
*RST:	0
Default unit:	V

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485.

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VPP[:MAX] <VppMax>

Set the maximum value of the driving voltage V_{pp} of the used external DC modulator.

Parameters:

<VppMax>   float

Range:	-0.02V to 8V
Increment:	1E-3
*RST:	1
Default unit:	V

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485.

Manual operation: See "V_{pp}Max" on page 182

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:EMF[:STATe] <EmfState>

Defines whether the EMF or the voltage value is used.

Parameters:

<EmfState>   1 | ON | 0 | OFF

*RST:	1

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485

Manual operation: See "EMF" on page 180

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:RIN <InputResistance>

Sets the input impedance R_{in} of the used external DC modulator.

Parameters:

<InputResistance>   float

Range:	50|100 to 1E6
Increment:	0.1
*RST:	50

Example: See Example"Generating an RF envelope signal and defining
                               the shaping function" on page 485

Manual operation: See "R$_{in}$" on page 180

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:TERMination <Termination>

Sets how the inputs of the DC modulator are terminated.

Parameters:
<Termination>   GROund | WIRE
                               *RST: GROund

Example: See Example"Generating an RF envelope signal and defining
                               the shaping function" on page 485

Manual operation: See "Termination" on page 180

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:BINPut <BipolarInput>

Enables the generation of a bipolar signal.

Parameters:
<BipolarInput>   1 | ON | 0 | OFF
                               *RST: 0

Example: See Example"Generating an RF envelope signal and defining
                               the shaping function" on page 485

Manual operation: See "Bipolar Input" on page 181

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:GAIN <Gain>

Sets the gain of the used external DC modulator.

Parameters:
<Gain>   float

                               Range: -50 to 50
                               Increment: 0.01
                               *RST: 0

Example: See Example"Generating an RF envelope signal and defining
                               the shaping function" on page 485

Manual operation: See "Gain" on page 182

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:OFFSet <VccOffset>

Applies a voltage offset on the supply voltage V$_{cc}$.

Parameters:

<VccOffset>   float

Range: 0 to 30
Increment: 1E-3
*RST: 0
Default unit: mV

Example: See Example"Generating an RF envelope signal and defining
the shaping function" on page 485

Manual operation: See "V$_{cc}$Offset" on page 182

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:MIN <VccMin>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:MAX <VccMax>

Sets the maximum value of the supply voltage V$_{cc}$.

Parameters:

<VccMax>   float

Range: 0.04 to 8
Increment: 0.001
*RST: 1

Example: See Example"Generating an RF envelope signal and defining
the shaping function" on page 485

Manual operation: See "V$_{cc}$Min/Max" on page 183

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue:PEP?

Queries the Vcc value of the current PEP of the generated RF signal.

Return values:

<VccForCrtPep>   float

Range: 0 to 38
Increment: 1E-3
*RST: 0

Example: See Example"Generating an RF envelope signal and defining
the shaping function" on page 485

Usage: Query only

Manual operation: See "Diagram" on page 194

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue:LEVel?

Queries the Vcc value of the current RMS power level (operating point).

Return values:

<VccForRfLevel>	float
	Range: 0 to 38 Increment: 1E-3 *RST: 0

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485

Usage: Query only

Manual operation: See "Diagram" on page 194

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue? <xValue>, <xUnit>, <xScale>

Queries the V_{CC} value for the selected `<xValue>`.

Query parameters:

<xValue>	float
	Value on the x-axis Value range depends on the selected "Envelope Voltage Adaptation" and $PEP_{in}Min$ and $PEP_{in}Max$ values.
<xUnit>	NORMalized | DBM | V
	*RST: NORMalized
<xScale>	VOLTage | POWer
	*RST: VOLTage

Return values:

<VccValue>	float
	Range: 0 to 38 Increment: 1E-3 *RST: 0

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485

Usage: Query only

Manual operation: See "Diagram" on page 194

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:PIN:MIN <PinMin>

Sets the minimum value of the input power P_{in}.

Parameters:

<PinMin>	float
	Range: -145 to 20 Increment: 0.01 *RST: -30

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Manual operation:	See "PEP$_{in}$Min/Max" on page 184

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:PIN:MAX <PinMax>

Sets the maximum value of the input power P_{in}.

Parameters:

<PinMax>   float

Range: -145 to 20
Increment: 0.01
*RST: -20

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Manual operation:	See "PEP$_{in}$Min/Max" on page 184

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:POWer:OFFSet?

Queries the current power offset, that is the sum of enabled "RF Level > Offset" and "User Correction".

Return values:

<PowerOffset>   float

Range: -200 to 200
Increment: 0.01
*RST: 0

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Usage:	Query only
Manual operation:	See "Power Offset" on page 183

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:MODE <ShapingMode>

Enables envelope shaping and selects the method to define the shaping function.

Parameters:

<ShapingMode>   OFF | LINear | TABLe | POLYnomial | DETRoughing | POWer

`LINear` = Linear (Voltage)
`POWer` = Linear (Power)

*RST: OFF

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485.
Manual operation:	See "Shaping" on page 187

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:SCALe <Scale>

Determines the units used on the x and y axis.

Parameters:

<Scale>	POWer | VOLTage
	*RST: VOLTage

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Manual operation:	See "Scale" on page 194

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:GAIN:PRE <PreGain>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:GAIN:POST
      <PostGain>

Sets a post-gain.

Parameters:

<PostGain>	float
	Range: -3 to 20
	Increment: 1E-2
	*RST: 0

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Manual operation:	See "Post-Gain" on page 192

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:CATalog?
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:CATalog?

Queries the available table shaping files in the default directory. Only files with the file extension `*.iq_lut` or `*.iq_lutpv` are listed.

Return values:

<Catalog>	string

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Usage:	Query only
Manual operation:	See "Shaping Table" on page 193

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE[:SELect]
      <Filename>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE[:SELect]
      <Filename>

Selects an envelope shaping file (extension `*.iq_lut` or `*.iq_lutpv`).

Parameters:

<Filename>	string
Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Manual operation:	See "Shaping Table" on page 193

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:DATA
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:DATA

Defines the shaping function in a raw data format.

See also `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:NEW` on page 497.

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:NEW
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:NEW

Stores the shaping values into a file with the selected file name and loads it.

The file is stored in the default directory or in the directory specified with the absolute file path. If the file does not yet exist, a new file is created. The file extension is assigned automatically.

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Usage:	Setting only

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:INTerp <Interpolation>

For envelope shaping with shaping tables, enables linear interpolation.

Parameters:

<Interpolation>	OFF | LINear | POWer
	`LINear` = Linear (Voltage)
	`POWer` = Linear (Power)
	*RST: OFF
Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Manual operation:	See "Interpolation" on page 193

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients

Sets the polynomial coefficients.

Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Manual operation:	See "Polynomial Order" on page 197 See "Polynomial constant and coefficients" on page 197 See "Apply, OK" on page 197

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients: CATalog?

Queries the available polynomial files in the default directory. Only files with the file extension `*.iq_poly` are listed.

Return values:

<Catalog>	string
Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Usage:	Query only
Manual operation:	See "Save/Recall Polynomial" on page 197

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:STORe <Filename>

Saves the polynomial function as polynomial file.

Setting parameters:

<Filename>	string
Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Usage:	Setting only
Manual operation:	See "Save/Recall Polynomial" on page 197

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:LOAD <Filename>

Loads the selected polynomial file.

Setting parameters:

<Filename>	string
Example:	See Example"Generating an RF envelope signal and defining the shaping function" on page 485
Usage:	Setting only
Manual operation:	See "Save/Recall Polynomial" on page 197

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:CLIPping:FROM
  <ClippingFrom>

Enables clipping and defines its limits.

Parameters:

<ClippingFrom>   integer

                        Range: 0 to 100
                        *RST: 0

Example: See Example"Generating an RF envelope signal and defining
                        the shaping function" on page 485

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:CLIPping:TO
  <ClippingTo>

Enables clipping and defines its limits.

Parameters:

<ClippingTo>   integer

                        Range: 0 to 100
                        *RST: 100

Example: See Example"Generating an RF envelope signal and defining
                        the shaping function" on page 485

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:
  FUNCtion <DetrFunction>

Sets the detroughing function.

Parameters:

<DetrFunction>   F1 | F2 | F3

                        *RST: F1

Example: See Example"Generating an RF envelope signal and defining
                        the shaping function" on page 485

Manual operation: See "Detroughing Function" on page 191

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:
  COUPling <CouplingState>

Enables/disables deriving the detroughing factor (d) from the selected V_{cc} value.

Parameters:

<CouplingState>   1 | ON | 0 | OFF

                        *RST: 0

Example: See Example"Generating an RF envelope signal and defining
                        the shaping function" on page 485

Manual operation: See "Couple Detroughing Factor with Vcc" on page 192

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:FACTor <DetrFactor>

Sets the detroughing factor.

Parameters:

<DetrFactor>   float

Range:	0 to 2
Increment:	1E-3
*RST:	0.2

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485

Manual operation: See "Detroughing Factor (d)" on page 192

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing: PEXPonent <PowerExponent>

Sets the exponent (a) for the detroughing function `F3`.

Parameters:

<PowerExponent>   float

Range:	1 to 10
Increment:	1E-3
*RST:	2

Example: See Example"Generating an RF envelope signal and defining the shaping function" on page 485

Manual operation: See "Exponent (a)" on page 192

10.14.14   SOURce:IQ:DPD subsystem

The `SOURce:IQ:DPD` subsystem contains the commands for enabling and configuring of digital predistortion.

Example: Defining correction coefficients and enabling digital predistortion

```
*RST

SOURce1:IQ:DPD:PIN:MIN -35
SOURce1:IQ:DPD:PIN:MAX -2.5


// select look-up table files with correction values
SOURce1:IQ:DPD:SHAPing:MODE TABLe
SOURce1:IQ:DPD:SHAPing:TABLe:AMAM:FILE:CATalog?
// Response: My_DPD_AM-AM,MyDPD_AM-AM
SOURce1:IQ:DPD:SHAPing:TABLe:AMAM:FILE:SELect "My_DPD_AM-AM"
```

```
SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?
// Response: My_DPD_AM-PM,MyDPD_AM-PM
SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:SELect "My_DPD_AM-PM"
SOURce1:IQ:DPD:SHAPing:TABLe:INTerp LINear
SOURce1:IQ:DPD:SHAPing:TABLe:INVert?
// Response: 0


// enable digital predistortion
SOURce1:IQ:DPD:AMPM:AMFirst 1
SOURce1:IQ:DPD:AMAM:STATe 1
SOURce1:IQ:DPD:AMPM:STATe 1
SOURce1:IQ:DPD:LREFerence BDPD
SOURce1:IQ:DPD:STATe 1


// enable the output
SOURce1:IQ:STATe 1
OUTPut1:STATe 1


// query the PEP, level and crest factor values before and after the DPD
SOURce1:IQ:DPD:INPut:PEP?
// Response: -3.43
SOURce1:IQ:DPD:INPut:LEVel?
// Response: -15
SOURce1:IQ:DPD:INPut:CFACtor?
// Response: 11.57


SOURce1:IQ:DPD:OUTPut:PEP?
SOURce1:IQ:DPD:OUTPut:LEVel?
SOURce1:IQ:DPD:OUTPut:CFACtor?


// change level reference and
// query the PEP, level and crest factor values before and after the DPD
SOURce1:IQ:DPD:LREFerence ADPD
SOURce1:IQ:DPD:OUTPut:ERRor:MAX 0.1
SOURce1:IQ:DPD:OUTPut:ITERations:MAX 3
SOURce1:IQ:DPD:MEASurement:STATe?
// Response: 1
SOURce1:IQ:DPD:OUTPut:ERRor?
// Response: 0
SOURce1:IQ:DPD:OUTPut:PEP?
// Response: -3.57
SOURce1:IQ:DPD:OUTPut:LEVel?
// Response: -15
SOURce1:IQ:DPD:OUTPut:CFACtor?
// Response: 11.43


// enable static DPD and set the pre-gain
SOURce1:IQ:DPD:LREFerence SDPD
SOURce1:IQ:DPD:GAIN:PRE -18
// set the predistorion values in raw format
```

```
SOURce1:IQ:DPD:SHAPing:TABLe:AMAM:FILE:DATA -30.4,-5.2, -25.1,-4.5, -18.5,-2.5, -10.5,-1
SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:DATA -30.4, -5, -25.1, 5, -10, 0
SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?
// Response: My_DPD_AM-PM,MyDPD_AM-PM
// set the predistortion values and store them into a file
SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:NEW "DPD_AM-PM_raw", -30.4, -5, -25.1, 5, -10, 0
SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?
// Response: My_DPD_AM-PM,MyDPD_AM-PM,DPD_AM-PM_raw
SOURce1:IQ:DPD:AMPM:VALue:PEP?
// Response: 4.255
SOURce1:IQ:DPD:AMPM:VALue:VALue? -30,DBM
// Response:-4.439

// change the shaping mode
SOURce1:IQ:DPD:SHAPing:MODE POLYnomial
// query files with polynomial functions in the default user directory
SOURce1:IQ:DPD:SHAPing:POLYnomial:COEFficients:CATalog?
// Response: MyDTD_Poly,myDTD_Poly4th
SOURce1:IQ:DPD:SHAPing:POLYnomial:COEFficients:LOAD "MyDTD_Poly4th"
SOURce1:IQ:DPD:SHAPing:POLYnomial:COEFficients?
// Response: 0,0,-0.25,0.2,0.6,-0.3,0.3,0.3,0.5,-0.4
SOURce1:IQ:DPD:SHAPing:POLYnomial:COEFficients:STORe "/var/user/myPoly.dpd_poly"
```

Commands:

[:SOURce<hw>]:IQ:DPD:STATe <State>

Enabels/disables the generation of digitally pre-distorted signals.

Parameters:

<State>   1 | ON | 0 | OFF

                           *RST: 0

Example: See Example"Defining correction coefficients and enabling digi-
                           tal predistortion" on page 500

Manual operation: See "State" on page 204

[:SOURce<hw>]:IQ:DPD:PRESet

Sets the default DPD settings (*RST values specified for the commands).

Not affected is the state set with the command [:SOURce<hw>]:IQ:DPD:STATe.

Usage: Event

Manual operation: See "Set to Default" on page 204

[:SOURce<hw>]:IQ:DPD:SETTing:CATalog?

Queries the files with digital predistortion setting in the default directory. Listed are files
with the file extension *.dpd.

Return values:

<Catalog>　　　　　　　string

Usage:　　　　　　　Query only

Manual operation:　　See "Save/Recall" on page 205

[:SOURce]:IQ:DPD:SETTing:DELete <Filename>

Deletes the selected file from the default or specified directory. Deleted are files with the file extension `*.dpd`.

Setting parameters:

<Filename>　　　　　　"<filename>"

　　　　　　　　　　　Filename or complete file path

Usage:　　　　　　　Setting only

Manual operation:　　See "Save/Recall" on page 205

[:SOURce<hw>]:IQ:DPD:SETTing:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.dpd`.

Setting parameters:

<Filename>　　　　　　"<filename>"

　　　　　　　　　　　Filename or complete file path

Usage:　　　　　　　Setting only

Manual operation:　　See "Save/Recall" on page 205

[:SOURce<hw>]:IQ:DPD:SETTing:STORe <Filename>

Stores the current settings into the selected file; the file extension (`*.dpd`) is assigned automatically.

Setting parameters:

<Filename>　　　　　　"<filename>"

　　　　　　　　　　　Filename or complete file path

Usage:　　　　　　　Setting only

Manual operation:　　See "Save/Recall" on page 205

[:SOURce<hw>]:IQ:DPD:AMAM:STATe <State>
[:SOURce<hw>]:IQ:DPD:AMPM:STATe <State>

Enabels/disables the AM/AM and AM/PM digital predistortion.

Parameters:

<State>   1 | ON | 0 | OFF

                              *RST: 0

Example: See Example"Defining correction coefficients and enabling digi-
                              tal predistortion" on page 500

Manual operation: See "AM/AM and AM/PM State" on page 206

[:SOURce<hw>]:IQ:DPD:AMAM:VALue? <XValue>, <XUnit>

Queries the delta power value of the generated RF signal for a selected <XValue>.

Query parameters:

<XValue>   float

                              Value on the x-axis.
                              Value range depends on the selected $PEP_{in}Min$ and $PEP_{in}Max$
                              values.

                              Range: -100 to 100
                              Increment: 0.01

<XUnit>   DBM | V

Return values:

<DeltaPower>   float

                              Range: -20 to 20
                              Increment: 0.01
                              *RST: 0

Example: See Example"Defining correction coefficients and enabling digi-
                              tal predistortion" on page 500.

Usage: Query only

[:SOURce<hw>]:IQ:DPD:AMAM:VALue:PEP?

Queries the delta power value for the current peak envelope power (PEP) level of the
generated RF signal.

Return values:

<DeltaPower>   float

                              Range: -20 to 20
                              Increment: 0.01
                              *RST: 0

Example: See Example"Defining correction coefficients and enabling digi-
                              tal predistortion" on page 500.

Usage: Query only

[:SOURce<hw>]:IQ:DPD:AMAM:VALue:LEVel?

Queries the delta power value for the current root mean square (RMS) power level of the generated RF signal.

Return values:

<DeltaPower>	float	
	Range:	-20 to 20
	Increment:	0.01
	*RST:	0

Example:	See Example"Defining correction coefficients and enabling digital predistortion" on page 500.
Usage:	Query only

[:SOURce<hw>]:IQ:DPD:AMPM:VALue? <XValue>, <XUnit>

Queries the delta phase value of the generated RF signal for a selected <XValue>.

Query parameters:

<XValue>	float	
	Value on the x-axis.	
	Value range depends on the selected PEP$_{in}$Min and PEP$_{in}$Max values.	
	Range:	-100 to 100
	Increment:	0.01
<XUnit>	DBM | V	
	*RST:	DBM

Return values:

<DeltaPhase>	float	
	Range:	-180 to 180
	Increment:	0.01
	*RST:	0

Example:	See Example"Defining correction coefficients and enabling digital predistortion" on page 500.
Usage:	Query only

[:SOURce<hw>]:IQ:DPD:AMPM:VALue:PEP?

Queries the delta phase value for the current peak envelope power (PEP) level of the generated RF signal.

Return values:

<DeltaPhase>	float	
	Range:	-180 to 180
	Increment:	0.01
	*RST:	0

Example:	See Example"Defining correction coefficients and enabling digital predistortion" on page 500.
Usage:	Query only

[:SOURce<hw>]:IQ:DPD:AMPM:VALue:LEVel?

Queries the delta phase value for the current root mean square (RMS) power level of the generated RF signal.

Return values:

<DeltaPhase>	float	
	Range:	-180 to 180
	Increment:	0.01
	*RST:	0

Example:	See Example"Defining correction coefficients and enabling digital predistortion" on page 500.
Usage:	Query only

[:SOURce<hw>]:IQ:DPD:AMFirst <AmAmFirstState>

Sets that the AM/AM predistortion is applied before the AM/PM.

Parameters:

<AmAmFirstState>	1 | ON | 0 | OFF	
	*RST:	0

Example:	See Example"Defining correction coefficients and enabling digital predistortion" on page 500
Manual operation:	See "AM/AM First" on page 205

[:SOURce<hw>]:IQ:DPD:LREFerence <LevelReference>

Sets whether a dynamic (BDPD|ADPD) or a static (SDPS) adaptation of the range the selected DPD is applied on.

Parameters:

<LevelReference>	BDPD | ADPD | SDPD	
	*RST:	BDPD

Example:	See Example"Defining correction coefficients and enabling digital predistortion" on page 500
Manual operation:	See "Level Reference" on page 205

[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor?

Queries the resulting level error.

Return values:

<AchievedError>   float

Example: see Example"Defining correction coefficients and enabling digital predistortion" on page 500

Usage: Query only

Manual operation: See "Achieved Output Level Error" on page 206

[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor:MAX <MaximumError>

Sets the allowed maximum error.

Parameters:

<MaximumError>   float

Range:	0.01 to 1
Increment:	0.01
*RST:	0.1

Example: see Example"Defining correction coefficients and enabling digital predistortion" on page 500

Manual operation: See "Maximum Output Level Error" on page 205
See "Maximum Number of Iterations" on page 205

[:SOURce<hw>]:IQ:DPD:OUTPut:ITERations:MAX <MaxIterations>

Sets the maximum number of performed iterations to achieving the required error set with `[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor:MAX`.

Parameters:

<MaxIterations>   integer

Range:	1 to 10
*RST:	3

Example: See Example"Defining correction coefficients and enabling digital predistortion" on page 500

[:SOURce<hw>]:IQ:DPD:MEASurement:STATe?

Queries whether the interactions are competed.

Return values:

<MeasureValidity>   1 | ON | 0 | OFF

*RST:	1

Example: See Example"Defining correction coefficients and enabling digital predistortion" on page 500

Usage: Query only

[:SOURce<hw>]:IQ:DPD:INPut:CFACtor?
[:SOURce<hw>]:IQ:DPD:OUTPut:CFACtor?
[:SOURce<hw>]:IQ:DPD:INPut:LEVel?
[:SOURce<hw>]:IQ:DPD:OUTPut:LEVel?
[:SOURce<hw>]:IQ:DPD:INPut:PEP?
[:SOURce<hw>]:IQ:DPD:OUTPut:PEP?

Queries the measured values the before and after the enabled digital predistortion.

Return values:

<PEP>　　　　　　　　float

　　　　　　　　　　　The query returns -1000 if the calculation is impossible or there are no measurements results available.

Example:　　　　　　see Example"Defining correction coefficients and enabling digital predistortion" on page 500

Usage:　　　　　　　Query only

Manual operation:　　See "Input/Output PEP, Level and Crest Factor" on page 206

[:SOURce<hw>]:IQ:DPD:PIN:MIN <PepInMin>
[:SOURce<hw>]:IQ:DPD:PIN:MAX <PepInMax>

Sets the value range of the input power.

Parameters:

<PepInMax>　　　　　float

　　　　　　　　　　　Range:　　　-145　to　20
　　　　　　　　　　　Increment:　0.01
　　　　　　　　　　　*RST:　　　　10

Example:　　　　　　See Example"Defining correction coefficients and enabling digital predistortion" on page 500

Manual operation:　　See "Input Range (PEP$_{in}$) From/To" on page 209

[:SOURce<hw>]:IQ:DPD:GAIN:PRE <PreGain>

Sets a pre-gain (i.e. an attenuation) to define the range the static DPD is applied in.

Parameters:

<PreGain>　　　　　　float

　　　　　　　　　　　Range:　　　-50　to　20
　　　　　　　　　　　Increment:　1E-2
　　　　　　　　　　　*RST:　　　　0

Example:　　　　　　see Example"Defining correction coefficients and enabling digital predistortion" on page 500

Manual operation:　　See "Pre-Gain" on page 209

[:SOURce<hw>]:IQ:DPD:SHAPing:MODE <Shaping>

Selects the method to define the correction coefficients.

Parameters:
<Shaping>   TABLe | POLYnomial | NORMalized
                         *RST: TABLe

Example: See Example"Defining correction coefficients and enabling digi-
                         tal predistortion" on page 500.

Manual operation: See "Shaping" on page 207

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:CATalog?
[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?

Queries the available table files in the default directory. Only files with the extension
`*.dpd_magn`(AM/AM) or `*.dpd_phase`(AM/PM) are listed.

Return values:
<Catalog>   string

Example: See Example"Defining correction coefficients and enabling digi-
                         tal predistortion" on page 500

Usage: Query only

Manual operation: See "Shaping Table" on page 209

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE[:SELect] <Filename>
[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE[:SELect] <Filename>

Selects a file with correction values (extension `*.dpd_magn` (AM/AM) or
`*.dpd_phase`(AM/FM)).

Parameters:
<Filename>   string

Example: See Example"Defining correction coefficients and enabling digi-
                         tal predistortion" on page 500

Manual operation: See "Shaping Table" on page 209
                         See "Pin (dBm), Delta Power (dB)/Pin (dBm), Delta Phase
                         (deg)" on page 211

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:NEW
[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:NEW

Stores the correction values into a file with the selected file name and loads it.

The file is stored in the default directory or in the directory specified with the absolute
file path. If the file does not yet exist, a new file is created. The file extension is
assigned automatically.

Example: See Example"Defining correction coefficients and enabling digi-
                         tal predistortion" on page 500

Usage: Setting only

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:DATA
[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:DATA

Defines the predistortion function in a raw data format.

See also `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:NEW`
on page 510.

Example: See Example"Defining correction coefficients and enabling digi-
                         tal predistortion" on page 500

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:INTerp <Interpolation>

Enables a linear (voltage or power) interpolation between the defined correction val-
ues.

Parameters:
<Interpolation>   OFF | POWer | LINear

                         POWer
                         Linear power interpolation

                         LINear
                         Linear voltage interpolation

                         *RST: OFF

Example: See Example"Defining correction coefficients and enabling digi-
                         tal predistortion" on page 500

Manual operation: See "Interpolation" on page 208

[:SOURce<hw>]:IQ:DPD:SHAPing[:TABLe]:INVert <InvertValues>

Inverts the defined correction values.

Parameters:
<InvertValues>   1 | ON | 0 | OFF

                         *RST: 0

Example: See Example"Defining correction coefficients and enabling digi-
                         tal predistortion" on page 500

Manual operation: See "Invert Correction Values" on page 208

[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients <I0>, <J0>, <J1>,
        <J1>

Sets the polynomial coefficients as a list of up to 10 comma separated value pairs.

In Cartesian coordinates system, the coefficients b_n are expressed in degrees.

Parameters:

<I0>	float		
	Range:	-1E6 to 1E6	
	Increment:	1E-3	
	*RST:	0	

<J0>	float		
	Range:	-1E6 to 1E6	
	Increment:	1E-3	
	*RST:	0	

<J1>	float		
	Range:	-1E6 to 1E6	
	Increment:	1E-3	
	*RST:	0	

<J1>	float		
	Range:	-1E6 to 1E6	
	Increment:	1E-3	
	*RST:	0	

Example:	See Example"Defining correction coefficients and enabling digital predistortion" on page 500.
Manual operation:	See "Polynomial Order" on page 214 See "Apply, OK" on page 214

[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:CATalog?

Queries the available polynomial files in the default directory. Only files with the file extension `*.dpd_poly` are listed.

Return values:

<Catalog>	string

Example:	See Example"Defining correction coefficients and enabling digital predistortion" on page 500
Usage:	Query only
Manual operation:	See "Save/Recall Polynomial" on page 213

[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:LOAD <Filename>

Loads the selected polynomial file.

Setting parameters:

<Filename>	string

Example:	See Example"Defining correction coefficients and enabling digital predistortion" on page 500

Usage: Setting only

Manual operation: See "Save/Recall Polynomial" on page 213

[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:STORe <Filename>

Saves the polynomial function as polynomial file.

Setting parameters:

<Filename>   string

Example: See Example"Defining correction coefficients and enabling digi-
                              tal predistortion" on page 500

Usage: Setting only

Manual operation: See "Save/Recall Polynomial" on page 213

[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA <Data>

Defines the normalized predistortion function in a raw data format (binary data).

Parameters:

<Data>   <#><LengthNoBytes><NoBytes><NormData>

                              <#>
                              The binary data must start with the sign #

                              <LengthNoBytes>
                              ASCII format
                              Sets the length of <NoBytes>, i.e. the number of digits used to
                              write <NoBytes>

                              <NoBytes>
                              An ASCII integer value that specifies the number of bytes that
                              follow in the <NormData> part
                              Each of the <NormData> parameters is coded with 8 bytes.
                              Then the number of bytes <NoBytes> is calculated as:
                              <NoBytes> = 8 + 8 + n(8+8+8), where n is the number of points
                              <NoPoints>.

                              <NormData>
                              <PinMax><NoPoints>{<VinVmax><DeltaV><DeltaPhase>}
                              Values in **binary format**, describing the maximum absolute input
                              power Pin_{max}, the number of subsequent points *n* and the nor-
                              malized values Vin/Vmax, ΔV/V, ΔPhase [deg].

Example:

```
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA #240<values>
// the binary <values> are not printable
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA:CATalog?
// norm
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA:STORe "My_DPD_Normalized"
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA:CATalog?
// norm,My_DPD_Normalized
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA:LOAD "norm"
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA?
// #3112
// the binary data <NormData> is 112 bytes long (3 points are defined)
// binary data is machine readable but not printable
```

Manual operation: See "Apply, OK" on page 216

[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:CATalog?

Queries the available files with normalized data in the default directory. Only files with the file extension *.dpd_norm are listed.

Return values:

<Catalog>   string

Example: See [:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA on page 513.

Usage: Query only

Manual operation: See "Save/Recall Normalized Data" on page 215

[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:LOAD <Filename>

Loads the selected file.

Setting parameters:

<Filename>   string

Example: See [:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA on page 513.

Usage: Setting only

Manual operation: See "Save/Recall Normalized Data" on page 215

[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:STORe <Filename>

Saves the normalized data in a file.

Setting parameters:

<Filename>   string

Example: See [:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA on page 513.

Usage:	Setting only
Manual operation:	See "Save/Recall Normalized Data" on page 215

10.14.15 SOURce:PHASe subsystem

[:SOURce]:PHASe <Phase>

Specifies the phase variation relative to the current phase.

Parameters:

<Phase>	float
	Range: -360 to 360
	Increment: 0.1
	*RST: 0
	Default unit: DEG
Manual operation:	See "Delta Phase" on page 219

[:SOURce]:PHASe:REFerence

Adopts the phase set with command `[:SOURce]:PHASe` as the current phase.

Usage:	Event
Manual operation:	See "Reset Delta Phase Display" on page 219

10.14.16 SOURce:PULM Subsystem

This subsystem contains the commands for setting the pulse modulation.

Programming Examples

Example: Performing pulse modulation
This example shows a command sequence to perform pulse modulation.

```
// ********************************************************************
// Reset the instrument to start from an initial state
// ********************************************************************
*RST; *CLS


// ********************************************************************
// Set the RF signal frequency and level
// ********************************************************************
SOURce:FREQuency:CW 4000000000
```

```
SOURce:POWer:LEVel:IMMediate:AMPLitude -25


// ********************************************************************
// Configure the pulse modulation settings
// ********************************************************************
// Select the internal modulation generator
SOURce:PULM:SOURce INT
// Set trigger mode
SOURce:PULM:TRIGger:MODE AUTO
// Select pulse mode
SOURce:PULM:MODE DOUB


// ********************************************************************
// Alternatively configure the pulse modulation settings for
// external modulation source
// ********************************************************************
// Select the external modulation source
SOURce:PULM:SOURce EXT
// Set the polarity of the externally applied modulation signal.
SOURce:PULM:POLarity NORMal
// Select the impedance for the external pulse modulation trigger input
SOURce:PULM:TRIGger:EXTernal:IMPedance G10K


// ********************************************************************
// Configure the pulse generator settings
// ********************************************************************
// Set pulse period
SOURce:PULM:PERiod 10 us
// Set pulse width
SOURce:PULM:WIDth 8 us
// Set double pulse width
SOURce:PULM:DOUBle:WIDTh 0.0000012
// Set double pulse delay
SOURce:PULM:DOUBle:DELay 0.0000045


// ********************************************************************
// Activate the signal output
// ********************************************************************
SOURce:PGENerator:OUTPut:STATe 1
SOURce:PULM:STATe 1
OUTPut1:STATe 1
```

[:SOURce<hw>]:PULM:DELay <Delay>

Sets the pulse delay.

Parameters:

<Delay>   float

Range: 0 to 100 s
Increment: 10 ns
*RST: 10 ns

Example: PULM:DEL 13 us
13 us elapse after a trigger before the first pulse is generated.

[:SOURce<hw>]:PULM:DOUBle:DELay <Delay>

Sets the delay from the start of the first pulse to the start of the second pulse.

Parameters:

<Delay>   float

Range: 40 ns to 100 s
Increment: 10 ns
*RST: 1 ns

Example: PULM:DOUB:DEL 22 us
22 us elapse between the beginning of the first pulse and the beginning of the second pulse in double-pulse mode.

Manual operation: See "Double Pulse Delay" on page 258

[:SOURce<hw>]:PULM:DOUBle:WIDTh <Width>

Sets the width of the second pulse in case of double pulse generation.

Example: PULM:DOUB:WIDT 33 us
sets a width of 33 us for the second pulse.

Manual operation: See "Double Pulse Width" on page 258

[:SOURce<hw>]:PULM:MODE <Mode>

Sets the mode of the pulse generator.

Parameters:

<Mode>   SINGle | DOUBle

SINGle
Enables single pulse generation.

DOUBle

Enables double pulse generation. The two pulses are generated in one pulse period.

*RST: SINGle

Example: `PULM:MODE DOUB`

enables double pulse generation.

Manual operation: See "Pulse Mode" on page 258

[:SOURce<hw>]:PULM:PERiod <Period>

Sets the period of the generated pulse. The period determines the repetition frequency of the internal signal.

Example: `PULM:PER 220 us`

the pulse period is 220 us.

Manual operation: See "Pulse Period" on page 258

[:SOURce<hw>]:PULM:POLarity <Polarity>

Parameters:

<Polarity>   NORMal | INVerted

NORMal
The RF signal is suppressed during the pulse pause.

INVerted
The RF signal is suppressed during the pulse.

*RST: NORMal

Example: `PULM:POL INV`

selects inverted polarity.

Manual operation: See "Polarity" on page 257

[:SOURce<hw>]:PULM:SOURce <Source>

Selects the source for pulse modulation.

Parameters:

<Source>   INTernal | EXTernal

INTernal
The internal pulse generator is used for the pulse modulation.

EXTernal
The signal applied externally via the trigger connector is used for the pulse modulation.

*RST: INTernal

Manual operation: See "Source" on page 257

[:SOURce<hw>]:PULM:STATe <State>

Activates the pulse modulation.

Parameters:

<State>	0 | 1 | OFF | ON
	*RST: 0

Example: `PULM:STAT ON`
activates pulse modulation.

Manual operation: See "State" on page 257

[:SOURce<hw>]:PULM:TRIGger:EXTernal:GATE:POLarity <Polarity>

Selects the polarity of the Gate signal.

Parameters:

<Polarity>	NORMal | INVerted
	*RST: NORMal

Example: `PULM:TRIG:EXT:GATE:POL NORM`
The pulse signal is generated while the gate signal is high.

Manual operation: See "Gate Input Polarity" on page 260

[:SOURce<hw>]:PULM:TRIGger:EXTernal:IMPedance <Impedance>

Selects the impedance for external pulse trigger.

Parameters:

<Impedance>	G50 | G10K
	*RST: G50

Example: `SOUR:PULM:TRIG:EXT:IMP G50`
selects 50 Ohm as the trigger impedance for the external pulse
trigger.

Manual operation: See "External Impedance" on page 257

[:SOURce<hw>]:PULM:TRIGger:EXTernal:SLOPe <Slope>

Parameters:

<Slope>	NEGative | POSitive
	*RST: POSitive

Example: `PULM:TRIG:EXT:SLOP NEG`
The pulse generator is triggered on the negative slope of the
external trigger signal.

Manual operation: See "Ext. Trigger Input Slope" on page 260

[:SOURce<hw>]:PULM:TRIGger:MODE <Mode>

Selects the trigger mode for pulse modulation.

Parameters:

<Mode>   AUTO | EXTernal | EGATe

AUTO
The pulse modulation is generated continuously.

EXTernal
The pulse modulation is triggered by an external trigger event. The trigger signal is supplied via the trigger connector.

EGATe
The pulse modulation is gated by an external gate signal. The trigger signal is supplied via the trigger connector.

*RST: AUTO

Example: `PULM:TRIG:MODE EXT`
selects triggering by an external trigger event.

Manual operation: See "Trigger Mode" on page 260

[:SOURce<hw>]:PULM:WIDTh <Width>

Sets the width of the generated pulse. The width determines the pulse length. The pulse width must be at least 20ns less than the set pulse period.

Example: `PULM:WIDT 33 us`
sets a width of 33 us for the pulse.

Manual operation: See "Pulse Width" on page 258

10.14.17 SOURce:POWer subsystem

[:SOURce]:POWer:ALC:DSENsitivity <Sensitivity>

Sets the power detector sensitivity. Used for compatibility reasons only.

Parameters:

<Sensitivity>   OFF | LOW | MED | HIGH

                        *RST: OFF

Manual operation: See "Detector Sensitivity" on page 230

[:SOURce]:POWer:ALC:SONCe

Briefly activates level control for correction purposes.

Usage: Event

Manual operation: See "Readjust" on page 227

[:SOURce]:POWer:ALC[:STATe] <State>

Activates/deactivates automatic level control.

Parameters:

<State>   1 | OFFTable | OFF | ONTable | AUTO | ON

                        *RST: ONTable

Manual operation: See "State" on page 230

[:SOURce]:POWer:ATTenuation:DIGital <AttDigital>

Sets a relative attenuation value for the baseband signal.

Parameters:

<AttDigital>   float

                        Range: 0 to 80
                        Increment: 1E-3
                        *RST: 0
                        Default unit: dB

Manual operation: See "Digital Attenuation" on page 225

[:SOURce]:POWer:ATTenuation:RFOFf:MODE <Mode>

Determines the attenuator's state after the instrument is switched on.

Parameters:

<Mode>   MAX | FATTenuated | FIXed | UNCHanged

MAX = FATTenuated
Sets attenuation to maximum when the RF signal is switched off.
This setting is recommended for applications that require a high
level of noise suppression.

FIXed = UNCHanged
Retains the current setting and keeps the output impedance
constant during RF off.

*RST: n.a. (factory preset: MAX)

Manual operation: See "RF-Off-Mode" on page 228

[:SOURce]:POWer:ATTenuation:SOVer[:OFFSet] <Offset>

Sets the switch-over offset value of the attenuator.

Parameters:

<Offset>   float

Range: -10 to 10
Increment: 0.1
*RST: 0

Manual operation: See "SATT Switch-Over Offset" on page 228

[:SOURce]:POWer:LIMit[:AMPLitude] <Amplitude>

Sets the upper limit of the RF signal power.

An instrument preset does not affect this value. A factory preset (SYST:FPR) sets the
specified factory upper limit value.

Parameters:

<Amplitude>   float

Range: -120 to 25
Increment: 0.01
*RST: n.a. (factory preset: 25)

Manual operation: See "Limit" on page 227

[:SOURce]:POWer:LMODe <LevMode>

Selects the level mode.

Parameters:

<LevMode>   NORMal | LOWNoise | LOWDistortion

NORM
automatic selection of the best settings

LNOISe
settings for lowest noise

LDIStortion
settings for lowest distortions

*RST: n.a. (factory preset: NORMal)

Manual operation: See "Mode" on page 226

[:SOURce]:POWer:POWer <Amplitude>

Sets the level at the RF output connector.

This value does not consider a specified offset. The command [:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] sets the level of the "Level" display, that means the level containing offset.

Parameters:
<Amplitude>   float

Range: -20 to 25
Increment: 0.01
*RST: -10

Example: POW:POW 15
sets the RF level at output to 15 dBm.

Manual operation: See "Level/Level Offset" on page 68

[:SOURce]:POWer:PEP?

Queries the RF signal peak envelope power.

Return values:
<PEP>   float

Usage: Query only

[:SOURce]:POWer:SCHaracteristic <Characteristic>

Selects the characteristic for the level setting.

Parameters:
<Characteristic>   AUTO | UNINterrupted | CVSWr | USER | MONotone

UNINterrupted
uninterrupted level setting

CVSWr
constant-VSWR

MONotone
strictly monotone

*RST: AUTO

Manual operation: See "Setting Characteristic" on page 226

[:SOURce]:POWer:SERVoing:SENSor <Sensor>

Sets the power sensor as mapped with the remote command :SLISt:
ELEMent<ch>:MAPPing on page 380.

Parameters:

<Sensor>   SENS1 | SENS2 | SENSor2 | SENS3 | SENSor3 | SENS4 |
                    SENSor4 | SENSor1 | UNDefined

                    *RST: n.a. (no preset. default: SENS1)

Manual operation: See "Sensor" on page 241

[:SOURce]:POWer:SERVoing:SENSor:APERture <Aperture>

Sets the aperture time (size of the acquisition interval) of the power sensor during
power servoing.

Parameters:

<Aperture>   float

                    Range: 10e-6 to 100e-3
                    Increment: 1e-6
                    *RST: 100e-6

Manual operation: See "Sensor Aperture Time" on page 242

[:SOURce]:POWer:SERVoing:SET? <Target>

Sets the target output power level and queries power servoing procedure status.

Parameters:

<Target>   float

                    Starts a single power servoing setting cycle, see "About power
                    servoing" on page 239.
                    Sets the desired output power level required at the DUT, see [:
                    SOURce]:POWer:SERVoing:TARGet on page 525.

Return values:

<Start>   0 | 1 | RUNning | STOPped

                    Queries the current status of the powerservoing procedure.

                    0|RUNning
                    Procedure is ok and or running without errors.

                    1|STOPped
                    Procedure is stopped due to an error.

                    *RST: n.a. (no preset. default: STOPped)

Usage: Query only

Manual operation: See "Start" on page 242

[:SOURce]:POWer:SERVoing:STATe <State>

Activates/deactivates power servoing.

Parameters:

<State>   1 | ON | 0 | OFF

                           *RST: 0

Manual operation: See "State" on page 241

[:SOURce]:POWer:SERVoing:TARGet <Targetlevel>

Sets the target output power level required at the DUT.

Parameters:

<Targetlevel>   float

                           Range: -120 to 25
                           Increment: 0.01
                           *RST: n.a. (factory preset: -10)

Manual operation: See "Target" on page 241

[:SOURce]:POWer:SERVoing:TEST?

Queries the state of the power servoing procedure.

Return values:

<Start>   0 | 1 | RUNning | STOPped

                           *RST: n.a. (no preset. default: STOPped)

Usage: Query only

Manual operation: See "Run Test" on page 299

[:SOURce]:POWer:SERVoing:TOLerance <Tolerance>

Sets the tolerance level interval, in which the "Target" output power level of the DUT lies.

A large tolerance accelerates the power servoing procedure but also reduces the accuracy of the target output power level.

Parameters:

<Tolerance>   float

                           Range: 0.01 to 3
                           Increment: 0.01
                           *RST: n.a. (factory preset: 0.1)

Manual operation: See "Tolerance" on page 242

[:SOURce]:POWer:SERVoing:TRACking <State>

Activates/deactivates level tracking. Activation increases measurement accuracy but also measurement time.

Parameters:

<State>   1 | ON | 0 | OFF

           *RST: 0

Manual operation: See "Level Tracking (500 ms)" on page 242

[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] <Amplitude>

Sets the RF level at the RF output connector of the instrument.

Parameters:

<Amplitude>   float

           Range: -120 to 25
           Increment: 0.01
           *RST: -10
           Default unit: dBm

Manual operation: See "Level/Level Offset" on page 68

[:SOURce]:POWer[:LEVel][:IMMediate]:OFFSet <Offset>

Specifies the constant level offset of a downstream attenuator/amplifier. If a level offset is entered, the level entered with `:POWer` no longer corresponds to the RF output level.

The following correlation applies:

`:POWer` = RF output level + `POWer:OFFSet`.

Entering a level offset does not change the RF output level, but rather the query value of `:POWer`.

Only dB is permitted as the unit here. The linear units (V, W, etc.) are not permitted.

Parameters:

<Offset>   float

           Range: -100 to 100
           Increment: 0.1
           *RST: 0

Manual operation: See "Offset / Offset (Gain)" on page 225

[:SOURce]:POWer:RANGe:LOWer?
[:SOURce]:POWer:RANGe:UPPer?

Queries the minimum/maximum level range in the current level mode

Return values:

<Upper>	float

Usage: Query only

Manual operation: See "Level Range" on page 226

[:SOURce]:POWer:WIGNore <State>

Ignores level range warnings.

Parameters:

<State>	0 | 1 | OFF | ON
	*RST: n.a. (factory preset: 0)

Example: `POW:WIGN ON`
suppresses the level range warnings.

10.14.18   SOURce:ROSCillator subsystem

[:SOURce]:ROSCillator:SOURce <Source>

Select the reference oscillator signal source.

Parameters:

<Source>	INTernal | EXTernal

Manual operation: See "Ref. Oscillator Source/Ext Ref On/Off" on page 68

[:SOURce]:ROSCillator:EXTernal:FREQuency <ExtFreq>

Selects the frequency of the external reference.

Parameters:

<ExtFreq>	10MHZ | 100MHZ | 1000MHZ | 13MHZ
	`13MHZ` requires RF board with part number 1419.5308.02.
	To find out the RF board installed in the instrument:
	Select "SGMA-GUI > instrument name > Setup > Hardware Config" > "RF Assembly"
	Observe the part number of the assembly "RfBoard".

Manual operation: See "Ext. Ref. Input Frequency" on page 222

[:SOURce]:ROSCillator:OUTPut:FREQuency <OutputFreq>

Selects the output for the reference oscillator signal.

Parameters:

<OutputFreq>   10MHZ | 100MHZ | 1000MHZ | 13MHZ

                     `13MHZ` requires RF board with part number 1419.5308.02.

Manual operation: See "Output Frequency" on page 222

[:SOURce]:ROSCillator:EXTernal:SBANdwidth <SBandwidth>

Sets the synchronization bandwidth for an external reference signal.

Parameters:

<SBandwidth>   WIDE | NARRow

                     NARRow
                     The synchronization bandwidth is.
                     WIDE
                     Synchronization bandwidth is.
                     *RST: n.a. (factory preset)

Example: `ROSC:SOUR EXT`
                     Selects the external source.
                     `ROSC:EXT:FREQ 10 MHz`
                     Informs the instrument that the external reference has a fre-
                     quency of 10 MHz.
                     `ROSC:EXT:SBAN WID`
                     Selects wideband setting for synchronization bandwidth.

Manual operation: See "Synchronization Bandwidth" on page 222

[: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.

If user-defined values are used, the instrument is no longer in the calibrated state.
However, the calibration value is not changed and the instrument resumes the calibra-
ted state after sending the com-
mand `:SOURce:ROSCillator:INTernal:ADJust:STATe OFF`.

Parameters:

<State>   0 | 1 | OFF | ON

                     *RST: n.a. (factory preset: 0)

Example: `ROSC:SOUR INT`
                     Selects the internal source.
                     `ROSC:ADJ ON`
                     Activates use of a user-defined adjustment value.
                     `ROSC:ADJ:VAL 1400`
                     Sets the adjustment value to 1400.

Manual operation: See "Adjustment Active" on page 223

[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue <Value>

Allows an application to shift the reference oscillator frequency by a small amount.

The setting range depends on the reference oscillator type and its factory calibration value. Allowed are the following ranges:

- For TCXO oscillator: Max - Min = 1023
- For OCXO oscillator: Max - Min = 65535 (option R&S SGT-B1 required.)

Parameters:

<Value>	integer
	Range: Min to Max
	*RST: 0

Manual operation: See "DAC Value" on page 223

10.15   STATus subsystem

This system contains the commands for the status reporting system. See also Chapter 9.5, "Status reporting system", on page 329 for detailed information.

*RST on page 351 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 SGT 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 STA-
                     Tus: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 STA-
                     Tus: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 num-
bers 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 537.

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

10.16 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?
// "SGT100A-101652"
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
```

Disabling LAN services

▶ **NOTICE!** Risk of loosing access over LAN. Disabling the LAN interface or the common services "LAN", "SCPI over LAN", "VNC" and "HTTP" locks the remote access to the instrument.

Use the commands in Example"To disable the LAN interface and LAN services" on page 533 to disable or enable the LAN interface and LAN interface services individually.

a) For the first parameter of the command, enter the security password of your instrument.
The default password is 123456.

b) For the second parameter of the command, enter the state: 1 (ON), 0 (OFF)

Example: To disable the LAN interface and LAN services

```
// **************************************************************************
// Disable the LAN interface.
// **************************************************************************
SYSTem:SECurity:NETWork:STATe "<password>", 0
```

```
// ******************************************************************************
// Disable the LAN services individually.
// ******************************************************************************
SYSTem:SECurity:NETWork:RAW:STATe "<password>", 0
// Disables remote access over raw socket.
SYSTem:SECurity:NETWork:SOE:STATe "<password>", 0
// Disables SCPI over Ethernet/LAN communication.
SYSTem:SECurity:NETWork:HTTP:STATe "<password>", 0
// Disables remote access over HTTP.
SYSTem:SECurity:NETWork:RPC:STATe "<password>", 0
// Disables remote access over remote procedure call (RPC).
SYSTem:SECurity:NETWork:SSH:STATe "<password>", 0
// Disables SSH network protocol that is used for service purposes.
SYSTem:SECurity:NETWork:FTP:STATe "<password>", 0
//    Disables FTP for file transfer.
SYSTem:SECurity:NETWork:SMB:STATe "<password>", 0
// Disables shared access over SMB.
SYSTem:SECurity:NETWork:AVAHi:STATe "<password>", 0
// Disables Avahi service for automatic instrument configuration in the network.
SYSTem:SECurity:NETWork:SWUPdate:STATe "<password>", 0
// Disables software updates over LAN.
```

:SYSTem:ERRor:ALL?

Queries the error/event queue for all unread items and removes them from the queue.

Return values:

<All>	string
	Error/event_number,"Error/event_description>[;Device-dependent info]"
	A comma separated list of error number and a short description of the error in FIFO order.
	If the queue is empty, the response is `0,"No error"`
	Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.
	Volatile errors are reported once, at the time they appear. Identical errors are reported repeatedly only if the original error has already been retrieved from (and hence not any more present in) the error queue.

Example:

```
SYSTem:ERRor:ALL?
// queries all entries in the error queue.
Response: 0, 'no error'
// no errors have occurred since the error queue was last read out.
```

Usage: Query only

:SYSTem:ERRor:CODE:ALL?

Queries the error numbers of all entries in the error queue and then deletes them.

Return values:

\<All\>   string

Returns the error numbers. To retrieve the entire error text, send the command `:SYSTem:ERRor:ALL?`.

0
"No error", i.e. the error queue is empty

Positive value
Positive error numbers denote device-specific errors

Negative value
Negative error numbers denote error messages defined by SCPI.

Example: SYSTem:ERRor:CODE:ALL?
// queries all entries in the error queue.
Response: 0
// no errors have occurred since the error queue was last read out.

Usage: Query only

:SYSTem:ERRor:CODE[:NEXT]?

Queries the error number of the oldest entry in the error queue and then deletes it.

Return values:

\<Next\>   string

Returns the error number. To retrieve the entire error text, send the command `:SYSTem:ERRor:ALL?`.

0
"No error", i.e. the error queue is empty

Positive value
Positive error numbers denote device-specific errors

Negative value
Negative error numbers denote error messages defined by SCPI.

Example: SYSTem:ERRor:CODE:NEXT?
// queries the oldest entry in the error queue.
Response: 0
// no errors have occurred since the error queue was last read out.

Usage: Query only

:SYSTem:ERRor:COUNt?

Queries the number of entries in the error queue.

Return values:

<Count>   integer

0
The error queue is empty.

Example: SYSTem:ERRor:COUNt?
// queries the number of entries in the error queue.
Response: 1
// one error has occurred since the error queue was last read out.

Usage: Query only

:SYSTem:ERRor[:NEXT]?

Queries the error/event queue for the oldest item and removes it from the queue.

Return values:

<Next>   string

Error/event_number,"Error/event_description>[;Device-depend-
ent 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. Identi-
cal errors are reported repeatedly only if the original error has
already been retrieved from (and hence not any more present in)
the error queue.

Example: SYSTem:ERRor:NEXT?
// queries the oldest entry in the error queue.
Response: 0, 'no error'
// no errors have occurred since the error queue was last read out.

Usage: Query only

:SYSTem:SERRor?

Returns a list of all errors existing at the time when the query is started. This list corre-
sponds to the display on the info page under manual control.

Return values:

<Serror>   string

Example: SYST:SERR
queries all errors existing in the error queue.

| **Example:** | Response: -221, 'Settings conflict', 153, 'Input voltage out of range' |
| | The two returned errors have occurred since the error queue was last queried. |

| **Usage:** | Query only |

:SYSTem:VERSion?

Queries the SCPI version the instrument's command set complies with.

Return values:

| <Version> | string |

Example:	SYSTem:VERSion
	// queries the SCPI version.
	Response: "1996"
	// the instrument complies with the SCPI version from 1996.

| **Usage:** | Query only |

:SYSTem:COMMunicate:GPIB:LTERminator <LTerminator>

Sets the terminator recognition for remote control via GPIB bus.

Parameters:

<LTerminator>	STANdard	EOI
	EOI
	The terminator must be sent together with the line message EOI (End of Line). This setting is recommended for binary block transmissions where a character could coincidentally have the value LF (Line Feed) but is not intended as the terminator. This setting must be selected for block data with undefined length.
	STANdard
	An LF (Line Feed) is recognized as the terminator regardless of whether it is sent with or without EOI.
	*RST: n.a. (factory preset: STANdard)

| **Example:** | SYSTem:COMMunicate:GPIB:LTERminator EOI |
| | Only a character which is sent simultaneously with the line message EOI is accepted as the terminator. |

:SYSTem:COMMunicate:GPIB:RESource?

Queries the VISA resource string for remote control via the GPIB interface.

To change the GPIB address, use the command :SYSTem:COMMunicate:GPIB[:SELF]:ADDRess.

Return values:

| <Resource> | string |

Example: `SYSTem:COMMunicate:GPIB:RESource?`
queries the VISA resource string.
Response: `"GPIB::28::INSTR"'`

Usage: Query only

:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <Address>

Sets the GPIB address.

Parameters:

<Address>   integer

Range: 0 to 30
*RST: n.a. (factory preset: 28)

Example: `SYSTem:COMMunicate:GPIB:SELF:ADDRess 28`
Sets GPIB address.

:SYSTem:COMMunicate:NETWork:IPADdress <IpAddress>

Sets the IP address.

Parameters:

<IpAddress>   string

Range: 0.0.0.0. to ff.ff.ff.ff

Example: `SYSTem:COMMunicate:NETWork:IPADdress "7.8.9.10"`
sets the IP address of the instrument.

Manual operation: See "IP Address" on page 288

: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: `SYSTem:COMMunicate:NETWork:IPADdress:MODE AUTO`
The IP address is assigned automatically (DHCP)

Manual operation: See "Address Mode" on page 288

:SYSTem:COMMunicate:NETWork:MACaddress <MacAddress>

Queries the MAC address of the network adapter.

Parameters:

<MacAddress>   string

Example: `SYST:COMM:NETW:MAC`
queries the MAC address.

:SYSTem:COMMunicate:NETWork:STATus?

Queries the network configuration state.

Return values:

<State>   0 | 1 | OFF | ON

Usage: Query only

:SYSTem:COMMunicate:NETWork:RESTart

Restarts the network connection to the instrument, terminates the connection and sets it up again.

Example: `SYSTem:COMMunicate:NETWork:RESTart`

Usage: Event

:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname <Hostname>

Sets the individual host name of the R&S SGT.

Note: it is recommended that you do not change the host name in order to avoid problems with the networdk connection. However, if you change the host name be sure to use an unique name.

The host name is a protected parameter, To change it, first disable protection level 1 with command `:SYSTem:PROTect<ch>[:STATe]` on page 549.

Parameters:

<Hostname>   string

Example: `SYSTem:PROTect1:STATe OFF,123456`
                             `SYSTem:COMMunicate:NETWork:HOSTname 'SIGGEN'`
                             sets the individual computer name of the R&S SGT.

Manual operation: See "Hostname" on page 288

: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 533.

: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: `SYSTem:COMMunicate:NETWork:IPADdress:GATeway`
`'1.2.3.4'`
sets the IP address of the default gateway.

Manual operation: See "Default Gateway" on page 289

:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK <Mask>

Sets the subnet mask.

Parameters:

<Mask>	string

Example: `SYSTem:COMMunicate:NETWork:IPADdress:SUBNet:`
`MASK '255.255.0.0'`
determines the subnet mask.

Manual operation: See "Subnet Mask" on page 288

:SYSTem:COMMunicate:NETWork:RESource?

Queries the VISA resource string, used for remote control of the instrument with VXI-11 protocol.

Return values:

<Resource>	string

Example: `SYSTem:COMMunicate:NETWork:RESource?`
Response: `"TCPIP::192.1.2.3::INSTR"`

Usage: Query only

Manual operation: See "Visa Resource Strings" on page 290

:SYSTem:COMMunicate:SERial:BAUD <Baud>

Sets the baudrate for the serial remote control interface.

Parameters:

<Baud>	2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200
	*RST: n.a. (factory preset: 115200)

Example: `SYSTem:COMMunicate:SERial:BAUD 115200`
Sets 115200 baudrate.

:SYSTem:COMMunicate:SERial:PARity <Parity>

Sets the parity for the serial remote control interface.

Parameters:

<Parity>	NONE | ODD | EVEN
	*RST: n.a. (factory preset: NONE)
Example:	`SYST:COMM:SER:PAR NONE`
	Selects parity NONE.

:SYSTem:COMMunicate:SERial:RESource?

Queries the VISA resource string for the serial remote control interface. This string is used for remote control of the instrument.

Return values:

<Resource>	string
Example:	`SYSTem:COMMunicate:SERial:RESource?`
	queries the VISA resource string.
	Response: `"ASRL1::INSTR"`
Usage:	Query only

:SYSTem:COMMunicate:SERial:SBITs <SBits>

Sets the number of stop bits for the serial remote control interface.

Parameters:

<SBits>	1 | 2
	*RST: n.a. (factory preset: 1)
Example:	`SYST:COMM:SER:SBIT 2`
	Selects 2 stop bits.

:SYSTem:COMMunicate:HISLip:RESource?

Queries the VISA resource string, used for remote control of the instrument with HiSLIP protocol.

Return values:

<Resource>	string
Example:	`SYSTem:COMMunicate:HISLip:RESource?`
	Response: `"TCPIP::192.1.2.3::hislip0::INSTR"`
Usage:	Query only
Manual operation:	See "Visa Resource Strings" on page 290

:SYSTem:COMMunicate:PCIexpress:RESource?

Queries the visa resource string for remote control via the PCIe interface.

Return values:

<Resource>	string

Usage:	Query only
Manual operation:	See "Visa Resource Strings" on page 290

:SYSTem:COMMunicate:SOCKet:PORT <ScpiEthPort>

Sets the port number for remote control via socket communication.

Parameters:

<ScpiEthPort>	integer
	Range: 1000 to 65535
	*RST: n.a. (factory preset: 5025)

Example:	`SYSTem:COMMunicate:SOCKet:PORT 5030`
	`// specifies the socket port number.`
Manual operation:	See "SCPI Port" on page 63

: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:	`SYSTem:COMMunicate:SOCKet:RESource?`
	Response: `"TCPIP::10.113.1.150::5025::SOCKET"`
Usage:	Query only
Manual operation:	See "Visa Resource Strings" on page 290

:SYSTem:COMMunicate:USB:RESource?

Queries the VISA resource string for remote control via the USB interface.

Return values:

<Resource>	string

Example:	`SYSTem:COMMunicate:USB:RESource?`
	queries the VISA resource string for remote control via the USB interface.
	Response: `"USB::72::000000::INSTR"`
Usage:	Query only
Manual operation:	See "Visa Resource Strings" on page 290

:SYSTem:IDENtification <Identification>

Selects the mode the instrument identification is performed.

Parameters:

<Identification>   AUTO | USER

                          AUTO
                          The `*IDN` string and the `*OPT` string are set automatically.

                          USER
                          Enables the selection of user definable `*IDN` and `*OPT` strings.

                          *RST: n.a. (factory preset: AUTO)

Example: `SYST:IDEN USER`
                          Selects the user-defined identification string.

Manual operation: See "Identification Mode" on page 293

:SYSTem:KLOCk <State>

Keyboard lock disables the front panel keys of the instrument.

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, set `SYST:KLOC OFF`.

:SYSTem:LANGuage <Language>

Sets the command set to be used.

The instrument can also be remote controlled via the command set of several other generators.

Note: While working in a emulation mode, the instrument's specific command set is disabled, i.e. the SCPI command `SYSTem:LANGuage` will be discarded.

The return to the SCPI command set of the R&S SGT can only be performed by using the appropriate command of the selected command set.

Parameters:

<Language>   string

Example: `SYSTem:LANGuage "SCPI"`
                          sets the SCPI command set.

Manual operation: See "Language" on page 293

: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`

Usage: Query only

:SYSTem:REBoot

Restarts the firmware and the operating system.

Usage: Event

:SYSTem:RESTart

Restarts the firmware. The operating system remains active.

Usage: Event

:SYSTem:SECurity:NETWork:AVAHi[:STATe] <SecPassWord>, <AvahiState>

Disables the Avahi service for automatic configuration of the instrument in a network.

Parameters:

<AvahiState>   1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>   string

                             Current security password.

Example: See Example"To disable the LAN interface and LAN services"
                          on page 533.

:SYSTem:SECurity:NETWork:FTP[:STATe] <SecPassWord>, <FtpState>

Disables FTP protocol for file transfer between the instrument and host.

Parameters:

<FtpState>   1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>   string

                             Current security password.

Example:	See Example"To disable the LAN interface and LAN services" on page 533.

:SYSTem:SECurity:NETWork:HTTP[:STATe] <SecPassWord>, <HttpState>

Disables control of the instrument over HTTP, the protocol for hypermedia information systems.

Parameters:

<HttpState>	1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>	string
	Current security password.

Example:	See Example"To disable the LAN interface and LAN services" on page 533.

:SYSTem:SECurity:NETWork:RAW[:STATe] <SecPassWord>, <RawState>

Disables the LAN interface for remote control of the instrument over raw socket port.

Parameters:

<RawState>	1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>	string
	Current security password.

Example:	See Example"To disable the LAN interface and LAN services" on page 533.

:SYSTem:SECurity:NETWork:REMSupport[:STATe] <NetRemSupport>

Disables communication over SSH (SCP) for service purposes.

Parameters:

<NetRemSupport>	1 | ON | 0 | OFF
	*RST: n.a. (factory preset: 1)

Example:	See Example"To disable the LAN interface and LAN services" on page 533.

:SYSTem:SECurity:NETWork:RPC[:STATe] <SecPassWord>, <RpcState>

Enables the LAN interface for remote control of the instrument via remote procedure calls (RPC).

Parameters:

<RpcState>	1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>   string

                       Current security password.

Example: See Example"To disable the LAN interface and LAN services"
                       on page 533.

:SYSTem:SECurity:NETWork:SMB[:STATe] <SecPassWord>, <SmbState>

Disables access to the file system, printers and serial ports in a network over SMB.

Parameters:

<SmbState>   1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>   string

                       Current security password.

Example: See Example"To disable the LAN interface and LAN services"
                       on page 533.

:SYSTem:SECurity:NETWork:SOE[:STATe] <SecPassWord>, <SoeState>

Disables control of the instrument over LAN using SCPI commands.

Parameters:

<SoeState>   1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>   string

                       Current security password.

Example: See Example"To disable the LAN interface and LAN services"
                       on page 533.

:SYSTem:SECurity:NETWork:SSH[:STATe] <SecPassWord>, <SshState>

Disables control of the instrument over LAN using the SSH network protocol.

Parameters:

<SshState>   1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>   string

                       Current security password.

Example: See Example"To disable the LAN interface and LAN services"
                       on page 533.

:SYSTem:SECurity:NETWork:SWUPdate[:STATe] <SecPassWord>,
<SwUpdateState>

Disables software update over LAN.

Parameters:

<SwUpdateState>   1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>   string

Current security password.

Example: See Example"To disable the LAN interface and LAN services"
on page 533.

:SYSTem:SECurity:NETWork[:STATe] <SecPassWord>, <LanStorState>

Disables the LAN interface in general, including all services.

Parameters:

<LanStorState>   1 | ON | 0 | OFF

Setting parameters:

<SecPassWord>   string

Current security password.
The default password is 123456.

Example: See Example"To disable the LAN interface and LAN services"
on page 533

Manual operation: See "LAN Interface" on page 285

:SYSTem:SHUTdown

Shuts down the instrument.

Usage: Event

: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?
// 1
// the startup of the instrument is completed

Usage: Query only

:SYSTem:PROTect<ch>[:STATe] <State>[, <Key>]

Activates and deactivates the specified protection level.

Suffix:

<ch>　　　　　　　　　Indicates the protection level.

Parameters:

<State>　　　　　　　select

　　　　　　　　　　　*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 password for the first level is 123456.

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`

:SYSTem:TIME:ZONE <TimeZone>

Sets the time zone. You can query the list of the available time zones with `:SYSTem:TIME:ZONE:CATalog?`.

Parameters:

<TimeZone>　　　　　string

Manual operation:　　See "Time Zone" on page 294

:SYSTem:TIME:ZONE:CATalog?

Querys the list of available time zones.

Return values:

<Catalog>

Usage:　　　　　　　Query only

Manual operation:　　See "Time Zone" on page 294

:SYSTem:OSYStem?

Queries the operating system of the instrument.

Return values:

<OperSystem>　　　　string

Example:	SYSTem:OSYStem?
	Response: "Linux"
Usage:	Query only

: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:MMEMory:PATH:USER?

Queries the user directory, that means the directory the instrument stores user files on.

Return values:

<PathUser>	string
Example:	SYSTem:MMEMory:PATH:USER?
	Response: "/var/user/"'
Usage:	Query only

: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 285

10.17 TEST subsystem

The TEST system contains the commands for performing test routines.

Self tests return a "0", if the test is performed successfully, otherwise a value other than "0" is returned. None of the commands of this system have an `*RST` value.

:TEST:ALL:STARt

Starts the selftest. Use the command `:TEST:ALL:RESult?` to query the result.

Usage: Event

Manual operation: See "Start Selftest" on page 297

:TEST:ALL:RESult?

Queries the result of the performed selftest. Start the selftest with `:TEST:ALL:STARt`.

Return values:

<Result>   0 | 1 | RUNning | STOPped

                     *RST: STOPped

Usage: Query only

Manual operation: See "Start Selftest" on page 297

:TEST:KEYBoard[:STATe] <State>

Enable/disable keyboard and LED test state.

Parameters:

<State>   1 | ON | 0 | OFF

:TEST:BBIN?

This command performs a selftest on the baseband input hardware options. Several analog diagnostics points are checked to verify the correct function of the module.

Return values:

<Bbin>   0 | 1 | OFF | ON

Example: TEST:BBIN?
                     Response: "0" on success, "1" on fail

Usage: Query only

:TEST:BB:CONNection?

Queries the state of the connection between connectors [USER1] and [USER2].

A `0=PASS` response indicates that the connection is established, whereas a response `1=FAIL` stands for a faulty connection.

Return values:

\<Connection\>	0 | 1 | PASS | FAIL

Usage: Query only

Manual operation: See "Execute Connection Test" on page 297

:TEST:EIQMode \<EiqMode\>

Triggers a connection test for testing the active external IQ devices.

Parameters:

\<EiqMode\>	IQIN | IQOut
	*RST: IQOut

10.18 UNIT subsystem

The `UNIT` subsystem contains the commands specifying which units are valid if no unit is indicated in a command. These settings are valid for the entire instrument.

:UNIT:ANGLe \<Angle\>

Sets the default angle unit for remote control. Does not influence the manual control parameter units and the display.

Parameters:

\<Angle\>	DEGRee | RADian
	*RST: RADian

Example: `UNIT:ANGL DEG`
sets DEG as a default unit for all commands which determine angle values.

:UNIT:POWer \<Power\>

Defines the default unit for 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

Example: `UNIT:POW V`

sets V as a default unit for all commands which determine power values.

10.19 List of R&S SGT commands

11 Waveform and list format

The R&S SGT uses a tag-oriented format for externally or internally generated wave-forms.

ⓘ   A waveform version number is not necessary due to the flexible, tag-based form.

Tags are self-contained information units. 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, a `DATA LIST` tag or a `EMPTYTAG` (from `:` to `}`, ASCII integer).

Each waveform file must begin with the `TYPE` tag. The sequence of the remaining tags is arbitrary. For each tag, an indication shows whether it must be included in the file concerned (mandatory) or can be included (optional).

Unknown tags are not analyzed by the R&S SGT. They are left unchanged, are saved without an error message and can be read back again.

R&S AMIQ waveforms can also be loaded on the instrument, where they are converted internally into an R&S SGT waveform.

11.1 Tag description

This section first describes the mandatory `TYPE` tag which identifies the file and is always located at the start of the file. The rest of the tags used in the R&S SGT are then described in alphabetical order. Most 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.

{TYPE: magic, xxxxxxxx}

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

Identifies the file as a valid R&S SGT file. It must be present and must be the first in the waveform. If a file of the same name already exists on the target medium, it is over-written.

Setting parameters:

magic	Designates the file type and has the following values:
	SMU-WV A valid R&S SGT waveform.
	SMU-MWV A valid R&S SGT multi-segment waveform.
xxxxxxxx	This parameter is an ASCII-coded checksum of the data part of the WAVEFORM tag in the file. 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 below. '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);
}
```

Example:	{TYPE: SMU-WV,106656} BB:ARB:WAV:TAG? 'TYPE' Queries the content of the TYPE tag. Response: 'SMU-WV,106656' The waveform is valid.

{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

{COMMENT: string}

The tag contains a plain text ASCII string of arbitrary length. The string is not analyzed in the R&S SGT. 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 SGT. 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

{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

{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: 4333}
`BB:ARB:WAV:TAG? 'SAMPLES'`
Queries the content of the `SAMPLES` tag of the selected waveform file.
`Response: '4333'`
The waveform contains 4333 I/Q samples.

Usage: Setting only

{[TRACE] LIST [#]: Pos0:Val0;Pos1:Val1;...Posx:Valx;...PosN-1:ValN-1}

(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. To select which of these signals is defined, `[TRACE]` and the associated number are used. For ARB waveforms, it is only meaningful to define marker signals (on ARB multi-segment waveforms these tags are ignored).

Setting parameters:

[TRACE] Specifies the name of the marker or control signal.
You can choose from the following names:
`MARKER; BURST; LEVATT; CW MODE; HOP, MAP`

[#] Specifies the number, if control signals and marker signals have the same name. There is a choice between 4 markers and 3 LEVATT signals. The lines LEVATT 1 and LEVATT 2 are needed for internal purposes. Do not use them.

Pos Specifies the number of the position in the sequence in ASCII format. The binary state of the marker or of the control signal changes from 0 to 1 or from 1 to 0.

Val	Specifies the binary state of the marker or of the control signal {0; 1} from Pos_x to Pos_{x+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

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

(mandatory for waveforms)

The tag contains the actual waveform data or multi-segment waveform data (I/Q stream).

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_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.

The tag CLOCK contains always the highest clock rate of all segments.

The tag MWV_SEGMENT_CLOCK contains the clock rates of the individual segments.

Setting parameters:

Mode	**UNCHANGED**
	The segments can have different clock rates.
	During the multi-segment calculation, the clock rates of all individual original waveforms were taken over unchanged in the segments of the multi-segment output waveform (no software resampling is done).
	If the segments have different clock rates, there are some restrictions on signal output, i.e. switching per external trigger and seamless switching between segments is not possible.
	If all segments have already an identical clock rate, this mode is usually set to HIGHEST.
	HIGHEST
	All segments have an identical clock rate, which is the highest clock rate of all original waveforms.
	If the original waveform has a lower clock rate, the instrument upsamples to the highest clock rate when calculating the multi-segment output waveform.
	USER
	All segments have an identical clock rate, which is given by the user.
	Note: Only upsampling is allowed, no downsampling.
	If the original waveform has a lower clock rate, the instrument upsamples to the highest clock rate when calculating the multi-segment output waveform.
Example:	{MWV_SEGMENT_CLOCK_MODE: UNCHANGED} {MWV_SEGMENT_CLOCK_MODE: HIGHEST} {MWV_SEGMENT_CLOCK_MODE: USER}
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_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 3dB 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_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/sine.wv", "/var/user/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 transmitted synchronously to the I/Q sample sequence. One marker element 'mx' consists of 4 bit, which are assigned to the 4 possible marker lines of the instrument (one bit per marker line). One 4-bit marker element is needed for every I/Q sample in the WAVEFORM tag, The number of marker elements M is equal to the number of I/Q samples. The CONTROL LENGTH tag has to contain the number of all marker elements M.

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 11-1: 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, but in principle this CONTROL LIST WIDTH4 format can also be used instead of the MARKER LIST x tags.

For multi-segment waveforms, this 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: #$m_0 m_1…m_x…m_{99}$} 100 marker elements, each marker element with 4 bits
Usage:	Setting only

11.2 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 578). They are saved in the file SICO.txt. The decimal values in SICO.txt are normalized such that they are

between −1.0 and +1.0. The data is converted into binary format. The appropriate mandatory tags are added and the data is packed into the `WAVEFORM` tag. As result, the waveform file `SICO.wv` is generated.

This example follows the general principle of creating of a waveform manually, using the tag file format. The Figure 11-2 illustrates this general workflow.

Figure 11-2: 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 saved in the file `SICO.txt`.

```
 0.000000  1.000000
 0.309017  0.951057
 0.587785  0.809017
 0.809017  0.587785
 0.951057  0.309017
 1.000000 -0.000000
 0.951057 -0.309017
 0.809017 -0.587785
 0.587785 -0.809017
 0.309017 -0.951057
-0.000000 -1.000000
-0.309017 -0.951056
-0.587785 -0.809017
-0.809017 -0.587785
-0.951056 -0.309017
-1.000000  0.000000
-0.951056  0.309017
-0.809017  0.587785
-0.587785  0.809017
-0.309017  0.951057
```

Figure 11-3: 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 11-4 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	678D	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 11-4: 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`.

```cpp
// 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;
    }
```

11.3 Editing waveform files

You can edit the internally and externally crated waveform files. The waveform contains 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, you have to change the `{EMPTYTAG-Length}` value.
  For example, if you add a new tag or add bytes to an existing tag, reduce the length information by the number of newly introduced bytes.

12 Error messages and troubleshooting

This chapter describes the error messages of the R&S SGT. The error messages are output in the "Info" line on the screen and entered in the error/event queue of the status reporting system.

A great variety of different messages such as status messages, error messages, warnings or information are displayed in the header field of the screen. Some error messages require that the error must be eliminated before correct instrument operation can be ensured. The "Info" window with a list of current messages and a detailed description of each message can be opened with the "Info" button (see also Chapter 5.2.1, "Info dialog", on page 64).

12.1 Status information

The status messages are displayed in the Info line of the R&S SGMA-GUI main panel. The status information gives the user an overview of the main operating states and settings of the instrument. The states are indicated for information only and do not necessitate any action by the user.

Status Information displayed in the Info line

AttFixed
Attenuator fixed mode is active.

The uninterrupted level settings are made in a fixed range without attenuator switching. The variation range is set automatically when this mode is activated. The range is displayed with the parameter "SGMA-GUI > Instrument Name > Level > Attenuator Fixed Range".

12.2 Error messages

Messages indicate errors in the instrument. They are displayed in the info line 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).

See also Chapter 5.2.1, "Info dialog", on page 64 and Chapter 5.2.2, "Understanding the messages in the info bar", on page 65.

12.2.1 Volatile messages

Volatile messages report automatic settings in the instrument (e.g. switching off of 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 back-ground. 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.

SCPI command: `:SYSTem:ERRor:ALL?` and `:SYSTem:ERRor[:NEXT]?`.

12.2.2 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 ensured.

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.

SCPI command: `:SYSTem:SERRor?`

12.3 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.

The errors are assigned negative 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.

12.4 Device-Specific error messages

The following table contains all error messages specific for the instrument in alphabetical order, and an explanation of the error situation. The positive error codes mark the errors specific of 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
180	Adjustment failed	Adjustment could not be executed	The adjustment data have to be generated first by an internal or external adjustment or to be loaded into the device.
182	Adjustment data missing	Adjustment data are missing.	The adjustment data have to be generated first by an internal or external adjustment or to be loaded into the instrument.
183	Adjustment data invalid	Adjustment data are invalid and must be restored.	The adjustment data have to be generated again by an internal or external adjustment or to be loaded into the instrument.
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 can be defective and requires replacement.
203	Invalid EEPROM data		
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. For instance, the file extension for mapping files is `*.map`. It is not possible to enter another file extension when selecting a list.	Check the selected list type.
460	Cannot open 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.	A file name has to be entered when creating a list.
464	Invalid filename extension	The file extension is not valid for the required operation.	Check the file extension. For instance, the file extension for the mapping files is `*.map`. It is not possible to enter another file extension when storing a list.

Error Code	Error	Description	Remedy
465	File contains invalid data	The selected file contains data that is not valid for the file type.	Check the file extension. 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 are therefore invalid.
468	Cannot find directory	Required folder cannot be found.	Check drive and path.
469	No files found	Folder is empty	

12.5 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 12-1: QR code to the Rohde & Schwarz support page

13 Transporting

Lifting and carrying

See:

- "Lifting and carrying the product" on page 12
- Chapter 3.1.1, "Lifting and carrying", on page 18.

Packing

Use the original packaging material. It consists of antistatic wrap for electrostatic protection and packing material designed for the product.

If you do not have the original packaging, use similar materials that provide the same level of protection. You can also contact your local Rohde & Schwarz service center for advice.

Securing

When moving the R&S SGT in a vehicle or using transporting equipment, make sure that the R&S SGT 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.

14 Maintenance, storage and disposal

The product does not require regular maintenance. It only requires occasional clean-ing. It is however advisable to check the nominal data from time to time.

14.1 Cleaning

How to clean the product is described in "Cleaning the product" on page 13.

Do not use any liquids for cleaning. Cleaning agents, solvents, acids and bases can damage the front panel labeling, plastic parts and display.

14.2 Storage

Protect the product against dust. Ensure that the environmental conditions, e.g. tem-perature range and climatic load, meet the values specified in the data sheet.

14.3 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 dis-posing of waste in a way that causes minimum environmental impact.

Disposing of electrical and electronic equipment

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.

Figure 14-1: Labeling in line with EU directive WEEE

Rohde & Schwarz has developed a disposal concept for the eco-friendly disposal or recycling of waste material. As a manufacturer, Rohde & Schwarz completely fulfills its obligation to take back and dispose of electrical and electronic waste. Contact your local service representative to dispose of the product.

Annex

A Telnet program examples

The following program example shows a simple `TcpClient` class that is intended to explain on how to get started with programming of sockets.

The example sets up a socket communication to R&S SGT and opens a simple user interface, very similar to the telnet, which allows input of commands. To enable real automation, further development of the program is required.

TcpClient.h

```
#include <string>
//defines structs for socket handling
#include <netinet/in.h>
using namespace std;
typedef struct sockaddr_in SockAddrStruct;
typedef struct hostent     HostInfoStruct;
class TcpClient
{
  public:
    TcpClient();
    ~TcpClient();
    void connectToServer( string &hostname, int port );
    void disconnect( );
    void transmit( string &txString );
    void receive( string &rxString );
    string getCurrentHostName( ) const;
    int    getCurrentPort( ) const;
  private:
    string           currentHostName;
    int              currentPort;
    int              currentSocketDescr;
    SockAddrStruct   serverAddress;
    HostInfoStruct * currentHostInfo;
    bool             clientIsConnected;
    int              receiveBufferSize;
};
```

TcpClient.cpp

```
#include <string>
//defines structs for socket handling
#include <netinet/in.h>
using namespace std;
typedef struct sockaddr_in SockAddrStruct;
typedef struct hostent     HostInfoStruct;
class TcpClient
```

```
                {
                  public:
                    TcpClient();
                    ~TcpClient();
                    void connectToServer( string &hostname, int port );
                    void disconnect( );
                    void transmit( string &txString );
                    void receive( string &rxString );
                    string getCurrentHostName( ) const;
                    int    getCurrentPort( ) const;
                  private:
                    string          currentHostName;
                    int             currentPort;
                    int             currentSocketDescr;
                    SockAddrStruct  serverAddress;
                    HostInfoStruct * currentHostInfo;
                    bool            clientIsConnected;
                    int             receiveBufferSize;
                };

                #include <netdb.h>
                #include <netinet/in.h>
                #include <unistd.h>
                #include "TcpClient.h"
                TcpClient::TcpClient()
                : currentHostName( "" )
                , currentPort( 0 )
                , currentSocketDescr( 0 )
                , serverAddress ( )
                , currentHostInfo( NULL )
                , clientIsConnected( false )
                , receiveBufferSize( 1024 )
                {
                }
                TcpClient::~TcpClient()
                {
                  currentHostInfo = NULL;
                }

                void TcpClient::connectToServer( string &hostname, int port )
                {
                  currentHostInfo = gethostbyname( hostname.c_str( ) );
                  if( currentHostInfo == NULL )
                  {
                    currentHostName  = "";
                    currentPort      = 0;
                    currentHostInfo  = NULL;
                    clientIsConnected = false;
                    printf("error connecting host\n" );
                  }
```

```
    currentHostName = hostname;
    currentPort     = port;
    currentSocketDescr = socket(AF_INET, SOCK_STREAM, 0);
    if( currentSocketDescr == 0 )
    {
      currentHostName   = "";
      currentPort       = 0;
      currentHostInfo   = NULL;
      clientIsConnected = false;
      printf("can't create socket\n" );
    }
    serverAddress.sin_family = currentHostInfo->h_addrtype;
    serverAddress.sin_port   = htons( currentPort );
    memcpy( (char *) &serverAddress.sin_addr.s_addr,
    currentHostInfo->h_addr_list[0], currentHostInfo->h_length );
    if( connect( currentSocketDescr, ( struct sockaddr *) &serverAddress,
    sizeof( serverAddress ) ) < 0 )
    {
     throw string("can't connect server\n" );
    }
    clientIsConnected = true;
}
void TcpClient::disconnect( )
{
    if( clientIsConnected )
    {
      close( currentSocketDescr );
    }
    currentSocketDescr = 0;
    currentHostName    = "";
    currentPort        = 0;
    currentHostInfo    = NULL;
    clientIsConnected  = false;
}
void TcpClient::transmit( string &txString )
{
    if( !clientIsConnected )
    {
    throw string("connection must be established before any data can be sent\n");
    }
    char * transmitBuffer = new char[txString.length() +1];
    memcpy( transmitBuffer, txString.c_str(), txString.length() );
    transmitBuffer[txString.length()] = '\n'; //newline is needed!
    if( send( currentSocketDescr, transmitBuffer, txString.length() + 1, 0 ) < 0 )
    {
      throw string("can't transmit data\n");
    }
    delete [] transmitBuffer;
}
void TcpClient::receive( string &rxString )
```

```
{
  if( !clientIsConnected )
  {
  throw string("connection must be established before any data can be received\n");
  }
  char * receiveBuffer = new char[receiveBufferSize];
  memset( receiveBuffer, 0, receiveBufferSize );
  bool receiving = true;
  while( receiving )
  {
    int receivedByteCount = recv( currentSocketDescr,
    receiveBuffer, receiveBufferSize, 0 );
    if( receivedByteCount < 0 )
    {
      throw string("error while receiving data\n");
    }
    rxString += string( receiveBuffer );
    receiving = ( receivedByteCount == receiveBufferSize );
  }
  delete [] receiveBuffer;
}
string TcpClient::getCurrentHostName( ) const
{
  return currentHostName;
}
int TcpClient::getCurrentPort( ) const
{
  return currentPort;
}
```

TelnetClient.cpp

```
#include <iostream>
#include "TcpClient.h"
void printUsage()
{
  cout<<"usage: EthernetRawCommand <server-ip> [scpi-command]"<<endl;
}
int main( int argc, char *argv[] )
{
  int errorCode        = 0; //no error
  bool useSingleCommand = false;
  string singleCommand  = "";
  string hostname       = "";
  int    port           = 5025;
  string input          = "";
  TcpClient client;
  switch( argc )
  {
    case 3:
```

```
    useSingleCommand = true;
    singleCommand    = argv[2];
  case 2:
    hostname         = argv[1];
    break;
  default:
     printUsage();
     return(-1);
}
try
{
  client.connectToServer( hostname, port );
  bool terminate = false;
  while( !terminate )
  {
    char buffer[1024];
    if( useSingleCommand )
    {
      input =  singleCommand; //send string
    }
    else
    {
      cin.getline( buffer, 1024 );
      input = buffer;
      if( input == "end" )
      {
        terminate = true;
      }
    }
    if( !terminate)
    {
      client.transmit( input ); //send string
      int qPos = input.find( "?", 0 );
      //receive string only when needed
      if( qPos > 0 )
      {
        string rcStr = "";
        client.receive( rcStr );
        cout << rcStr << endl;
      }
    }
    if( useSingleCommand )
    {
      terminate = true;
    }
  }
}catch( const string errorString )
{
  cout<<errorString<<endl;
}
```

```
    client.disconnect( );
    return errorCode;
}
```

Glossary: References

Symbols

1GP103: Rohde & Schwarz application note 1GP103 "Connecting and Interfacing with SGMA Instruments" available at:
https://www.rohde-schwarz.com/appnote/1GP103

1GP109: Rohde & Schwarz application note 1GP109 "Remote Emulation with the R&S®SGT100A SGMA Vector RF Source " available at:
https://www.rohde-schwarz.com/appnote/1GP109

1MA028: Rohde & Schwarz application note 1MA028 "IQWizard IQ-Signal Measurment & Conversion" available at:
https://www.rohde-schwarz.com/appnote/1MA028

R

R&S NRQ6 Power Servoing application sheet: Rohde & Schwarz application sheet of the power servoing functionality R&S NRQ6-K2 of the R&S NRQ6 available at:
https://www.rohde-schwarz.com/manual/NRQ6

R&S Pulse Sequencer software user manual: Rohde & Schwarz user manual of the R&S Pulse Sequencer software available at:
https://www.rohde-schwarz.com/manual/pulse-sequencer/

R&S WinIQSIM user manual: Rohde & Schwarz user manual of the R&S WinIQSIM signal generation software available at:
https://www.rohde-schwarz.com/manual/winiqsim2

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